Determinants of Technological Change in the Korean Machine Tool Industry: A Comparison of Large and Small Firms

by

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To my parents

Yong-han Kim and Ok-lei Lee,

and my family

Haeyoung, Jieun and Goeun

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Abstract

This thesis analyses the determinants of firm size differences in technological performance in a Korean industry, as an effort to improve the conceptualisation of technological change in the Third World. It argues that the neo-Schumpeterian approach, which is currently dominant in the study of Third World technology, does not seriously consider the dimension of firm size. Neglecting firm size differentiation can, however, lead to a tendency to devote insufficient attention to differences in technological behaviour and performance shown by firms of different sizes in developing countries, and in particular the role of small and medium firms in technological change. The existing literature on firm size and innovation in developed countries provides useful guidelines, but a special consideration is necessary given the different circumstances of the Third World in terms of form(s) of technological change and economic environment. In developing countries, where learning and adapting foreign technologies are the main forms of technological activities by industrial firms, the approach traditionally used for exploring the question of firm size and innovation in developed countries does not seem to be appropriate, because it tends to be limited to counting *major* innovations and exploring the conditions for such innovations. So the analytical framework for this study has been formulated in a way which enables it to capture(and reflect) the characteristics of developing countries.

The case study of 23 Korean machine tool firms(9 large and 14 small and medium-sized) found significant differences between large and small firms as regards both their level of technological capabilities and their rates and patterns of technological change. Although large firms appeared superior in most of the aspects compared, the gap was uneven. Small and medium firms have not been stagnant in technological efforts. Large firms seem to be clearly superior in terms of product manufacturing capability and R&D, but not in terms of indigenous design capability. Among the different types of technological change classified in this study, large firms showed higher performance in formal and relatively major(i.e. expensive) types, while small and medium firms performed well in informal and minor ones.

Determinants of these differences in technological performance were examined in terms of size effects, labour market factors, capital market factors, product market structure, state policy and firms' internal organisation. Among them, size itself and factors concerning capital market, product market and state policy seem to have been important. Ultimately firm size and state policy appeared as the primary factors which determined the firm size differences in technological performance, either directly or indirectly(i.e. *via* other factors). As for the relationship between the two, the bias in state policy towards large firms seems to have been more a product of the state's autonomous decision rather than a consequence of the stronger political influence of these firms.

In general, this study confirms the importance of making a distinction about firm size when studying technological change in Third World countries, and suggests that a careful consideration of sectoral differences is required to enhance the relative advantages of large and small firms in technological innovation and to maximise the consequent benefits.

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PART I

The Issue of Firm Size and Technological Change in the Third World

Chapter 1
Introduction

1-1. The general purpose of the study

It is increasingly recognised that 'technological change' is essential to achieving economic development. (*Technological change* is defined here as all major and minor changes in the transformation of inputs into outputs of production, including those leading to wholly new products or processes.) This recognition was initially drawn from the experience of advanced industrial countries where sustained economic growth has largely been propelled by such technological change since the Industrial Revolution (Landes, 1969; Rosenberg, 1976). From the latter 1970s however, research on Third World countries began to point out that some of these countries,too, have benefited greatly from improvements in technology and productivity in their process of industrialisation and have achieved rapid economic growth based upon such changes. This new recognition of the active role of technological change in the Third World development has been largely contributed by a newly emerged approach, often described as 'neo-Schumpeterian' in the literature (for a useful survey of this, see Fransman, 1985). Studies emanating from this approach have persuasively reasoned that the successful economic performance and international competitiveness of the so-called 'newly industrialised countries'(NICs) owed a great deal to their efforts in the area of technological change. In other words, the success of NICs like Korea and Taiwan is not simply the result of comparative advantage *given* by their relative factor prices (especially, cheap labour costs) as has been conventionally argued in neo-classical-type explanations (see Chapter 2), but can be ascribed to the process of acquiring, using and generating technology by the countries and the consequent increases in productivity of their industries. Apart from the import and adoption of foreign

techniques, the successful countries have also made conscious efforts to develop the indigenous technological capabilities which are necessary for both the successful assimilation of foreign technology and the generation of local innovations[1]. Not surprisingly, a major feature of the neo-Schumpeterian approach lies in its new characterisation of technological change itself. In contrast to the neo-classical model, which regarded technological change as *exogenous* to the economy (especially in the case of developing countries, for most of the technologies they use are seen to be just 'transferred', i.e. without change, from advanced countries), it attempts to explain technological change as an *endogenous* phenomenon, i.e. one which is largely conditioned and shaped by factors internal to an economy. Accordingly, considerable investigations have been undertaken into not only grasping the dynamic process of technological change *per se* but also identifying the main determinants which influence the extent and the form(s) of such change. If economic growth is really critically dependent on technological change, to understand the latter's determinants is very important for a country to formulate an effective strategy to promote its technological, and thereby economic, development. In this respect the neo-Schumpeterian literature has made a significant contribution by shedding light on some of the major determinants. Among most frequently discussed ones in the NICs context are, for instance, the firm's entrepreneurial capacity; competitive pressures in domestic and international markets; protection and other forms of state intervention; and the role of the capital goods industry (see Fransman, ibid.; also papers by Stewart, Ranis, Katz, Lall and Westphal et al. in Fransman & King, 1984).

However, despite considerable theoretical developments such as above, it seems still true that many important determinants of technological change in Third World countries

[1] There are vast numbers of studies on the subject of technological capabilities in NICs by now. A most recent survey of such research is Dahlman, Ross-Larson and Westphal (1987), which reports the major findings of a World Bank research project (RPO-672-48) on "The Acquisition of Technological Capability".

remain unexplored or at best poorly understood. This study attempts to fill part of this gap by dealing with a variable regarded as a principal factor which brings about inter-firm differences in technological change : namely, firm size. In general large and small firms are believed to show different performances in technological change because of either their different capacities to cope with the costs and risks of innovation or their different behavioural and organisational characteristics (Rothwell and Zegveld, 1982). Depending on the point of emphasis on either of those aspects, disagreements over the appropriateness and relative contribution of large and small firms to innovation have existed among researchers on technological change (ibid.). Although this debate concerning firm size and innovation is of long standing in advanced countries, it has been largely neglected in the current neo- Schumpeterian literature on technological change in the Third World. This is rather ironical in that it was the work of Schumpeter himself which originally provoked the debate (see Kamien and Schwartz, 1975 and 1982). Most of the existing studies from the neo-Schumpeterian perspective have been devoted to finding out how Third World countries acquire and develop their technological capabilities and explaining the sources of their success or failure. The lack of attention to the issue of firm size could thus stem from the very focus of their interest : for them whether a country (or sector) as a whole is successful or not is far more important than what roles large and small firms have respectively shown in it. Since the performance of each country (or sector) is often represented by its bigger firms, it is not surprising that most of the empirical studies have tended to describe the activities of *leading* firms only, leaving those of the rest, a large number of *un*-leading and smaller firms almost unexplained [2]. Consequently, little is known about the role of small and medium firms in technological change within Third World countries. This may be partly due to the problem of less information being available on these firms, but the main reason must be the biased attention of the existing research as was mentioned above. In any case, without a clear distinction being made

[2] To our knowledge, the rare exceptions which explicitly distinguish large from small firms in their analysis are Katz(1984) and Pack(1981).

between large and small firms in research, there is a danger of assuming that all firms in developing countries operate in more or less similar environment and thus follow a homogeneous pattern of technological behaviour, i.e. such as shown by *leading* firms. At least in the more industrialised developing countries, like the NICs, the differentiation of size among firms seems to be so evident as to make such perceptions simply unrealistic. More to the point, blurring the heterogeneity amongst firms of different sizes tends to leave out the question of the role of small and medium firms in technological change in these countries (for instance, their specific contribution to innovation, their particular dynamics and problems in technological change, and so on). And if this question is ignored, then the (potentially) crucial role of small and medium firms as 'seed beds' of technological entrepreneurship and creators of new jobs and economic regeneration (Rothwell and Zegveld, 1982) will be missed in subsequent policy considerations. The important role and specificity of small and medium firms is demonstrated by the fact that most advanced countries have a separate policy on these firms (ibid.). So our study is based on the premise that firms will show significantly different technological behaviour according to their size difference, although this may vary from country to country, from sector to sector. In fact, differences in the technological behaviour between large and small firms might be greater in Third World (than in advanced) countries. In many of these countries, large and small firms often start on completely different initial scales and technical bases due to, say, state intervention or foreign investment and operate under very imperfect market conditions (Sagasti, 1980: 36). A broad aim of this study then is to redress the gap in the neo-Schumpeterian literature by illuminating the importance of such firm size differences to technological matters, and to identify the implications of this for the strategy of technological development by Third World countries.

An examination of the issue of firm size and technological change in the Third World context poses many new questions and might yield quite different results from the

case of advanced countries. This is mainly because Third World countries are distinguished from the advanced countries in the following two, closely related, characteristics: (1) they are located in the earlier stages of industrialisation ; (2) they can be regarded as 'technology followers',i.e. not leaders of the world technological frontier. The first condition implies that only 'relatively low' levels of knowledge are necessary for Third World firms, while the second one is often associated with a major advantage as a late-developer in the world economy, i.e. the possibility of reducing the high costs and risks involved in inventing new technology. To quote Fransman who combines these two conditions (op. cit.: 610 ~ 611),

> "....there are important advantages in a firm or country being a technology follower. Most importantly, the costs of knowledge and risk are reduced, thus facilitating increases in productivity at relatively little cost. This relates closely to the 'depth of knowledge' discussion above, suggesting that only relatively 'shallow' levels of knowledge are required in adopting a technology-following position behind the world technology leader(s)."

The rise of Japan and the NICs has often been suggested as evidence of the possibility of rapid growth by exploiting the advantages pertaining to a technology follower. As a result of the above two conditions peculiar to Third World countries, the content of their technological change is actually quite different from that in advanced countries. It is not about new technologies to move the world technological frontier, but consists of the activities of absorbing or adapting foreign technologies. Therefore, from the viewpoint of a world technology leader, most technological changes in Third World countries can be thought of as merely 'minor' (or incremental).

The important point here is that the requirements of this minor type of technological change could be significantly different from those in advanced countries where new inventions and innovations are of paramount importance. Accordingly, the relative opportunities and problems of large and small firms in technological change may also be

very different between Third World and advanced countries. The existing models or conclusions on the issue may have to be considerably modified in the Third World context. The central question is : in the position of a technology follower whose main focus is on 'searching' and 'learning' foreign technologies rather than on radical innovations, which size group of firms is more efficient, and why ? If the greatest disadvantage of small firms in technological change lies in their inability to afford large R&D costs and cope with high technological and market risks, the conditions of a technology follower, i.e. the lower knowledge requirement and the possibility of reducing costs and risks, seem to be certainly more favourable to these firms than in the case of a country with technology leadership. Besides, other conditions can also operate in favour of small firms: the smaller size of the local market, the shorter history of industry (especially in the case of the capital goods sector), and the possibility of exploiting advantages of being a technology follower to large firms within their own countries (as implied in the above quotation of Fransman's) may all help further the position of small and medium firms in the Third World.

On the other hand, their disadvantages also abound. Apart from their usual financial and market weaknesses, there are at least two conjunctural disadvantages, applying to the NICs in particular. First, when a country progresses from the earlier stages of industrialisation to the later stages, like in most NICs today, it increasingly requires 'deeper' levels of knowledge, and thus greater costs become necessary. Second, in the present micro-electronics-based 'technological paradigms' (for an elaboration of this concept, see Dosi,1982 and Freeman, Clark and Soete, 1982), industrial technologies have become more science-based than before and thus more R&D efforts are needed for innovation. Therefore, though the position of small and medium firms in Third World countries may be considerably different from that of their counterparts in advanced countries, it cannot be said to be always more advantageous than the latter. And we may well expect that the question of firm size and technological change will be as complex as in advanced countries.

Given the above theoretical and empirical context of the issue, this study will address the following questions by referring to the experience of NICs specifically : (1) what are the comparative performances of large and small firms in technological change in a developing country, pursuing the course of a 'technology follower' in the international economy ?; (2) what kind of factors operate as the relative advantages and disadvantages of large and small firms in such a case, and how are these results different from (or similar to) the existing findings on advanced countries?; (3) in order to promote effectively the overall rate of technological change and to maximise its beneficial effects in a developing country, what kind of policy is most desirable concerning large and small firms ?

The exploration of these questions is likely to further our understanding of the determinants of technological change in the Third World. But it must be noted that considering firm size is not merely to add 'one' more determinant of technological change to our existing knowledge of other such determinants at the firm level. As firm size is often regarded, and in fact used, as a proxy which sums up various conditions and characteristics of different firms, to consider it helps us to examine, concomitantly, other important determinants of technological change as well. So we would approach the issue of firm size not in its isolated relationship to technological change but as a particular dimension of the broader problem of the determinants of *inter-firm differences* in technological performance and productivity (see Nelson, 1981 for this latter issue). Our study seems useful for practical purposes too, for it can provide lessons on technology policy, especially for lesser developed Third World countries where most firms are smaller than those in the NICs. It will help them to decide whether fostering larger firms is necessary for successful technological 'catching-up' and economic growth. Also regarding the NICs, this may offer an important clue for explaining why even NICs with similar strategies of industrialisation, e.g. Taiwan and Korea, have shown significantly different development patterns, say, in terms of industrial concentration. This is because development patterns and the structure of international competitiveness

are likely to be significantly influenced by the relative contribution of firms of different sizes to technological change in each country.

1-2. The case of the Korean machine tool sector

Having pointed out the importance of the issue of firm size and technological change in Third World countries, we must add that it is unlikely that any 'general' answer, valid for the whole industrial sector, exists. As one expert who has dealt widely with the subject in the context of advanced countries suggests, "the debate concerning firm size and innovation should proceed on a sector-by-sector basis" (Rothwell, 1984 : 21). So this study attempts to explore the above issue through a case study of one of the most important branches of the capital goods sector, viz. machine tools, in a prominent example of the NICs : Korea. The relevance of the Korean machine tool industry to our study is suggested below:

Firstly, the machine tool industry is generally regarded as strategic, because it has special importance in economic growth and technological diffusion as the sector of 'Mother Machines' (i.e. the machines to make all other machines). The capacity to produce capital goods, and machine tools in particular, has been associated with a developing country's capacity to overcome technological dependence (Merhav, 1968). Not surprisingly, it has been promoted as a priority industry in Korea as well as in all the rest of the Asian NICs. Therefore, it provides a good example not only of the overall technological level of a country, but also of the performance of Korea (and other NICs) in technological change as a 'technology follower', and is useful as well to examine state intervention and other factors which determine such performance.

Secondly, in spite of being a heavy industry, it is believed to have only 'modest' scale economies because it traditionally depends on high skill-intensity, small batch production and volatile demand of a cyclical nature. Nevertheless, the production of

machine tools needs a sizeable amount of capital investment and involves considerable design and R&D costs. So it is one-sidedly advantageous neither to large nor to small and medium firms. Therefore, the relative strengths and weaknesses of large and small firms in technological change can be compared relatively well without too much influence from sector-specific bias.

Thirdly, the structure of the Korean machine tool industry shows a typical dual structure in which a small number of leading large firms account for a disproportionate share of output, with the more numerous small and medium-sized firms sharing the rest of it (see chapter4). This has much in common with other sectors in Korea where large firms, especially those belonging to *jaebuls* (i.e. Korean conglomerates owned by a few families), play the dominant role. Therefore, a study of the machine tool is not only relevant for these other sectors as well, but is also interesting to see why such a dual structure replicates itself in a sector with only modest scale economies.

Lastly, since 1975 the world machine tool industry has been undergoing rapid technical change following the introduction of micro electronics-based CNC (computer numerical control) machine tools. This has had an important impact on scale economies in the industry, though its implications for the opportunities for firms of different sizes are rather dubious (Jacobsson,1984; Watanabe, 1987). There is much debate about the impact of microelectronic innovation on the growth prospects of developing countries, and the NICs in particular (see Fransman, 1984 : 21-24). It is a very interesting subject to see how the NICs respond to such innovation, and what implications it has on different size firms within them. So the Korean machine tool industry is a relevant case in this regard as well.

Before moving to the case study of the Korean machine tool industry, we need to have a deeper understanding of the problem of firm size and technological change in the Third World and an appropriate framework to approach it in the context of Korea. To do this, we will review the theoretical issues and relevant approaches to our subject and thus attempt to extract from it some useful guidelines for the subsequent analysis in the next chapter.

Chapter 2
Theoretical Review

The purpose of this chapter is to review the theoretical issues and approaches relevant to the question of firm size and technological change in the Third World and to suggest a useful framework to approach this question through a case study on Korea. The chapter starts by discussing the background to the rise of the neo-Schumpeterian approach in the field of development economics and points out its contributions to the explanation of technological change in Third World countries. This is followed by an effort to identity the implications of the approach for the present study and a summary of some of the major concepts and analytical categories that will be explored in the subsequent analysis. After this, there is a brief review of the literature on 'firm size and innovation', i.e. a loosely categorised collection of research conducted on the relationship between size of firm and innovative activities by scholars in advanced countries. Although this literature has dealt almost exclusively with the experience of advanced countries and therefore must be interpreted with due caution in a study of Third World countries, the points of their analyses and of their findings provide broad guidelines for this analysis. In particular, this analysis will draw on their explanation of size advantages and disadvantages in innovation and integrate these into the analytical framework proposed at the end of the chapter.

2-1.The neo-Schumpeterian conceptualisation of technological change in the Third World

2-1-1. changes in paradigms[1].

A dramatic shift has occurred in the perspectives on technology in the Third World

[1] The ideas presented in this section owed greatly to Fransman(1985), although we did not exactly follow the framework of his explanation.

since the latter 1970s. The emergence and increasing dominance of the neo-Schumpeterian approach represents the central feature of this shift. To understand the background and significance of this, we need to look at what might be termed as 'paradigm changes', in the Kuhnian sense, in the broader field of development studies during the 1970s and their impact on the study of Third World technology [2]. Related to this, it must also be noted that such paradigm changes did not arise from purely intellectual reasons, but were closely related to important empirical events in the world economy, as will be indicated below.

Until the late 1970s the two paradigms which exerted dominant influences on most research on Third World technology were neoclassical economics and dependency theory (Sagasti, 1980; Stewart and James, 1982; Bell, 1983; Fransman, 1985). Around this time, however, their influence began to wane, in close connection with their decline as dominant theories of economic development in general. What factors contributed to such decline? In the case of neoclassical economics two initial reasons might be discerned: on the one hand, the 'stagflation' of the Western capitalist economics which was not anticipated or readily explained by neo-classical economics and, on the other, the theoretical attack on its logical inconsistency waged in the so-called 'capital controversy' (Fransman, 1984). Meanwhile, in a quite different vein, the neoclassical theory was also criticised by authors like Nelson and Winter (1974, 1977 and 1982) for its inability to come to grips with the actual processes and determinants of technological change. They argued that the central features of the neoclassical model, i.e. aggregation, maximisation and equilibrium, tend to suppress the diversity and change that are central to explaining technical advance. For example, Nelson, discussing the basic framework of the neoclassical growth theory (elaborated by the pioneering work of

[2]Although other areas of development studies have also been influenced by such paradigm changes, (for instance, growth and trade theories), it seems that it is in the area of Third World technology that their impact has been most decisive and has yielded rich research outcomes based on a new perspective. See Fransman(1984: 26, note 9).

Solow(1956) amongst others), pointed out:

> "Firms are the key productive actors, transforming inputs into outputs according to a production function. The production function, which defines the maximum output achievable with any given quantity of inputs, is determined by the state of technological knowledge. Technological knowledge is assumed to be public or at least this is implicit in models based on an industry or an economy-wide production function. Firms choose a point on their production function to maximise profits, given product demand and factor supply conditions. Generally these markets are assumed to be perfectly competitive so that a firm treats prices as parameters ...Over time, output grows as inputs increase and firms move along their production function, and as technology advances. Assuming differentiability of the production function, profit maximisation, and factor price taking on the part of the firms, the elasticity of output with respect to any input equals its share of total factor returns, at least for small increments to inputs. Proportional output growth due to input growth along the production function equals the sum of share-weighted proportional input growths. The *residual* (if any) is a measure of production function shift, or technological advance. There clearly are some strong presumptions here. The view of firms and markets is very stylised---not much room for incompetent management, labor-management strife, or oligopolistic rivalry. Technological advance, *while acknowledged as a central feature of growth*, is treated in a very simple way, and the Schumpeterian proposition that technological advance (via entrepreneurial innovation) and competitive equilibrium cannot co-exist is ignored....The sources of growth are viewed as operating independently and additively...The institutional environment is very simple - there is no particular place in the structure for labor unions, banking system, schools, or regulatory regimes." (1981: 1031; italics are my emphasis).

In the neo-classical model, therefore, technology is assumed to be *exogenously* determined (presumably, according to scientific advance) and the acquisition of technological knowledge (including new technology) is assumed to be unproblematical. Within the exogenously given technology, the choice of a particular technique is

automatically 'given' by relative factor prices and the assumption of profit maximisation. The so-called 'induced innovation' school is a leading example of this (e.g. Hicks, 1932; Ruttan and Hayami, 1971; Binswanger and Ruttan, 1978). In such a literature, no account is given of the *complex process which actually bring about* technological change. This is a fatal flaw in a theory of economic growth, when a large part of such growth is attributable, as many neoclassical theorists themselves acknowledge (e.g. Abramovitz, 1956; Solow, 1957), to technological change. As Nelson(ibid.) rightly points out, a satisfactory theory of growth must explain the following crucial matters related to growth: the determinants of productivity at the level of the firm and of inter-firm differences; the processes that generate, screen, and spread new technologies; and the influence of macroeconomic conditions and economic institutions on productivity growth. However, by assuming that technology is accessible to all firms, the neoclassical approach shifts attention away from these matters which have a central bearing on technological change and therefore on the performance of firms, industries and countries.

The increasing attacks on the neoclassical paradigm, and especially the kind of devastating critique made by Nelson and Winter around the conceptualisation of technological change, had a great impact particularly on the study of Third World technology. By and large, existing research in this field had been inspired, and moulded, by neoclassical-type questions such as: the labour and capital intensity of technology, the substitutability of labour and capital in response to changing factor prices, and the use of a production function in the estimation of the contribution of technology to output and productivity (Fransman, op.cit.). The dominance of these questions tended to limit the research agenda on Third World technology to 'choice of technique' or 'appropriate technology'.[3] In much of this research, not surprisingly, the central question of technology in Third World countries was often

[3] Or rather, the scope of the debate has been narrow because it relied on the neoclassical conceptual framework. "The choice of techniques debate has seldom broken out of a neoclassical mould." (Sutcliffe, 1984: 129).

presumed merely as a problem of rational choice *from the international shelf of well-known technological options* under their relative factor scarcities (Nelson, 1978). Little consideration has been given to questions about how technology is actually acquired, absorbed and changed over time by firms in these countries (ibid.). For instance, questions arising from the inherent uncertainty of technology acquisition, the costs necessiated for access to information, and the variation of success among firms in the absorption and use of technology have been largely ignored(Teitel, 1981). This is because such studies have implicitly accepted the misleading assumptions built into the neoclassical model - that is, technological knowledge is a public good and growth is an equilibrium process (Fransman,1985 and 1986b). However, as the shortcomings of this model became clear and the dominance of the neoclassical paradigm in general declined, old questions and preconceptions were gradually discarded and new questions began to be posed. The focus of attention increasingly shifted from the choice and appropriateness of techniques to the processes involved in the mastering and adaptation of technology (Stewart and James, op.cit.). Instead of rigid (and unrealistic) neoclassical assumptions, researchers began to acknowledge uncertainty and disequilibrium as central to the understanding of technological change and economic growth, following the viewpoint of authors like Nelson and Winter who were deeply influenced by Schumpeter's ideas on capitalist economic development.

The demise of the neoclassical paradigm was not the only source of this change, however. What facilitated, and also complemented, such change was the dramatic decline of another major paradigm of the 1970s: dependency theory.

Dependency theory had permeated into the discussion of Third World technology around the influential concept of 'technological dependency' in the early 1970s (Cooper, 1973; Stewart, 1977, chapter 5; Sagasti, 1980). The following quotation from Cardoso seems to express succinctly the main concern underlying this concept:

> "Basically the dependency situation is maintained because, in addition to the already stated factors of direct control by the multinationals and dependence on the external markets, the industrial sector develops in an incomplete form. The production goods sector (Department 1), which is the centre-pin of accumulation in a central economy, does not develop fully. Ordinarily, economists refer to 'technological dependency' and it means that the economy has to import machines and industrial inputs, and consequently has to stimulate exports (especially of primary goods) to generate the necessary foreign exchange." (quoted in Warren, 1980: 181-2).

Several aspects of technological dependency were discussed with regard to transfer pricing by multinational companies (Vaitsos, 1974), private technology appropriation such as patents (Vaitsos, 1973; Patel, 1974) and trademarks (O'Brien, 1976), technology market imperfections (Cooper and Hoffman, 1978), or the 'marginalisation' of scientific and technological systems in 'peripheral' countries (Cooper, 1973; Herrera, 1973; Halty-Carrere, 1979). It was suggested that developing countries had to pay extremely high prices for the technology that they purchased, whether as a result of their relatively weak bargaining power or covert pricing practices by MNCs. Also, technology imports were seen to replace local R&D activities and thus deprive the host economy of the opportunities for technological learning: hence the 'self-reinforcing' tendency of technological dependency. In the view of the dependency approach, therefore, indigenous technological development in Third World countries was seen to be impossible so long as their reliance on imported technology remained.

However, the dependency paradigm was under attack on both empirical and theoretical grounds and, consequently, lost much of its power by the late 1970s. First, the rapid rise of the newly industrialised countries in Asia and Latin America was the sort of phenomena which could be neither predicted nor explained by the pessimistic logic of dependency theory. The experience of these countries apparently proved that successful capitalist accumulation was possible in 'the periphery'. Second, another major blow to dependency theory came from the critique by Marxist writers such as Warren (1973 and

1980), who saw the rise of the newly industrialised Third World countries as confirming the Marx's view that capitalism would successfully take root when it was introduced into backward countries. Being stimulated by this new empirical and intellectual climate, researchers on Third World technology also began to challenge the validity of the 'technological dependency' argument, and found that underlying the economic success of the NICs there was in fact a significant degree of technological change within these countries. For instance, research done in the latter 1970s by Katz on Latin America and by Lall on India, and a little later by Westphal, Rhee and Pursell on South Korea, showed that countries such as these were able to successfully master foreign technology and use it for exports; and that important, though incremental, forms of technological change were occurring in these countries, resulting in the export of modified products and processes. These research findings suggested that local technological capabilities in developing countries had been underestimated and the assumption of 'blocked' technological learning by the reliance on technology import was too simplistic.

A more systematic criticism was made by Soete(1981) as regards the overemphasis of the dependency approach on the cost (i.e. transactional) aspect of technology transfer at the expense of its more crucial but not easily measurable, dynamic and positive effects (including all sorts of dynamic spill-over and diffusion effects as well as improved terms of trade, etc.). To quote him on this,

> "....there are what we would call the specific technological dependency fallacies, which, by reducing most of the discussion of technological dependency to the specific exchange value aspect of technology and focusing on the way the latter is used for 'the international redistribution of the economic surplus', ignore completely the crucial dynamic aspect of technology." (Soete, 1981: 181-182).

By the early 1980s a strong consensus on the weakness of the dependency approach had emerged among researchers on Third World technology, which the

following remark by Bell well summarises:

> "Recent empirical studies have made a significant contribution by throwing into question some of the unsubstantiated excesses in earlier discussions of 'technological dependency'. They have shown quite clearly that various forms of technical change do take place in at least the most industrialised of the peripheral economies. They have also shown that this technical change is generated by the active deployment of stocks of technical skill and knowledge - by the deployment of 'technology-capital' or 'indigenous technological capability'. However, they also suggest that doing that technical change by having learned was as common as learning by having done it." (1984: 203).

Therefore, although derived from criticisms of two very different theoretical paradigms, the changing direction of new questions posed by research on Third World technology in the 1980s was common: the shift of focus from a rather static concern in the past on the costs and appropriateness of imported technology to a more dynamic concern about technological *change* within Third World countries. In particular, there was an increasing interest in explaining the determinants of technological development by the more successful developing countries (i.e. the NICs), not only because they represented important cases for theoretical reasoning but also because they were expected to suggest useful policy implications for the less industrialised Third World countries. So, what are the characteristics of the newly emerged, and now increasingly influential, neo-Schumpeterian approach to the explanation of technological change and its determinants in Third World countries? We now turn to this question.

2-1-2. The characteristics of the new approach

Some of the main features of the neo-Schumpeterian approach were briefly mentioned in the previous section. What follows is a more systematic introduction to its characteristics, and to some of the major contributions it has made [4].

[4] The focus here is limited to the literature devoted to the study of Third World technology.

a. uncertainty in technology acquisition

In the neo-Schumpeterian approach uncertainty is central to understanding technological change. The acquisition of new knowledge, whether by original R&D effort or by technology transfer, inherently involves a degree of uncertainty. First, the outcome of attempts to create new knowledge is uncertain. Certainty requires complete knowledge, which in turn precludes the possibility of creating new knowledge. Thus an essential feature of R&D is its uncertainty "about which of a vast set of potential designs or solutions will prove the best" (Nelson, 1981: 1046). As already noted, this is a major departure from neoclassical theory which assumes public technological knowledge and an automatic choice of techniques under given factor prices. Second, uncertainty is also inherent to technology transfer. This may sound strange because the transfer of a technology, as Rosenberg perceptively points out, "is too frequently thought of as merely a matter of transporting a piece of hardware from one location to another" (quoted in Teitel, 1984: 39). But when a firm introduces a particular technique used by another firm, the transfer always involves a variety of idiosyncratic problems to be digested before the technique functions satisfactorily in the new environment. What matters here is those aspects of technology which are often called 'firm-specific' skills or 'tacitness' of technology. As Dahlman et al. (1987) put it, "many elements of technology are tacit: they can be understood and effectively used only through experience of the circumstances of their use" (p.773). Because of such tacitness (or sometimes called 'implicitness'), the process of assimilating and reproducing imported technology requires a firm to solve numerous problems, the answers to which are not always given by the seller of the technology.

The existence of uncertainty in technology transfer has major implications for Third World countries, for the acquisition of technology by them, characterised by a heavy reliance on technology transfer, is not as simple as it has been usually assumed

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Consequently, another major area of the neo-Schumpeterian work, centring around the idea of 'long waves', is excluded. See, for example, Mensch(1979), Freeman(1981) and Van Duijn(1983). Freeman et al.(1982) is a good introduction as well as an important contribution to this literature.

(Nelson, 1978). The problems to be solved before a successful assimilation are particularly significant in 'north'-'south' transfers, since the conditions under which the technology was developed differ substantially from those in the recipient country (Teitel, 1981). Adaptation of the technology would be a necessary task simply for accomplishing production under the latter's different conditions (ibid.). Therefore, one of the most important points made by the neo- Schumpeterian approach is that the assimilation and reproduction of technology involves a process of technological *change*, however minor. Based on this refreshing perception, some empirical studies (notably the pioneering works by Katz and Lall) convincingly showed that these changes in some cases led to the emergence of a different 'technological trajectory' [5] from that prevailing in the richer countries. In turn, this led to the appearance of products and processes that were sufficiently different from those produced in the richer countries to show up in figures of (mainly 'south-south') exports of technology in various forms.[6]

b. learning and technological capabilities

Absorbing the technology transferred requires technical skills and knowledge for its adaptation to local conditions, and in turn this adaptation increases the stock of such skills and knowledge, thereby enhancing the capacity for further technological change. Authors like Bell, Scott-Kemmis and Satyarakwit(1980), Maxwell(1981) and others have focused on exploring the processes by which technical skills and knowledge are acquired by individual firms. The term 'learning' is generally used by them to express the processes, while 'technological capabilities' designating the acquired technical skills and

[5] The concept of a 'technological trajectory' was introduced into the technology literature by Rosenberg and Nelson and Winter. Following Nelson & Winter (1977), "there is a sense that innovation has a certain inner logic of its own... advances seem to follow advances in a way that appears somewhat "inevitable" and certainly not fine tuned to the changing demand and cost conditions" (pp. 56-7).

[6] For technology exports by newly industrialising countries, see a special issue on it of *World Development*(edited by Lall), Vol. 12, No. 5/6, 1984.

knowledge. In short, 'learning' is used to refer to the acquisition of increased technological capabilities. Maxwell(ibid.) breaks it down into several different elements and suggests a more detailed definition of learning as follows:

> "The set of processes by which firms accumulate technical knowledge, know-how, and experience relevant to the planning, construction, operation, adaptation, improvement and replacement of production processes" (pp. 19- 20).

As implied in Maxwell's definition, the mechanisms of learning, as well as its outcomes, are diverse and very complex. Increasingly commentators found it necessary to introduce distinctions between various types of learning and thereby advance the opening of the technological 'black box'(see Rosenberg, 1982) involved in a firm's technological progress over time. Bell(1984) distinguishes between two broad categories of learning, and this distinction has important implications for technology policy. He distinguishes between doing-based learning, or more often called 'learning-by-doing', and learning which is based on mechanisms other than doing. The first category includes those mechanisms where learning is a costless 'by-product' of doing (and Bell includes here "learning by operating" and "learning by changing"), while the second one refers to learning which involves explicit effort and investment, i.e. the allocation of resources for learning (that is, "system performance feedback", and "learning by training", "by hiring" and "by searching")[7] . Although R&D is normally distinguished from learning, it may also be included in the latter category of learning, *in its broad sense*, since it clearly is a form of direct effort to generate additional knowledge by investing resources for the very purpose [8].

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[7] For the more detailed explanation, and the examples, of each sub- category of learning, see Bell, ibid.

[8] In fact, Bell acknowledges this in his description of the whole mechanism of learning in an enterprise (ibid.: 190-191). But he excludes R&D in the later discussion, presumably because it is normally distinguished from the term 'learning ' (in this case, mainly 'learning-by- doing') in the literature.

Learning has often been discussed with the issue of infant-industry policy in developing countries. Various authors expressed the view that protection was necessary to promote learning, and hence technological progress, in their infant industries (e.g. Cooper and Maxwell, 1975; Lall, 1980; Westphal, 1981; or Fransman, 1982). But in many of these studies, as Bell(ibid.) criticises, 'learning' tends to be assumed to be only a function of experience: in other words, they focus only on 'doing-based' mechanisms of learning. Consequently, protection for doing is seen to be essential for enhancing learning. However, such protection may be inapproriate, or even counter-productive, if non-doing-based learning processes are also important as sources of increased technological capability. In relation to this, it is particularly important to know that the relative significance of different types of learning mechanism can change quite radically during the technological evolution of firms and industries. According to Bell(ibid.), 'qualitative discontinuities' in the path of technological development (e.g. shifts to much more sophisticated types of technology or to higher levels of technological capabilities) make explicit investment in technological capacity necessary. Since these discontinuities are often, but not always, demanded by changes in product and factor markets, stimuli for 'explicit' learning effort tend to decrease under protectionism. But it needs to be remembered that the latter type of learning requires additional investment. Thus competitive pressures may also be counter-productive if firms are unable, even with all the resources at their disposal, to meet such competition successfully (see Fransman, 1985: 595). Therefore, authors acknowledging this delicate problem of infant industry policy for learning suggest the need for a careful 'sequencing' of learning of technological capabilities (for instance, Katz, 1984a & 1984b; Dahlman et al., 1987). A sequence of learning enabling a gradual progression from 'lower' to 'higher' levels of technological knowledge has usually been recommended, although the difficulty of devising such policy in concrete terms has been recognised.

The sequencing question is closely related to the transition from the earlier to the later stages of industrialisation. If the relative significance of non-doing-based learning

mechanisms (including R&D, in this case) tends to increase according to such transition, the increasing costs inevitably associated with them may become a major burden for firms in the developing countries moving into a higher plane of industrial development. This also has important implications for the issue of firm size in such countries, as we will see later.

c. forms of technological change

When technological capabilities, acquired through various mechanisms of learning (including R&D), are actually applied to the production process and thereby lead to changes in the transformation of inputs into outputs, technological change occurs. As mentioned before, probably the most significant contribution of the neo-Schumpeterian literature lies in its recognition of the existence of technological change in Third World countries. Put simply, such change is *necessary* because of the uncertainty (including adaptation problem) involved in technology transfer, and is made *possible* with the knowledge and skills acquired through various learning processes. What, nevertheless, distinguishes technological change in Third World countries from that made by advanced industrial nations is its 'incremental' nature. In fact, one notable difference between the neo- Schumpeterian approach and the original view of Schumpeter lies in its stress on the significance of minor forms of technological change. This contrasts with Schumpeter's exclusive concern with major innovation. Since Schumpeter's original work, economists have tended to associate the term 'technological change' with major innovation. Rosenberg(1976: chapter4) describes this as a typical economist disease, which might be called the 'major innovation syndrome' [9]. Not surprisingly, both neoclassical and dependency approaches were no exception to this 'syndrome'. This explains part of the reason why they failed to 'see' technological change occurring in the Third World. The great merit of the neo-Schumpeterian approach is that it allows one to recognise various incremental forms of technological change, during and after technology transfer, produced by developing

[9] We quote this term from Soete (1981: 181).

countries . Katz's following description provides a typical example of this:

> "...specialised technical departments of medium size and large firms .... generate incremental units of technical knowledge in the areas of product design, process engineering and production planning and organization. They adapt foreign technology to the local environment and gradually build up a stock of proprietary technology and know-how highly specific to the firm. It is here where domestic technological capabilities actually appear and develop." (quoted in Fransman, 1985: 586).

As Lall(1982) points out, these activities will usually be well within the international technology frontier.

What, however, is commonly stressed by authors following the neo-Schumpeterian approach is that it would be wrong to underestimate the significance of incremental technological changes. They argue with some empirical evidence that the cumulative significance of such incremental changes may over time outweigh that of radical change. Dahlman and Fonseca's study (1978) on the technological development of a Brazilian steel plant (Usiminas) is a much cited case to support the argument. Using it as an example, Dahlman and Westphal (1982) argue:

> "Most of the technological changes uncovered in existing research can be characterised as minor, in the sense that they do not create radically new technologies but rather adapt existing ones. None the less, as shown by the example of the Brazilian steel plant, a sequence of minor technological changes can have a pronounced cumulative effect on productivity. In fact, the cumulative sequence of technological changes following the initiation of a new activity may have a greater impact on the productivity of employed resources than that produced by its initial establishment" (p. 115).

But such a finding is not restricted to developing countries. It is consistent with research finding of many studies on the process of technological evolution in

industrialised countries. Enos's study (1962) of the petroleum refining industry is a classical example.

Another point that is often stressed in connection with incremental technological changes in the Third World is that they are much less costly and risky than major innovations. This is so because the 'depth of knowledge' required for such incremental changes is relatively low. If we can divide technological knowledge into two different levels, i.e. 'know- how' and 'know-why' (a distinction made by Lall, 1984), for most developing countries at the early stages of industrialisation the former may be sufficient for their successful technological changes. The experience of Korea seems to demonstrate the validity of this judgement (see Westphal, Rhee and Pursell, 1981). In fact, this is inherent to the position of developing countries as a technology follower in the world economy. In such a position, no such great effort is needed as to generate new knowledge capable to move the international technology frontier. Absorbing, using and adapting existing knowledge generated abroad involve relatively small costs and risks. None the less, it must be recognised that a qualitative jump will inevitably be required at some stage of technological evolution, as we already mentioned above. As a country progresses into the later stage of industrialisation, the understanding of 'know-why' will be more and more needed.[10] Also, costs will increase as progression takes place to such 'deeper' levels of knowledge. Thus the ability of, and constraints on, firms and countries to make this progression may be important in determining longer-run progress.

2-1-3. the implications for the present study

So far we have reviewed the background to, and some of the main features of, the neo-Schumpeterian approach to the study of Third World technology. This section will

[10] The case of Japan shows, according to Ranis(1984), a progression from simpler production engineering skills through more complicated applied research to, more recently, basic research, rather than the other way round as usually supposed for other industrialised countries.

consider the implications of this analysis for the present study of the Korean machine tool industry. It begins by exploring some of the useful aspects of the approach for our study.

Compared with the earlier perspectives, whether the neoclassical model or dependency theory, the neo-Schumpeterian approach certainly represents significant progress in the conceptualisation of technological development in the Third World. By highlighting the existence of technological change in Third World countries and its significance for their industrial development, neo-Schumpeterianism effectively refutes the characterisation of these countries - implicit in both earlier perspectives- as merely 'passive recipients' in technology transfer. Such a characterisation not only neglects the necessity for active involvement and assimilation efforts by local firms in any successful technology transfer, but also fails to recognise the evolution of indigenous technological capabilities through learning processes associated with the experience of such involvement and efforts. If technology transfer is not an automatic process and if its results largely depend on the active role of the recipient firms, then it is not strange that varying degrees of success, as well as different forms of knowledge, can and have resulted from the transfer of an identical technology to different firms. It is on the basis of this insight that the neo-Schumpeterian approach has paved the ground to an understanding of why certain developing countries have shown more rapid technological and industrial change than the others, and how the former could develop 'technological trajectories ' significantly different from those prevailing in advanced countries,thereby becoming themselves exporters of technology. Korea, as a representative case of the NICs, is a good example of this. It has indeed become an important object of study for many researchers following the neo-Schumpeterian perspective in one way or another, and also often been used to generate empirical evidence of its validity. In general, therefore, the neo-Schumpeterian approach seems to provide a useful broad framework for the study of technological development in Korea. Moreover, its stress on the role of the capital goods sector (e.g. Lall, 1980; Dahlman and Westphal, 1982)

together with a number of significant investigations which have been made on the latter (e.g. Chudnovsky et al., 1984; various works in Fransman, 1986) provide ample reference points for our research on the machine tool industry. In our view, however, the most important elements of the approach of relevance to our study are its unique conceptualisation of technology acquisition (including learning processes), technological capabilities and forms of technological change. So these will enter our later analysis as major analytical categories, though being redefined for our own purposes.

One criticism which can be made about the current neo-Schumpeterian literature is that it lacks any serious consideration of the *dimension of firm size*. Most existing studies have focused rather exclusively on explaining how some developing countries could successfully reduce their technological gap with developed countries. The theme of 'catching-up' has dominated the motivation of most empirical studies, whether conducted on individual country bases or on comparisons of different countries. Consequently, rather little attention has been paid to the existence of firm size differentiation within these countries and the significance it might have for the performance of technological change or the pattern of economic development in each country. Since we already suggested this point in the first chapter, we would not repeat it in detail here. Suffice it to say that there is a danger of grossing over experiences of different size firms. The role of small and medium firms are particularly vulnerable to neglect in studies focused on 'catching-up' stories. This is especially likely in a country like Korea where a few leading large firms dominate the economy and have dazzled foreign observers with the splendour of their success in international markets. Not surprisingly, in contrast with large firms, relatively little is known about the role of small and medium firms in the Korean industrialisation. Despite the growing literature on Korea from the neo-Schumpeterian approach, existing research has done little to illuminate the specific role or problems of small and medium firms in technological

change in comparison with their large counterparts and what significance these could have on the country's structure of innovation and development. To overcome this shortcoming, therefore, we need to differentiate the size of firms in an empirical study on technological change in Korea and in other developing countries. In so doing, a focus on industrial and technological concentration must complement the one-sided interest in 'catching-up' in order to get a deeper understanding of the internal structure of the economy, on the basis of which such catching-up occurs.

The justification for a firm size distinction in relation to technological change can easily be found in the innovation literature on advanced countries. It is now a well established fact that in such countries large and small firms show different types of technological behaviour and have different strengths and weaknesses in innovation. So we will review the relevant literature in the following section. But there is a final point to be made before that: while the neo-Schumpeterian approach has given little attention to the issue of firm size, it nevertheless seems to contain some interesting, if indirect, implications for it. The latter are associated with the predominance of incremental forms of technological change in developing countries, the transition form earlier to later stages of industrialisation with its changing requirement of the type of learning, and a high degree of tacitness of technology in the machinery sector. We will discuss these later (see 2-2-3), combined with an assessment, from a Third World point of view, of the literature on firm size and innovation which we now turn to.

2-2. The literature on firm size and innovation

2-2-1. the debate: a summary view

It was Schumpeter who first suggested the ideas which have provoked the intense controversy surrounding the question of firm size and innovation. In his early works *The Theory of Economic Development*(1934) and *Business Cycles*(1939), Schumpeter gave central importance to the role of the entrepreneur as the agent of innovations. He

carefully separates the concept of invention from that of innovation (as well as their respective human agents). Important inventions or scientific breakthroughs can occur without being incorporated into innovations affecting industry. The innovation is the outcome of a process of combining production factors in novel ways to produce old products more efficiently or to create entirely new products. It is the act of entrepreneurship that transforms inventions to innovations, thereby bringing the former to their fruition. Successful entrepreneurs are rewarded with exceptional growth and temporary monopoly profits. But these profits will later be whittled away by the entry of swarming secondary innovators. This early model of innovation described by Schumpeter has been termed 'Model 1' by Freeman(1982: 211-214). Schumpeter's 'Model 1' can, therefore, be regarded as a model placing the dynamic of small-firm innovations at its centre.

In contrast, Schumpeter's later work *Capitalism, Socialism and Democracy* (1942) puts forward a model which essentially argues that large capitalist organisations now control innovation. The incorporation of inventive activities into R&D departments within large companies implies that innovation is now carried out largely independently of individual persons, but as a normal, internalised function of these companies. In Schumpeter's 'Model 2' (Freeman, ibid.), therefore, the innovating role of entrepreneurs is replaced by that of large firms which have increasingly strong market and financial power and superior research capabilities. Hence a tendency towards concentration of innovations in large firms is envisaged with increased market concentration, and *vice versa.*

This later model of Schumpeter's was further developed by Galbraith(1952 and 1968). In fact, it can be suggested that it is because of Galbraith that most people have tended to include only Schumpeter's later model as one of the two major hypotheses on innovation normally identified with Schumpeter.[11] In his work

[11] According to Kamien and Schwartz, the two 'Schumpeterian hypotheses' are: "(1) There is a positive relationship between innovation and monopoly power with the concomitant above normal profits. (2) Large firms are more than proportionately more innovative than small firms." (1982: 22).

American Capitalism (1952), Galbraith claimed that the era of the cheap invention was over and that the remaining costly inventions could only be undertaken with resources of the magnitude commanded by large firms. To quote a famous and much-disputed statement:

> "A benign providence .... has made the modern industry of a few large firms an almost perfect instrument for inducing technical change ... There is no more pleasant fiction than that technical change is the product of the matchless ingenuity of the small man forced by competition to employ his wits to better his neighbor. Unhappily, it is a fiction. Technical development has long since become the preserve of the scientist and the engineer. Most of the cheap and simple inventions have, to put it bluntly, been made. Not only is development now sophisticated and costly but it must be on a sufficient scale so that successes and failures will in some measure average out ... Because development is costly, it follows that it can be carried on only by a firm that has the resources associated with considerable size" (1952: 91-2).

However, some authors challenged the idea that the locus of inventive and innovative activities had definitely shifted to large firms. Jewkes and his colleagues argued in their classic study on invention (1958) that the importance of the large corporate R&D had been greatly exaggerated and that the creative independent inventor remained as the principal source of important inventions. Their argument has been supported by the empirical findings of Hamberg(1963) and others. But Freeman(1967) showed, through a re-examination of Jewkes et al.'s own data, that while universities, independent inventors and small firms made the major contribution to the more radical type of invention in the early part of this century, since World War II corporate R&D has played the dominant role.

Heated debates have continued concerning the relative importance of large and small firms as the source of invention and innovation. The main findings from various

empirical research on the relationship between firm size and innovative activity are summarised in Freeman(1982: chapter 6), Kamien and Schwartz (1982: 75-83) and Rothwell and Zegveld (1982). What follows is a few of the major conclusions from this. First, the evidence on firm size and R&D expenditure so far largely supports the view of those economists who postulated a high degree of concentration in industrial R&D activities. The OECD statistics (1967 and 1971) show conclusively that the performance of R&D is highly concentrated in large firms in all the industrialised capitalist countries. Despite the concentration, however, there is a far weaker correlation between research intensity and size of firm (Kamien & Schwartz, 1975). But it is important to note that the vast majority of small firms (probably over 95 per cent) do not engage in any formal R&D. In several countries those few small firms who do perform R&D have above average research intensities.

Secondly, evidence concerning the relative contributions of firms of different sizes to *inventive* output is limited. The results of a few studies on the frequency of major inventions by small firms or independent inventors are compared in Prakke (1974). They suggest that small firms and independent inventors have played a disproportionately large part in producing major twentieth century inventions. In particular, Jewkes et al. (op.cit.) made a strong case for this. Also, according to data from the United States, small firms show a much higher number of patents per dollar of R&D expenditure than large firms. This has been claimed as evidence of the superior productivity of small-firm R&D (see Rothwell and Zegveld, 1982). However, Schmookler(1966), the leading expert on U.S. patent statistics, provides evidence that, contrary to general belief, large firms in the U.S. have a lower propensity to patent than small ones. Small firms usually cannot afford *not* to patent and cannot wait long before they patent, so that patent statistics tend to exaggerate the contribution of small firms to inventive output, and that of private inventors. Moreover, it must be also noted that at least half the 'private' inventions in Jewkes'(op.cit.) subsequently owed their successful commercial exploitation to the development work of large firms.

Thirdly, there is the question of the relative contribution of small and large firms to *innovation*. It may be reasonable to postulate that small firms may have some comparative advantage in the earlier stages of inventive work and the less expensive, but more radical innovations, while large firms have an advantage in the later stages and in improvement and scaling up of early breakthroughs. There have been major advances in the evidence on the subject during the 1970's and 1980's. The two inquiries conducted by the Science Policy Research Unit (SPRU), in 1971 for the period 1945-70 (Freeman, 1971) and in the early 1980's for the period 1971- 80 (Townsend et al., 1982), seem to represent the most detailed data relating to firm size and innovation. Together they include more than two thousand important innovations introduced by UK companies in all major branches of industry during 1945-80. The most important findings are summarised by Freeman(1982: 139) as follows:

- small firms (employing fewer than 200 employees) accounted for about 12 per cent of all industrial innovations made since the war. This may be compared with their share of production and employment, which in 1963 amounted to about 19 per cent of net output and 22 per cent of employment;
- the share of small firms in innovation has apparently been fairly steady (Table 2-1), but their share of output and employment has been falling;
- the share of the largest firms (10,000 employees and over) in the total number of innovations increased substantially over the period, at the expense of medium-sized firms (1,000-9,999 employees).

Since the share of small firms in total R&D expenditures was only 3 to 4 per cent, they produced a much higher proportion of innovations than, their share of R&D, but much lower than their share of total output or employment. This seems to support the view that the innovative *efficiency* (i.e. innovations per unit of R&D expenditure) of small firms may be grater than that of large firms. But part of the reason might also be that because of a lower degree of functional specialisation in small firms, a higher proportion of their

innovative activities occur outside of what is defined as R&D activities (Wyatt, 1982).

Table 2-1. Percentage of innovations in each firm size category for five-year perid

No. of employees	1945-9 %	1950-4 %	1955-9 %	1960-4 %	1965-9 %	1970-4 %	1975-80 %	Total %
1-199	16.0	12.0	11.0	11.0	13.0	15.0 (11.0)	17.0 (12.0)	14.0 (12.0)
200-499	9.0	6.0	8.0	6.0	7.0	9.0 (7.0)	7.0 (6.0)	7.0 (7.0)
500-999	3.0	2.0	7.0	5.0	5.0	4.0 (4.0)	3.0 (3.0)	4.0 (4.0)
1,000-9,999	36.0	36.0	25.0	27.0	23.0	17.0 (19.0)	14.0 (13.0)	23.0 (23.0)
10,000 and over	36.0	44.0	50.0	51.0	52.0	55.1 (59.0)	59.0 (66.0)	52.0 (54.0)
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No. of innovations	94	191	274	405	467	401	461	2293

Note: Numbers between brackets for the periods 1970-4 and 1975-80 are the weighted percentage contributions, assuming the same sectoral mix as in the period 1945-69.

Source: J. Townsend et al., *Science and Technology Indicators for the UK: Innovations in Britain since 1945* , Science Policy Research Unit, Occational Paper No. 16,1982.

From the evidence suggested so far, it seems a reasonable conclusion that while Galbraith is right in believing that the large corporation predominates in contemporary industrial innovation, Jewkes is right, too, in believing the growth of professional R&D in the large corporation has not eliminated the contribution of small firms to industrial invention and innovation.

Besides the above general conclusion, some of the more specific conclusions and further developments of ideas need to be stated here. First, the distribution of innovations by size of firm varies a great deal between different branches of industry. Table 2-2 shows the result of Freeman's study(1971) relevant to this. Generally speaking, in the capital-intensive industries, both product and process innovations were produced mainly by large firms. The major exceptions are aerospace, shipbuilding and pharmaceuticals where, although capital-intensity is low, the development costs for most new products are very high. Small firms made their major

contribution in scientific instruments, machinery and electronics where both capital-intensity and development costs are low, and where entry costs for new firms are also low. These branches account for two-thirds of all the small firm's innovations reported. Although small firms made a significant contribution to innovation in such traditional industries as textiles, leather and furniture, the total number of innovations in these industries was relatively small.

Table 2-2. Share of small firms in innovations and net output of industries surveyed in the United Kingdom

1958 SIC MLH Number	1958 SIC title of industry	Percent share of innovations by small firms 1945-70	Number of innovations by small firms 1945-70	Number of innovations by all firms 1945-70	Percent share of net output by small firms 1963	Value of net output by all firms 1963 (£ million)
471-3	Timber and furniture	39	7	18	49	220
351	Scientific instruments	28	23	84	23	154
431-3	Leather and footwear					
450		26	5	19	32	157
335	Textile machinery	23	15	65	21	65
481-3	Paper and board	20	6	30	15	317
339	General machinery	17	18	108	14	409
332	Machine tools	11	4	38	18	100
411-15	Textile,carpets	10	6	63	18	670
417,419						
492						
364	Electronics	8	13	160	8	320
211-29	Food	8	3	38	16	814
381	Vehicles,tractors	4	3	64	5	733
276	Synthetic resins and plastic	4	2	52	12	77
370	Shipbuilding	2	1	59	10	215
271(1)	Dyes	0	0	22	7	35
272(2)	Pharmaceuticals	0	0	44	12	124
463	Glass	0	0	13	14	96
464	Cement	0	0	18	0*	41
383	Aircraft	0	0	52	2	185
321	Aluminium	0	0	16	10*	100*
311-13	Iron and steel	0	0	68	9	630
101	Coal	0	0	23	0	655
601	Gas	0	0	15	0	216
500,336	Construction,earthmoving equipment and contractor's plant	12	4	33	53	1931

* Estimated.

Source: Freeman(1971).

Secondly, the stage of the growth cycle of each industry is also very important. In the early stages of the establishment of a new industry, small innovative firms can play

a major role, but their importance may diminish as the industry matures and economies of scale are exploited. In fact, the prominent role of small firms in scientific instruments and electronics which is shown in Table 2-2 is closely related to this. Recently, there is a growing body of literature on 'new technology-based firms' (NTBFs)[12]. NTBFs are new, independent small firms established by entrepreneurs who seek to exploit technically innovative ideas. The role of these firms attracts special attention with regard to their ability to develop industries based on new technologies. Salient examples are semiconductors, computer aided design(CAD), microcomputers and biotechnology.[13] This literature suggests that NTBFs played a crucial role during the early phases of the evolution of these high-technology industries, most notably in the US. As the industries mature, scale economies become increasingly important and strong oligopolies are formed, a situation characteristic of the semiconductor and CAD industries today. Therefore, if we consider the relative contribution of large and small firms to innovation from the viewpoint of the industrial cycle, Schumpeter's 'Model 1' and 'Model 2' discussed earlier are quite consistent in a particular industry. Also, such relative contributions in the economy as a whole are not fixed, but can change considerably according to the resurgence of small-firm innovations in newly emerged industries.

Thirdly, on the basis of the above idea of the industrial cycle, authors like Rothwell and Zegveld have developed a thesis of the 'dynamic complementarities' between large and small firms (1982; Rothwell, 1984). They reject a tendency in the debate on firm size and innovation to emphasise *either* the role of small firms *or* that of large firms in innovation. Instead of this rather static approach, they stress the interactions between the two in the dynamics of industrial evolution. For instance, in both semiconductors and CAD the initial breakthroughs were made in the R&D laboratories of large companies which produced components and equipment for in-house use; it was

[12] For a good review of this literature, see Bollinger et al. (1983).

[13] See Rothwell(1984) for the cases of semiconductors and CAD (and biotechnology, too) and Kenney(1986) for the US biotechnology industry.

through the actions of NTBFs that these innovations were diffused into more general use. Again in both cases, the basic technological know-how, the entrepreneurs themselves and often the risk capital, derived from the original innovating large companies (Rothwell, ibid.). Therefore, according to Rothwell and Zegveld, both large and small firms are necessary and complement each other in the process of industrial evolution. This recognition seems to be an important step further for the debate on firm size and innovation.

Lastly, however, it is essential to keep in mind that small innovative firms (like NTBFs) are the rare exception rather than the general rule, in relation to the vast majority of small firms which do not perform any R&D. The latter can survive so long as the industries in which they are operating remain relatively unaffected by technical change. Also, we must not forget that even innovative small firms face a limit when the industry matures and thus high costs for large-scale development are needed. In this stage, however high a firm's research intensity may be, if its *absolute* size of R&D expenditure does not exceed a certain level it cannot survive in the market. Freeman's concept of the 'threshold' of R&D (1982: 146) describes this point. These basic facts about small firms need to be taken into account in any interpretation of data on firm size and innovation.

2-2-2. size advantages and disadvantages

In parallel with the attempts to measure the relative contribution of large and small firms to innovation, various explanations have been suggested for advantages or disadvantages related to size in terms of innovation. Since the purpose of our study is to understand the determinants of firm size differences in the performance of technological change, it seems appropriate to look at what the scholars in advanced countries have suggested about such size advantages and disadvantages in innovation.

It has already been indicated that Galbraith (1952) stressed high, and increasing, costs of innovation in modern times as the main factor which makes large firms adept at innovation. Other economists have suggested many other advantages accruing to large

size. For instance, Nutter(1956) indicates that large firms can hedge against the technical uncertainties associated with innovation by undertaking several projects simultaneously. And Nelson(1959) asserts that the diversified firm may also be more likely to find use, and a broader range of uses, for the uncertain outcome of an R&D project than will a single-product, firm. He implies that a single-product firm is unable to exploit an invention not directly linked to its primary product, through licensing to others or developing a new product line. Moreover, the advantage of an established name and reputation which is often associated with a larger firm is useful for this, because such a large firm can more easily enter a new market than a firm without such attributes. Also, it is indicated that R&D activity itself involves economies of scale (Kamien & Schwartz, 1982). Researchers tend to be more productive when they have more colleagues with whom to interact. Colleagues may have new insights or special familiarity with a problem that reduces the effort required to arrive at a solution. Moreover, a large research group may permit a greater division of labour. Each researcher can develop expertise in a particular area and rely on the expertise of colleagues when needed.

However, there may be some negative effects of firm size on innovative activity (Kamien & Schwartz, ibid.). In a large organisation, for example, unexpected research findings may be more likely to get lost in the shuffle than in a small firm. Researchers may also be less motivated in a large firm than in a small one because in the latter, their compensation may be more directly related to their performance. This and other disadvantages of large size seem to be indicated by the examples of several employees of a large firm leaving it to form their own company to exploit an innovation that the firm would not sponsor. A recent example of these is Steve Chen, one of the foremost supercomputer designers, who left Cray Research of Minneapolis, i.e. the leading U.S. supercomputer company, with about 45 members of his research team to set up his own firm after Cray refused his plan to build an ambitious new machine (*Time*, 28 March 1988).[14] Meanwhile, some economists believe that small firms have a number of

inherent advantages in innovation owing to their small size. Abernathy and Utterback (1979) argue that the character and atmosphere of small firms is one which is particularly suited to encouraging major product innovations. Most of empirical evidence and reasoning for this kind of argument come from studies on NTBFs (see Bollinger et al., 1983). Roberts, one of the pioneers of the study of NTBFs, attributes the success of such firms to the unique characteristics of technological entrepreneurs (such as a strong entrepreneurial heritage, young age, high educational levels, etc.) and other factors relating to firm formation, organisation and management (ibid.). Other researchers indicate that because of their loose and less bureaucratic internal organisation, small technology-based firms can keep abreast of rapidly changing market needs(ibid.).

Rothwell and Zegveld (1981: 180-184) provide us with a most comprehensive and well-balanced list of advantages and disadvantages of small firms in the innovation process. The advantages they suggest are: (i) through close contact with customers small firms are able to respond quickly and efficiently to both market and technological changes: (ii) dynamic and entrepreneurial management style enables small high-technology firms to react swiftly to take advantage of new opportunities and undertake boldly subsequent high-risk innovation projects; (iii) their easy and better internal communication enables a faster response to internal problem- solving as well as to changes in the external environment. On the other hand, the disadvantages are: (i) without a formal R&D department and sufficient R&D expenses, they often experience considerable difficulty in attracting and financing on a permanent basis qualified technical manpower; (ii) because of their lack of resources, they are at a disadvantage in gathering and analysing various crucial information on technology, marketing, government policies and so on - i.e. they are disadvantaged in external communication; (iii) their management can often run into trouble because of autocratic leadership or lack of managerial expertise; (iv) their lack of financial resources and difficulty in financing often constrain not only innovation (especially, high-risk projects) but also marketing startup with new innovative products;

[14] Other similar cases in the U.S. are reported in *Time*, 5 September 1988, pp. 46-48.

(v) economies of scale form a substantial entry barrier to small firms in some areas (such as automobiles, consumer durables); (vi) small firms experience considerable difficulties in coping with government regulations, because they are simply too burdensome, or the cost of compliance can be too high. Also, small firms might not possess either the technical or the legal expertise to cope with such regulations. In short, while small firms enjoy a number of advantages over large firms in innovation (such as flexibility, rapid response to market shifts and entrepreneurial leadership), they also suffer from many inherent disadvantages related to scale (i.e. lack of finance and qualified manpower, inability to obtain economies of scale in production and distribution).

A comparison of the advantages and disadvantages variously ascribed to large and small firms in innovation is suggested in a diagram form in Table 2-3 next.

Of course, these are only a summary of general points. Size advantages and disadvantages in innovation can vary in concrete situations. They depend, to a considerable degree, not only on sectorial characteristics (e.g. its technology, market conditions, stage of maturation) but also on country backgrounds. So what actually constitutes advantages and disadvantages in a specific case is largely a subject of empirical inquiry. Unfortunately, there seem to have been but a few empirical studies attempting to do this.

Table 2-3. Advantages and disadvantages* of small and large firms in innovation

	Small Firms	Large Firms
Marketing	Ability to react quickly to keep abreast of fast changing market requirements. (Market start-up abroad can be prohibitively costly.)	Comprehensive distribution and servicing facilities. High degree of market power with existing products.
Management	Lack of bureaucracy. Dynamic, entrepreneurial managers react quickly to take advantage of new opportunities and are willing to accept risk.	Professinal managers able to control complex organizations and establish corporate strategies. (Can suffer an excess of bureaucracy. Often controlled by accountants who can be risk-averse. Managers can become mere 'administrators' who lack dynamism with respect to new long-term opportunities.)
Internal Communication	Efficient and informal internal communication networks. Affords a fast response to internal problem solving; provides ability to reorganize rapidly to adapt to change in the external environment.	(Internal communications often cumbersome; this can lead to slow reaction to external threats and opportunities.)
Qualified Technical Manpower	(Often lack suitably qualified technical specialists. Often unable to support a formal R&D effort on an appropriate scale.)	Ability to attract highly skilled technical specialists. Can support the establishment of a large R&D laboratory.
External Communication	(Often lack the time or resources to identify and use important external sources of scientific and technological expertise.)	Able to 'plug-in' to external sources of scientific and technological expertise. Can afford library and informationservices. Can subcontract R&D to specialist centres of expertise. Can buy crucial technical information and technology.
Finance	(Can experience great difficulty in attracting capital, especially risk capital. Innovation can represent a disproportionately large financial risk. Inability to spread over a portfolio of projects.)	Ability to borrow on capital market. Abilty to spread risk over a portfolio of projects. Better able to fund diversification into new technologies and new markets.
Economies of Scale and the Systems Approach	(In some areas scale economies form a substantial entry barrier to small firms. Inability to offer integrated product lines or systems.)	Ability to gain scale economies in R&D, production, and marketing. Ability to offer a range of complementary products. Ability to bid for large turnkey projects.
Growth	(Can experience difficulty in acquiring external capital necessary for rapid growth. Entrepreneurial managers sometimes unable to cope with increasingly complex organizations.)	Ability to finance expansion of production base. Ability to fund growth via diversification and acquisition.
Patents	(Can experience problems in coping with the patent system. Cannot afford time or costs involved in patent litigation.)	Ability to employ patent specialists. Can afford to litigate to defend patents against infringement.
Government Regulations	(Often cannot cope with complex regulations. Unit costs of compliance for small firms often high.)	Ability to fund legal services to cope with complex regulatory requirements. Can spread regulatory costs. Able to fund R&D necessary for compliance.

Note(*): The statements in brackets represent areas of potential disadvantage.
Source: Rothwell(1984).

2-2-3. the peculiarities of the Third World context

As stated before, the debate on firm size and innovation has developed on the basis of the experience of advanced countries. But when it is extended to the case of Third World countries, significant modifications may be required to the assumptions implicitly underlying most of the existing research on the topic, and thus to the approaches used for analysis. In this section, we will critically comment on these assumptions and approaches from a Third Word point of view, by highlighting the substantial contextual differences that exist between developed and developing countries. In fact, it is here that some injection of the neo- Schumpeterian ideas from the earlier section can be of great help. The discussion that follows draws heavily on Sagasti (1980: 35-36) [15], Teitel(1981) and Katz(1984).

Broadly, two kinds of factors can be considered as constituting potentially critical differences: those related to the nature of technological activity, and those concerning economic environment. Among the former, first, while existing research on firm size and innovation assumes a situation where technology is developed through indigenous R&D, most technological activities in developing countries appear in and around the transfer of existing technologies in developed countries. This means not simply that there are few original innovations in developing countries, but also implies that the environment which determined the origin and evolution of technologies acquired by a developing country is largely exogenous to the latter. Therefore, models developed to explain innovative behaviour indigenous to a firm, industry or country, and findings from such models, have only limited, if any, relevance to the situation in developing countries. Secondly, the existing literature tends to focus on *major* innovations and neglects the small adaptations and improvements that are the main sources of technological change in developing countries. Most empirical studies on firm size and

[15] Although Sagasti(ibid.) does not follow himself a neo-Schumpeterian approach, in suggesting the contextual differences between developed and developing countries he frequently quotes the work of Katz and other authors following such an approach.

innovation count only major innovations.[16] Inevitably, such an approach misses the theoretical and practical significance of *minor* forms of innovation, some of which have recently been elucidated by the neo- Schumpeterian approach in a different context (see section 2-1). To explore the problem of firm size and innovation in developing countries, it is therefore necessary to take account of these minor innovations, although there are more empirical difficulties in identifying them than in the case of major ones.

There may also be several major differences between developed and developing countries in terms of their economic environment. First of all, the size and characteristics of domestic markets in developing countries differ widely from those featuring developed industrial economies. In the former, markets tend to be smaller, highly protected by import restrictions, less specialised among firms (though often more segmented among customers with different income levels, etc.), and thus characterised by much weaker competitive atmosphere and stronger market imperfections. So assumptions made by approximating the market conditions of developed countries do notapply to the situation in developing countries. Secondly, factor market characteristics are also different. Capital markets are often primitive and tend to be subject to heavy intervention by the state in the form of credit rationing in developing countries. Most firms, except a privileged few, operate with severe limitations on the financing of working capital. Access to foreign exchange is strictly controlled by the state. Also, there is usually an acute shortage of skills in labour markets. The problem is not always a shortage in the supply of scientific, engineering or technical personnel compared to firms' demand, but often lies in the irrelevance of their skills. Unionisation of workers is elementary and suppressed, so unions' power is much weaker than in advanced countries. Thirdly, the predominance of state intervention in the conduct of economic and industrial affairs alters the context in which firms operate in less developed countries. Having accepted the benefits (and constraints) of the government's protection, firms then react to market signals. Thus the incentives to innovate, the orientation of technological change, and the

[16] This is also true of the SPRU studies mentioned earlier (i.e. Freeman, 1971; Townsend et al., 1982).

access to the sources of technological innovation for firms in developing countries will be influenced by the government to a greater degree than for enterprises in developed countries. This, in turn, pushes the industrialists in the direction of becoming political pressure groups, and of acting beyond the economic boundary of the firm if they are to conduct their business successfully. Finally, though industrial concentration is common to both developed and developing countries, its origins are different. Most leading industrial firms in the latter do not *evolve* from small to medium and then to large enterprises. They start large, often with excess capacity, usually as a result of foreign investment or some form of state intervention. Small indigenous firms often remain small in a subordinate position and seldom have the opportunity to grow, evolve and challenge the leading firms in their respective branches. In addition, not surprisingly, a close co-operative relationship between large and small firms is largely absent in developing countries. Unlike in most developed countries where subcontracting networks are well established, such networks are lacking or highly imperfect in these countries. Consequently, a much higher degree of vertical integration is found at the individual firm level.

Given all of these contextual differences between developed and less developed countries, it seems very likely that the debate on firm size and innovation needs to involve significantly new terms of discussion in the context of the Third World. Both the nature of technological activity and the characteristics of economic environment in these countries mean that the relative advantages and disadvantages of large and small firms in innovation could be quite different from the situation in developed countries. Some conflicting effects may be discerned in this regard. On the one hand, as Teitel(1981 and 1984) points out, the minor, adaptation type of technological change characterising developing countries tends to reduce the degree of uncertainty inherent to the creation of knowledge. Also, such adaptive technological change generally requires much less R&D investment than in the case of major inventions and innovations, which result from considerable amounts of basic (and applied) research efforts. Accordingly, the type of

technological change dominant in developing countries seems to reduce much of the comparative disadvantage of small and medium firms in innovation. In addition to the condition of the smallness of domestic markets, the reduced risk and lower R&D costs are likely to operate as favourable conditions to small firms in developing countries. On the other hand, the characteristics of the economic environment prevailing in developing countries seem to be largely unfavourable to small and medium firms. Not only do these firms face their generally weaker competitive positions in product and factor markets, but the favouritism often shown in state intervention in these countries towards larger firms further weakens their position. Consequently, the shortage of finance, qualified manpower and other scarce resources (especially, information) in small firms can be more serious in developing countries. Therefore, while small, entrepreneurial firms may have been particularly important as a source of *major* innovations in some developed countries (e.g. the US and the UK), the same cannot be true in Third World economies, where the capacities of small firms are far weaker and institutional assistance for them is also generally poor.

Meanwhile, there are further issues more specific to our present study. For instance, Korea, like other NICs, is now going through the transition from the earlier to the later stages of industrialisation. This means that the country has reached the stage where the 'qualitative discontinuities', described by Bell(1984), i.e. shifts to deeper levels of technological knowledge, become necessary for further industrial development. Therefore, the relative significance of different types of learning has also changed: the costless learning-by-doing has become less important and, instead, R&D and other costly learning are increasingly required. This poses an interesting question regarding the issue of firm size, i.e. as costly learning becomes more important, are large firms developing greater advantages and becoming more appropriate in innovation than small and medium firms? In other words, with the transition to higher levels of industrialisation and technological sophistication inevitably lead a more significant role for large firms in Korea? On the other hand, the *sectorial characteristics* must also be

considered. As Nelson(1981: 1048) points out, the relative importance of learning-by-doing and deliberate R&D varies according to industries and technologies. In this sense, it is interesting to note Amsden's argument that in capital goods industries like machine tools, learning-by-doing is crucial for technological change and productivity improvements. In her study on the Taiwanese machine tool industry (1985), she argues that because of high level of tacit nature of technology in the industry, technological change depends greatly on skill formation through production experience. If so, this is a plus factor for small and medium firms, which have poor R&D resources but accumulated knowledge through learning on the shopfloor. This is especially so in the Korean machine tool industry, because most of the small and medium firms have longer experience of production than large ones in the sector, as we will see later.

In short, although we ascertained some of the significant peculiarities of the Third context concerning the issue of firm size and innovation, we find that, as in developed countries, there is no *a priori* reason to suppose absolute comparative advantage either for large or for small firms. So, in the Third World context also, the issue must be examined through empirical studies. The present study will be a contribution to this. However, this review of the relevant literature has given us some ideas to help construct an analytical framework for this study. We will suggest a brief description of this framework in the following section.

2-3. An analytical framework for the present study

As we stated in the first chapter, this study explores the following questions, with a specific focus on the experience of the Korean machine tool industry:

(1) the comparative performances of large and small firms in technological change in the context of a Third World country;

(2) factors operated as the relative advantages and disadvantages of large and small firms in such a case as (1);

(3) policy implications of (1) and (2).

To get answers to these questions, therefore, an investigation seems to be needed into the following two broad areas: first, an assessment of technological efforts by firms of different sizes and, second, the sources of firm size differences in such efforts. As far as the former is concerned, the traditional approach in developed countries seems to require some modification in a way appropriate to Third World peculiarities. The existing measures typically used for this purpose, i.e. R&D expenditure (total or as a percentage of sales), no. of patents or no. of major innovations, cannot properly capture the forms of technological efforts which are often of central importance in the Third World context. As the neo-Schumpeterian approach stressed, the main part of technological change in these countries tends to result from various efforts to search and learn foreign technologies and thus take the form of *minor* adaptations and improvements. Therefore, it comes from not only R&D personnel but also from production engineers and workers on the shopfloor, and rarely results in patents or major original innovations. The notorious difficulty of measuring technological change is thus even greater in Third World countries (see Fransman, 1985: 587-589). So it seems to us that the best possible way to undertake the first task is to adopt a kind of eclectic, or pluralistic, approach: i.e. to see and assess the various aspects of firms' technological efforts by using a number of relevant (both input and output) indicators available and thereby try to grasp the peculiar type of such efforts in the Third World as much as possible. We thus decided to inquire into these in the following three different categories: (i) the mode and source of technology acquisition; (ii) the level of technological capabilities; (iii) the rate and pattern of technological change. We will see if there is any significant difference between large and small firms in each category (see Chapter 5).

Meanwhile, the (possible) sources of size differences in technological efforts may also be broadly classified into two: the effects of size *per se* and those which are not. Among

the latter we can consider those factors constituting firms' external and internal environment, which are often affected by size but not inherent to size itself in the strict sense. For instance, the advantage of large firms in access to credit may be influenced by size, but it nevertheless is not an *attribute* of size as such, but rather a *consequence* of it in a certain specific context.[17] Therefore, the size advantages and disadvantages in innovation suggested by Rothwell & Zegveld (see Table 2-3 earlier) seem to be best regarded as a combination of the two. The reason why we distinguish between these two comes from both analytic and policy considerations: on the one hand, it seems necessary to separate the influence of size itself from that of other variables in attempting to explain the sources of differences between large and small firms in technological performance in our later analysis (because, only by doing so, can the independent influence of each of the latter variable be ascertained.); on the other hand, only through such discrete assessment of each variable can one draw on specific diagnosis and policy implications relevant to actual problem areas. Among such possible sources of size differences in technological efforts, we can include not only the factors usually regarded as size advantages/disadvantages in innovation but also those which have been suggested by various existing studies as determinants of technological change at the firm level. The latter represent the variables which are seen to cause inter-firm differences in technological change and productivity *in general*. (In this respect, the firm size differences are actually only a special case of these, although a very important one).

So there are great many variables to be considered as candidates of the possible sources of size differences in technological efforts. Through our own literature analysis, we found that we can classify them largely into the following six categories[18] : the

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[17] Parker(1978:72) makes a similar point as follows:

> ".... indicators of size really a catch-all for a wide variety of other influences which need separating. In effect it may not be size, as such, which is important, but the consequences of size. The character of the general arguments on the advantages of size only indicate potential benefits. The nature of the arguments makes it clear that size is really being used as a proxy for a large number of influences that may be conducive to technological commitment."

effects of size itself, labour market factors, capital market factors, product market structure, state policy, firms' internal organisation. In each of these categories, we included several variables which were thought of as most important in explaining differences between large and small firms in technological efforts and performance. Our focus of interest in each category is as follows:

1) size effects:
   - major advantages and disadvantages pertaining to firm size itself

2) labour market factors:
   - access to technical labour in the external labour market
   - degree of development of the internal labour market

3) capital market factors:
   - access to credit
   - diversity in channels of finance
   - internal financing capability

4) product market structure:
   - size and growth of markets
   - market share and segmentation
   - degree and structure of competition
   - market stability (or fluctuation)
   - customer characteristics

5) state policy:
   - bias in general industrial policy
   - bias in technology policy
   - protection of small and medium firms

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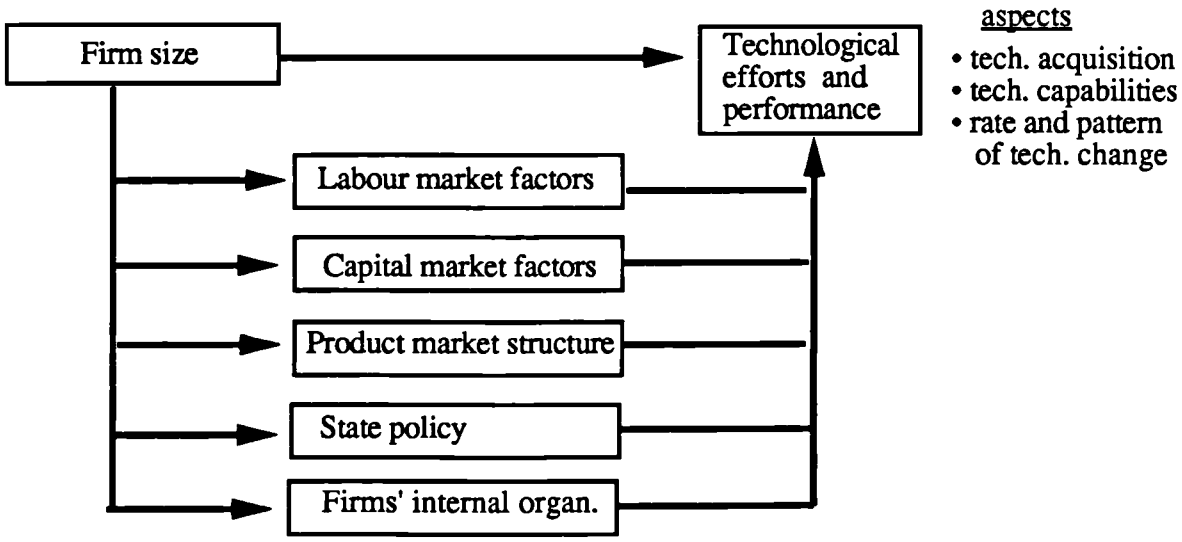
[18] At first, we supposed one more category: 'access to information and technology sources'. But later we dropped it as a separate category, because access to information is largely derivative of other factors, say, financial and human resources (see Rothwell & Zegveld, 1981 : 181). It also greatly depends on state provision of such services, especially in Korea. So we incorporated it into either the section on technology acquisition (see Chapter 5) or the discussion on state policy (Chapter 10).

- access to public information and technology sources
- access to policy-makers

6) firms' internal organisation:
- quality and style of management
- organisational structure / decision-making style
- internal communication and co-operation
- labour relations

This chapter has not reviewed most of the relevant literature on most of these variables. Rather, details of their specific theoretical backgrounds and our hypotheses based on them are included in later chapters(i.e. Chapters 6~11). To conclude, our analytical framework for the present study can be summarised as Figure 2-1 below.

Figure 2-1. An analytical framework for this study



Chapter 3
Research Methodology

3-1. Preparation for data collection

Choice of research method: The Korean machine tool industry was chosen as the object of our investigation, for the reasons outlined in the introductory chapter. It was clear from the analytical framework developed through literature review, that, to explore this framework, we would need to collect firm-level data. So a field survey of Korean machine tool firms was planned. A postal survey was judged inappropriate for this study. Instead, we determined to visit firms selected and to collect data through both personal interviews and written questionnaires. And, originally, in-depth case studies on one large and one or two small firms were also planned, in order to get a deeper understanding of the processes concerning how Korean machine tool firms have actually accumulated technological capabilities and what factors influenced this accumulation. Unfortunately this plan had to be abandoned because we failed to find managers who were either willing or sufficiently well-informed to promise sufficient time and information for us to do it. (Consequently, we could not get detailed data on such subtle topics as history of technological learning, nature of technological trajectories, policy influence on firms' innovative behaviour, role of political connections, etc. These could be studied only through close contacts with appropriate persons for a sufficient period of time.)

Preparation of questionnaires: Before designing the questionnaires, we classified the kinds of data needed in this study into three groups according to their (potential) sources: first, those which could be acquired from the outside of firms; second, those which are available in firms' published materials; last, those which must be filled in by firms themselves. The idea was to utilise the first and second categories as much as

possible so as to reduce the demands made on respondents. But differences seemed to exist between large and small firms in this regard. For instance, although most large firms could provide published materials containing general information about them, few small and medium firms seemed to be able to do the same. So we did not eliminate in our final question list all the data which could be included in the first two categories. Once we made a rough list of the questions to be asked, we split them into several types by considering both the character of questions and the type of respondents who can best answer each type of questions. Then we completed a detailed phrase and design of each question. In doing this, we tried to make all the variables (including many qualitative ones) into quantifiable forms as far as possible, thereby enabling them to be useful in our later statistical analysis. In consequence, seven different types of questionnaires were constructed as follows:

Type	Respondent	Method
1. General information	head office	fill in later
2. Management & market strategy	managing director	face-to-face
3. Top manager	chief executive	face-to-face
4. Manpower & employment	personal manager	fill-in-later
5. Labour relations	representative of union (or of workers)	face-to-face
6. Government policy	chief executive (or managing director)	face-to-face
7. Technological development	technology manager (or chief engineer)	fill in later

The questions on `General information', `Manpower & employment' and `Technological development' required substantial amounts of statistical information(see Appendix), and so questionnaires covering these areas were left with firms after field work visits for subsequent completion. But the other questionnaires could be filled in during the field visits. In addition to the above questionnaires, we decided to develop later some more questions for personal interviews after we visited some firms for pilot survey.

Sampling: The field work took place in between February and August 1985. To get some initial knowledge on the industry and the list of machine tool companies from which we could select our samples for field survey, we made contacts with several

people who were well-informed of or had recently researched the industry. Through these contacts, we came to know that most of the companies active in the industry, except some tiny and/or not easily identifiable firms, were members of the Korea Machine Tool Manufactures' Association (KOMMA), an industrial association which serves as both a representative of machine tool makers in Korea and a bridge between the latter and the government. From KOMMA, we were able to get their *Membership Directory* which listed their member companies together with their main products, addresses and telephone numbers. Since KOMMA covers different branches such as metal cutting machine tools, metal forming machine tools, woodworking machinery, parts and cast iron, it seemed necessary to focus on companies in one branch in order to generate data which would allow comparability among sample firms and a statistically significant analysis. We decided to choose metal-cutting machine tool branch because it represented the most important and typical branch of the industry in Korea (i.e. occupying more than 60% of its total machine tool production) as well as in most other countries. From the KOMMA Directory we identified 53 metal-cutting machine tool manufacturers in total. According the criterion of 300 employees [1], this group consisted of 11 large firms and 42 small and medium ones. From this group a sample of 9 large and 23 small and medium firms were selected. The selection followed a kind of cluster sampling on the basis of, mainly, locational considerations. In Korea, most large machine tool factories concentrate in a particular city, i.e. Changwon, as a result of government policy (see Chapter 4). Small and medium firms are scattered around the country, although many of them are located in suburb areas of Seoul. Therefore, to save time and costs it seemed rational to select firms as groups in these two areas and in other cities near or between them. We initially approached all of 32 firms, and were able to gain access in 23 ; composed of 9 large and 14 small and medium firms. Given that the total number was

[1] This criterion follows the Basic Act for Small and Medium Business in Korea. In 1978 the Act redefined the scope of small and medium business in manufacturing industry as the firms with up to 300 ordinary employees (the earlier criterion was 200 employees: See KFSB, 1985). Since then this criterion has been used in all the related policy-making and implementation as well as in official statistics.

53, this seemed to be reasonable enough to represent the population of metal-cutting machine tool manufacturing firms in Korea. They ranged from firms with less than 50 employees to those with over 1000 employees (see Table 3-1). They were scattered in 9 different cities (or to consider their geographical vicinity, in 5 different regions) (see Table 3-2).

Table 3-1. The size distribution of sample firms

No. of employees	1-49	50-99	100-199	200-299	300-499	500-999	over1000	Total
No. of firms	2	5	7	0	2	3	4	23

Table 3-2. The regional distribution of sample firms by size groups

	Regions					
Size group	Seoul/Kyunggi*	Daejon	Daegu	Changwon/Mansan	Kwangju	Total
large firms	2	-	-	6	1	9
small & medium firms	6	3	2	2	1	14

Note(*): This region includes cities like Inchon, Anyang and Buchon which are located in Kyunggi province, and within a commutable distance of Seoul.

3-2. Data collection and analysis

Field survey: The survey was conducted between May and early August 1985 (although some of the questionnaires were received until February 1986). Before the main survey, preliminary visits were made to three large firms located in Changwon as a pilot survey. This was done without using questionnaires. Our main aim was rather general, i.e. to get some first- hand knowledge on major trends in the industry, to see

realistically how much co-operation we could expect from firms in our survey, and to make connections with key persons in the companies for our later visits. We spoke to a managing director in one company and technology managers in the other companies. Since the companies were leading firms in the industry, they seemed to know quite well its technological and market frontiers and the strengths and weaknesses of them and their competitors in coping with these. During this pilot survey we discovered that it was probably not feasible to interview chief executives, even for a few minutes, in large firms, which meant that we would have to find alternative respondents for the questions designed for chief executives. These could be managing directors or other senior managers. We also found that Korean companies seemed to like a `formal' approach for a survey like ours, i.e. official letters form reputable institutions, formal procedures of contacts set by the companies, and so on. In addition, except brochures and catalogues direct access to company documents seemed to be extremely difficult.

To conduct the main survey, we succeeded in getting official letters from KOMMA and the Korea Advanced Institute of Science and Technology (the author's former base in Korea) and sent them to all our sample firms before visiting. Also, from KOMMA we managed to get the names of key persons in sample firms, through whom we could open contacts with the firms and get help for arranging interviews and so on. In general these people proved to be helpful during our survey. In Changwon, we also got extremely generous help from a director of a research department (specialised in NC technology) at the Korea Institute of Machinery and Metals. He not only briefed us on the general situation of machine tool companies in Changwon, but also arranged almost all the visits we made to firms in the city.

In large firms, we typically met respondents in the following order: technology manager ---> managing director (or a director of the board) ---> personnel manager ---> a representative of union (or a senior production worker). To complete the interviews in a company took between 4 and 5 hours on the average. After the interviews, a guided tour of plants was offered in most cases. There, we could have a look at some of the new

products which the companies had recently developed and the features of the production processes employed by each of them. A dominant impression from our experience in large firms was that, except two companies which had already been in financial troubles then, they looked quite optimistic about the prospects of their business. This seems to reflect both their leading positions in the market and a clear trend of the recovery of machine tool business at the time mainly owing to the booming car and electronics industries.

Meanwhile, interviews at a small and medium firm usually started with its chief executive or managing director. That is, a sort of `top-down' procedure of interviews was arranged in these firms. This was understandable in that a contact from the outside, like our survey, would only be permitted through the personal decision of top management in small and medium firms.

During the survey we experienced a number of problems. For instance, it was often difficult to arrange all the relevant interviews in a company during the day of our visit. Often, appropriate persons were absent or too busy. On several occasions we had to visit again, but this was costly in terms of expense and time. In addition, most large firms had their head offices in Seoul. So we had to visit them separately, before or after our visits to their factories, to get the data for the questionnaire on `General Information'. Apart from the bothersome extra efforts for such separate visits, difficulties also arose from poor communication between factories and head offices. This seemed to be a typical example of the problems of bureaucracy. Meanwhile, one great difficulty commonly faced in large and small firms was in interviewing representatives of workers. Firms were very sensitive about the fact that an outsider would have an interview with those who represented their workers. This seemed so particularly because at the time of our survey industrial disputes were spreading across many industries. In fact, a large company in our own sample had been hardly hit by a strike just before our visit. The company was so notorious for its low wages, associated with its ties to a religious group, that even small and medium firms in our sample felt threatened by its wage levels. But later in the famous national strikes of the summer 1987, not only this

company but also several other machine tool firms experienced labour disputes. So labour relations seem to be currently a weakest point of Korean industrial firms in general, and thus an inquiry into labour relations is likely to always face difficulties similar to ours for a considerable period of time.

Data analysis: For analysing the collected data which are of statistical nature, a usual procedure of survey analysis was followed. First, a codebook was prepared to put the data into computer. Variable names, column numbers and missing values were specified. Second, the data on the questionnaires were directly put into computer, and, third, statistical analysis of the data was conducted. The computer package we used is SPSSx, i.e. a new version of SPSS (Statistical Package for the Social Sciences), installed at the Imperial College Computer Centre. The main programs we used for getting descriptive statistics are FREQUENCIES, CONDESCRIPTIVE and, less often, CROSSTABS. In analysing the significance of differences between large and small firms in some variables or the significance of correlations among various variables, we relied on the programs for nonparametric statistics, i.e. NPAR TESTS and NONPAR CORR. Although most variables included in these analyses are of at least `interval' scale of measurement ( including 5- point Likert scales used in our questionnaires, which we assumed as `interval'), parametric statistical tests were not considered as appropriate because (i) our sample size is too small and, more importantly, (ii) the normal distribution can never be assumed for the population of Korean metal-cutting machine tool firms (for the related methodological discussion, see Siegel, 1956, chapter 3; Blalock, 1972, chapter 14). The specific statistical techniques we used are Mann-Whitney test and Spearman's rho (ibid.).

3-3. A profile of the sample firms

It seems useful to introduce some of the basic features of our sample firms before

turning to the findings from data analysis. In terms of size and ownership, our sample firms represent an interesting distribution of heterogeneous types of firms which characterise many Korean industries at present. They comprise 6 large companies affiliated to *jaebul* groups, 3 large non-*jaebul* companies, 12 indigenous and independent small and medium companies and 2 small joint-venture companies (invested by a Japanese and a US firm respectively)[2]. Though we cannot say that such a distribution exactly reflects the composition of firms in the Korean industry as a whole, it certainly seems to represent a fairly typical picture of the industrial structure prevailing in Korea. So a comparative analysis on large and small firms in the sector might provide many findings which are also suggestive to other sectors.

The products which our sample firms produce range from conventional machine tools like lathes, milling machines, drilling machines, etc. to NC lathes, NC milling's and machining centres. Too see their importance in quantitative terms, their share in total output of metal-cutting machine tools in 1984 was 85.4 % (i.e. 84 billion won among total 98 billions), while the figure in total exports was even higher, i.e. 93.9 % (21 million US dollars among total 22 millions)[3]. In Table 3-3 in the next page, the share of our sample firms in the output of each product item in the year 1984 is presented. As can be seen in the Table, the products of our sample firms cover almost the whole items of metal-cutting machine tools presently produced in Korea, except only hobbing machine, tapping machine and shaper. Moreover, their share in each item is mostly very high. In short, therefore, in quantitative terms the representativeness of our sample firms can be said to be quite high for the industry.

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[2] The absence of wholly owned foreign subsidiaries in the sector is a result of the explicit government policy of not allowing such investment in the capital goods sector (Chudnovsky, 1986).

[3] These figures were calculated from the statistics in *Machine Tool*, No. 9.

Table 3-3[4] The share of sample firms in output by product category in the year 1984.

Product items	No. of firms Total	No. of firms Sample	Output (million won) Total(A)	Output (million won) Sample(B)	% share of sample (i.e.(B)/(A)x100)
lathe	17	14	36,682	35,030	95.5
milling m/c	12	11	15,089	14,820	98.2
drilling m/c	10	5	4,795	2,647	55.2
boring m/c	3	2	2,081	2,039	98.0
grinding m/c	19	10	6,506	5,187	79.7
electrical discharge m/c	3	1	2,364	650	27.5
sawing m/c	4	1	2,163	792	36.6
hobbing m/c	2	-	1,161	-	-
tapping m/c	2	-	485	-	-
special-purpose m/c	5	2	2,662	1,027	38.6
NC lathe	6	6	9,616	9,616	100.0
NC milling	6	6	2,906	9,206	100.0
machining centre	5	4	7,497	7,227	96.4
shaper	1	-	791	-	-
planer	1	1	485	485	100.0
others	7	1	2,674	1,229	46.0
Total	**45***	**23***	**97,957**	**83,655**	**85.4**

Note(*): The sum of the number of firms is small, because a firm often produces several product items.

Source: KOMMA, *Machine Tool*, No. 9, 1985.

[4] The scope of firms included in Tables 3-3, 4-1(see p.69) and 4-4(p.78) is different from one another. Table 3-3 covers metal-cutting machine tool manufacturers surveyed by KOMMA, while Table 4-1 covering the entire machine tool sector(i.e. both metal-cutting and metal-forming branches) and Table 4-4 covering those firms whose primary product is metal-cutting machine tools.

PART II

Firm Size and Technological Change in the Korean Machine Tool Industry

Chapter 4
Historical Background

The purpose of this chapter is to describe the origins and to give brief history of the machine tool industry in Korea. Since its technological development is an integral part of the history and cannot easily be separated, its technological history is also included. As the transformation of the industry has been closely associated with changes in the relative role of small and large firms in different phases of its development, a section is included which discusses changes in the size distribution of firms.

4-1. The history of the industry

The pre-1960 era

The exact time of the origin of the Korean machine tool industry is unclear, but it is believed to coincide more or less with Independence from Japanese colonial rule in 1945. The earliest firms were Samsung Iron Works and Hongjung Industrial Co. which produced a few simple machine tools like the pulley-driven lathe and shaper (C. Kim, 1979). However, the Korean War,1950~53, seems to have swept away this small patch of early development and thus the industry had to start again,from scratch, after the War. The post-truce rehabilitation of war-damaged industries and the boom of repair work for machine parts and equipment gradually provided a basis for the subsequent development of the industry. This means that the Korean machine tool production did not start by implanting modern manufacturing plants from abroad, but grew from small machine repair shops based on the skills of the craftsmen-owners. The re-start of machine tool production began in 1954. The items which were initially produced were lathes, drill machines, shapers and sawing machines. Seven firms were reported to produce these

machine tools and all of them were small firms with less than 50 workers. Total production in 1955 was reported as 40 units (The Bank of Korea, 1955).

In the late 1950s aid funds from the international agencies of the U. N. and the USA such as UNKRA (United Nations Korean Reconstruction Agency), ICA (International Co-operation Administration, i.e. AID) were made available to a few large firms. They used these funds (about US$ 50,000 for each firm) to introduce modern plants and facilities from the USA, West Germany, Italy, etc.; part of this equipment and facilities were used for machine tool production, which contributed to the upgrading of product quality in the industry. The initial production items of these new entrants to the industry were lathes, bench drilling machines, and parts like chuck, drill, etc. However, since these firms entered the industry as part of a diversification strategy, machine tool production remained as a side business for them. Due to the constraints of the small market and fluctuating demand, they did not develop to play a leading role in the industry. Though they continued to produce a small amount of machine tools throughout the 1960s, by the early 1970s all of them had ceased machine tool production because of lack of demand and other reasons (C. Kim, op.cit.).

In short, the pre-1960 era can be regarded as the time in which the Korean machine tool industry gradually developed from the form of repair machine shops to the establishment of some manufacturers, be they very small-scale, becoming able to make a few simple types of machine tools, especially belt-driven lathes, etc.

The 1960s

The launch of the First 5-year Economic Development Plan in 1962, the subsequent economic boom and rapid industrial growth stimulated the industry and led to a considerable increase in the number of firms, as indicated in Table 4-1. The number and range of producible items were also increased [1], which contributed to some degree of

[1] For example, metal-cutting machine tools which could be produced in 1963 were lathe, shaper, planer, hobbing M/C, boring M/C, grinder, drilling M/C, gear- cutting M/C, and milling M/C (EPB and Korean Reconstruction Bank, 1963).

import substitution. Moreover, from 1964 some products began to be exported, though in small amounts, to South East Asian countries (the Philippines, Vietnam, Thailand) and Japan [2]. In spite of this noteable performance, however, there was little fundamental change in either firm size or production scale, and the technological level remained at the infant stage in terms of all aspects, i.e. design, processing, assembly, etc. Product development was still almost wholly reliant on copying foreign models (especially Japanese ones), sometimes with some minor modifications. Though exports had begun, they were very small relative to imports [3], and were limited to a few low-grade items. So the industry mainly served the function of import substitution. However, the rate of import dependence did not decrease and remained at around 80 % in this period because imports were increasing as fast as domestic production (Ministry of Finance).

Table 4-1. Number of establishments in the machine tool industry* by size groups: 1955~66

	Year				
Size of employment	1955	1958	1960	1963	1966
5 ~ 9	4	5	12	37	51
10 ~ 19	1	2	7	29	41
20 ~ 29	1	2	5	3	14
30 ~ 49	1	3	2	5	7
50 ~ 99	-	-	3	4	5
over 100	-	-	-	-	-
Total	**7**	**12**	**29**	**78**	**118**

Note(*): The above numbers include metal-cutting and metal-forming machine tool manufacturers.

Source: EPB, *Report on Mining and Manufacturing Census*, various years.

[2] The export amounted to 42 tons(in weight) and $52,000(in value) in 1964 and included such items as lathe, planer, shaper, slotter, boring M/C, broaching M/C, drilling M/C, reaming M/C, and tapping M/C (The Ministry of Finance, 1964).

[3] Less than 3% throughout the 1960s. And the ratio was actually decreasing towards the end of the decade because of increasing imports against stagnant export (Ministry of Finance, various years).

Turning to government policy in this period, the machine tool industry was designated as a Special Category of Machinery Industry to be promoted (Machinery Industry Promotion Law , March 1969). 11 items (including lathes, milling machines, drilling machines, etc.) were selected as the products for localisation in the following year (C. Kim, op. cit.). However, the actual effect of this policy was believed to be little because of the lack of real support. In November 1972 a special means to support the industry was devised. Machine Tools Specialised Companies were selected by the government in order to facilitate the localisation and improve the quality of machine tool products (ibid.). Thereafter the role of government intervention in this industry has become increasingly important, as will be discussed later.

To summarise, although the industry saw many new developments during the 1960s, it by and large remained a small, infant industry and the pace of technological development was slow. This rather slow tempo of development and import substitution prompted some measures of government intervention, but the latter had little significant effect during this period. Nevertheless, the foundation of the later development of the industry seems to have been established largely in the 1960s.

The 1970s

In 1973 the government announced the Heavy and Chemical Industry Promotion Plan, which subsequently provoked a fundamental change in the machine tool industry as well. Since the Plan was closely associated with the government's aim to promote the defence industry, it generated increasing interest amongst both policy makers and large firms in the production of machine tools which were regarded by them as crucial to arms production. In particular, the construction of the Changwon Machinery Industry Complex[4], implemented as a part of the Plan, provided the opportunities for large

[4] This Complex was established as the centre of the machinery industry in Korea, according to the Long Term Promotion Plan for the Machinery Industry promulgated in September 1973. See KIEI (1980) for details.

machinery firms to invest and participate in the machine tool industry. The government supported them with preferential loans, tax reduction and other incentives. Consequently, famous large firms like Daewoo Heavy Industries, Korea Heavy Machinery Ind., Kia Machine Tool Co., Tongil Co., Dongyang Machinery Co., and Doosan Manufacturing Co., most of which belonged to *jaebuls*, i.e. Korean conglomerates, entered the industry for the first time during the second half of the 1970s. Their entry had a great impact on the hitherto small industry and transformed its structure and technology entirely. Investing about $50 million on the average (C.Kim, op.cit.), they considerably enhanced the scale of production and consequently, its management and organisation. Moreover, by introducing up-to-date foreign facilities and equipment on a large scale, and by actively importing foreign technologies through licensing, not only did the product mix became more diversified (in particular, many high performance products were newly introduced), but also the product quality improved rapidly and thus reached a level similar to foreign products, at least in some areas.

As can be seen in Table 4-2 below, technology imports (in the form of licensing agreements) were concentrated in the period 1975-79. Most of these imports were made by the newly entered large firms, though their impact on the existing small firms led to an increase in technology imports by the latter as well. Encouraged by government

Table 4-2. Number of licensing agreements* by periods and firm size

Size groups	Time periods 65-69	70-74	75-79	after 1980	Total
large firms	1	2	20	9	32
small firms	1	1	5	7	14
Total	**2**	**3**	**25**	**16**	**46**

Note(*): The above numbers include only those licensing agreements related to final products of metal-cutting machine tools, i.e. those of metal-forming machine tools and components production are excluded.

Source: the Ministry of Trade and Industry and our survey data.

incentives (import restriction, subsidies, tax reduction, etc.) and the growing domestic market (especially demand from military, automobile and other machinery industries), large firms vigorously invested to absorb foreign technologies as well as to expand their production capacity during this period.

The source of most imported technology was Japan: among the total 46 licensing agreements in Table 4-2, 36(i.e. 78%) were made with Japan, 6 with the USA, and the rest 4 with West Germany. This caused some typical problems of `technological dependency' [5], which have gradually withered away as the firms have accumulated their own technological capabilities.[6] Therefore, by the end of the 1970s, many major items of conventional machine tool products, including various grinding machines and gear-cutting machines began to be produced domestically. This reduced the rate of import dependence which had remained at around 80 % until 1979 to 65 % in 1980 (Ministry of Trade & Industry and KIET, 1982).

In 1976 a prototype of NC lathe was developed for the first time in Korea through a joint effort between the Korea Institute of Science and Technology (now KAIST) and Whacheon Machinery Works Co., adapting the latter's existing model of a high speed precision lathe. Production began the next year and from 1978 the export of NC lathes started (mainly to the USA). Also from 1979 NC milling machines began to be produced, and in 1980 the first machining centre was developed by Tongil Company. Therefore, Korea successfully emerged as one of the NC producers in the world

[5] Korea's dependence of technology imports from Japan is common to other industries, though it appears more salient in the machine tool sector. The reasons for this are various, including both economical (costs) and noneconomical (historical, geographical, linguistic, etc.). For reference, see H. Kim(1982).

[6] Though dependent on technology import, the Korean firms have also made efforts in their own R&D. For example, among 49 new product developments of metal-cutting machine tools reported until 1981, 16 were indigenous ones whereas 33 were made by licensing agreements (Ministry of Trade & Industry and KIET, 1982).

machine tool industry during the second half of the 1970s.

During this period the government intervened more directly in the industry by devising specific measures for it. In November 1977, the government announced `the Basic Development Plan for the Machine Tool Industry' aimed to boost production and to enhance product quality up to international standards. Firms to be promoted were classified, to facilitate specialisation, into `comprehensive machine tool producers' (mainly large firms), `specialised machine tool producers' (small and medium firms), `component producers', and `raw material producers'. Appropriate companies were selected in 1978 and received various special privileges guaranteed by the government (the Ministry of Trade and Industry, 1977 and 1978). Thus these companies enjoyed higher growth rates relative to others and contributed to a rapid expansion of the production base of the industry. But, as we shall see later(Chapter 10), the focus of the Plan was on inducing large business groups to enter the industry and using them as the vehicle of its rapid growth. Accordingly, small and medium firms actually received much less support than these large firms. So large firms began to take the leading role in the industry after the implementation of the Plan.Though abrogated in 1984 (according to the legislation of the Fair Trade Act), this Plan has constituted the main framework of government policy towards this industry and has given it a great boost.[7]

To summarise, the heavy government intervention and the subsequent participation of large firms in the industry since the mid-1970s led to a rapid growth. Massive technology imports were an integral part of this process. As a consequence, the initiative of the industry decisively shifted from the small to large firms, implying the whole change of the technological base at the same time. Korea, owing to this process of rapid development, had become an NC machine tool producer by the end of the 1970s.

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[7] Besides this Plan, the Pre-Quality Test enforced from 1975 and the designation of the Small and Medium Size Specialised Machinery Producers(500 including machine tool firms) from 1976 were important to the industry (C. Kim, op. cit.).

The 1980s

One single important characteristic of the industry since 1980 has been the acceleration of NC technology development. After having some experience of developing simple NC models in the late 1970s, firms tried to import foreign technologies to get more sophisticated NC technology as fast as possible.[8] But they experienced difficulties with this, especially the unwillingness of the licensors (especially, Japanese companies) to offer `key' technologies, so firms have also tried to develop their own models of NC machine tools. In this regard, several firms have co-operated with government research institutions such as the Korea Institute of Machinery and Metals (KIMM) and the Korea Advanced Institute of Science and Technology (KAIST). These institutions have not only provided technical guidance and advice on NC technology but also have done contract research to develop specific products for individual firms. So by the end of 1984, nine firms had have the capacity to produce CNC lathes, CNC milling's, or machining centres in one way or another (KOMMA, 1985). Now, some of the leading firms like Daewoo, Tongil, and Whacheon are trying to develop higher automation and unmanned systems technology such as flexible manufacturing cells(FMC) and flexible manufacturing systems(FMS) by linking their CNC products with industrial robots. A history of NC technology development in Korea can be best described in the comparison with world technological frontier in this field. Figure 4-1 in the next page summarises this.

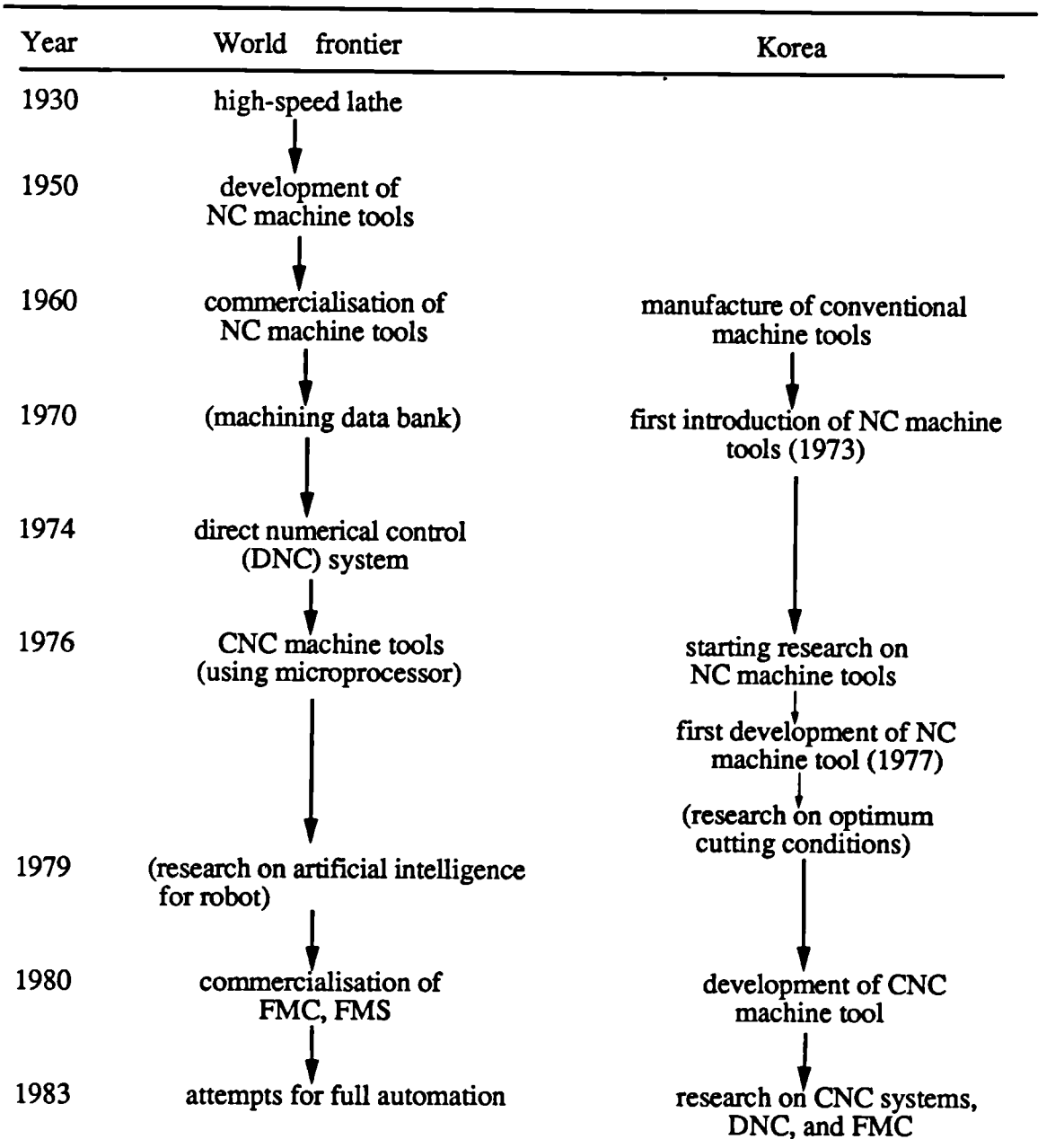
The current phase and its problems

In spite of its apparently rapid and smooth development, NC machine tool production in Korea is still at an infant stage and has many weaknesses. First of all, it is almost totally dependent on the import of key components such as NC units, servo motors(AC/DC), hydraulic systems, high speed bearings and ball screws. For example,

[8] Of the nine licensing agreements entered by large firms since 1980 in Table 4-2, six are related to NC products.

virtually all NC units are imported from Japanese companies such as FANUC [9] or Toshiba. Considering that these components constitute the major cost in a NC product (Jacobsson, 1983), it is vital to localise them. Some of these components are being

Figure 4-1. A comparison of technological development in NC machine tools



Source : modified from Figure 1-4 in Han, 1984, p.23.

[9] They are imported either directly from FANUC or indirectly through Korea Numerical Control Co. (KNC) which is a joint venture between FANUC and a Korean company.

developed by local firms receiving the support from the government (KOMMA, 1985), and so a certain extent of localisation can be expected to progress in the near future. Secondly, some basic technologies are still very weak. Design, heat treatment, and super-precision processing technologies in particular, lag very much behind advanced countries. This weakness has resulted from the industry's short history as well as its heavy dependence on copying or importing foreign technologies. The remedy for this may need a much longer time. Thirdly, there is the problem of economies of scale. Since the domestic market for NC machine tools was very small, the NC producers had to enter the export market at an early stage of production (see Table 4-3). However, according

Table 4-3. Production and trade of NC machine tools in Korea

Year	Value(US $1,000)			Units		
	Production	Import	Export	Production	Import	Export
1977	200	2,821	0	5	66	0
78	850	9,684	210	20	113	27
79	1,800	31,793	1,185	40	174	39
80	1,090	6,579	169	22	69	4
81	4,624	20,389	2,136	100	66	57
82	15,683	4,022	9,460	295	40	170
83	22,280	9,532	5,682	371	116	103
84	24,120	43,214	6,712	?	?	?

Source: Han(1984) and KOMMA(1985)

to one estimate (Han, 1984), the prospect of `total' demand for domestic NC products is between 500 ~ 1000 units in 1987. This only amounts to the minimum efficient scale (i.e. the break-even point) of `one' NC producer according to Jacobsson(1983). So in order to be profitable in NC production, Korean firms must significantly expand their market in a short period. At all events, it is unlikely that they can make profit in this area before 1990, and so they will probably have to depend on the government special support until then.

The area of conventional machine tool production also has many problems. The participation of large firms and the government support for them led to over-capacity and a

chronic shortage of demand (especially, in the case of lathe, milling and drilling machines). This, in turn, resulted in excess competition between the existing small and medium producers in the domestic market, which forced upon them an ever-present threat of bankruptcy. In addition, this area shares the problems of dependence of on the import of key components, lack of design and engineering capabilities, and low precision and durability due to the backwardness of some basic technologies like heat treatment, precision processing, with the NC production area.

From 1984, the government began to change its policy in such a way as to gradually remove direct intervention and, instead, encourage the competitiveness of the industry through introducing import liberalisation and a freer competition (e.g. by abolishing the promotion of selected companies). Accordingly, in May 1985, most conventional machine tools were announced as import liberalisation items. Through this measure, the government is also trying to induce domestic producers of conventional machine tools into the export market. It has already set the objective of $100 million export of machine tools in 1988.[10] It is known that the government encourages the form of division of labour in which small and medium firms are specialised in conventional type products and large firms in NC and automatic types. The present main focus of government support seems to be on the development of key components and engineering (including R&D) capabilities. So in this area and NC machine tool production, government intervention seems likely to continue for a while.

4-2. Trends in firm size distribution

Now let us briefly look at changes in the firm size distribution of the Korean machine tool industry. Since we have no data specific to the `metal- cutting' machine tool sector (on

[10] In 1984 the export of machine tools (including metal-forming ones) was $21.6 million according to the estimate by the Ministry of Trade and Industry (KOMMA, 1985, No. 9).

which we focus in this study) before 1970, our discussion will be limited to the period after this time.

As can be seen in Table 4-4 next, until 1972 the industry had been virtually dominated by small and medium firms.[11] Only in 1974 (i.e. one year after the announcement of

Table 4-4. Number of establishment in metal-cutting machine tool industry* by size group : 1970-82

Year	Size of employment								
	5~9	10~19	20~49	50~99	100~199	200~299	300~499	over500	Total
1970	22	16	12	5	2	-	-	-	57
72	18	23	8	3	3	-	-	-	55
74	26	19	15	6	1	-	1	-	68
76	17	28	26	5	5	-	-	1	82
78	17	48	36	6	5	4	-	1	117
80	27	26	15	6	8	1	2	-	85
82	27	23	12	6	9	-	2	2	81

Note(*):The above numbers include only those firms whose `main' business is metal-cutting machine tool production.

Source: EPB, *Report on Mining and Manufacturing Census*, various years

the Heavy and Chemical Industry Promotion Plan), did a large firm appeared. Since then several medium-sized and large firms have appeared . During 1970-82 we can see little change in the number of those small firms with less than 100 workers. This implies not that their business has been relatively stable and safe, but that though many small firms went out of the business new firms have continuously been recruited. One notable fact is that the numbers in the size group 100-199 have consistently increased. They seem to represent relatively successful firms among the small and medium size category. The number of large firms (over 300 workers) is underestimated, because it does not include those large firms which have not specialised in machine tools, i.e. those whose `main' product is not a machine tool (for instance, firms belonging to large conglomerates). However, the data clearly show that firm size has continuously

[11] Though a few large firms began to produce machine tools from as early as the late 1950s as we indicated earlier, they did it as a side business and were thus excluded from the Table.

increased within these groups whereas it has been relatively stagnant in the smaller groups. This implies an increasing concentration in the industry, which will be discussed further below. And lastly, the total number of firms reached its peak in 1978, but has decreased thereafter. This is probably because of the increased competition from the entry of large firms as well as the economic recession in the early 1980s.

Table 4-5. Output by firm size in the metal-cutting machine tool industry

(unit : million won, %)

Year	Gross output(A)	Output per firm	Small firms		Large firms		Share by large firms
			total output	average output	total output(B)	average output	((B)/(A)x100)
1970	1,125	19.7	1,125	19.7	-	-	0.0
72	938	17.1	938	17.1	-	-	0.0
74	3,472	51.1	2,271	33.9	1,201	1,201	34.6
76	8,593	104.8	7,137	88.1	1,456	1,456	16.9
78	31,227	266.9	23,929	206.3	7,298	7,298	23.4
80	34,869	410.2	24,206	291.6	10,663	5,331	30.6
82	68,269	842.8	26,999	350.6	41,270	10,317	60.5

Note(*) : small firms= 5~299 workers; large firms =300 and over

Source: the same as Table 4-4.

Table 4-5 above shows the trend in output by firm size during the same period. It shows not only the growth of the industry but also the rapid process of its concentration. Though we must take into account the inflation effect (i.e. the figures are in current value), the growth rate was very high indeed during the second half of the 1970s. It is notable that whereas the total output by small firms has been relatively stagnant since 1978, that by large firms has steadily increased. So it is not too much to say that the initiative in the industry has shifted from small to large firms during the period. Though the growth rate of the average output by small firms has been similar (or higher) to that by large firms since 1974, it stems not from the real growth of those small firms but from the disappearance of many tiny firms with less than 50 workers (see Table 4-4 before). In contrast, there has been a real growth in both the total and the average output by large firms since their entry to this industry. All of these are reflected in the increasing share by large firms in the industry. As shown in the Table (see the last column), it

surpassed the share by small firms in less than ten years. But, as already mentioned, since the Table does not include the output by some conglomerate firms, the real share by large firms must be even higher. According to a report by the Ministry of Trade & Industry and KIET(1982), the large firms' market share amounts to about 80% of the industry. In conclusion, it can be said that the rapid growth of the industry has been paralleled by a rapid process of concentration.

The above finding on the firm size distribution generates an important question regarding our study. Has the apparent rapid growth of large firms, and their consequent domination of the industry, relied upon their superior technological efforts and performances ? In other words, were large firms better equipped with, and comparatively more efficient in, the forms of technological change that were needed to succeed in the Korean machine tool industry ? This is the question we want to answer in the next chapter. To do this, we will present the results of our data analysis on technological efforts by the sample of firms which we surveyed.

Chapter 5
Comparisons of Technological Performance between Large and Small Firms

The brief review of the history of the Korean machine tool industry in the last chapter showed that until the last decade the industry largely remained at the infant stage. Since then it has experienced rapid growth and structural transformation. Korea has thus been, and still is, a typical 'technology follower' in the world frontiers of the machine tool industry. This means that the specificity of the Third World in technological change, which we described at the beginning of this study, must be clearly taken into account when examining the issue of firm size and technological change in the context of the Korean machine tool industry. Therefore, large and small firms may have sought different forms of technological effort to those in developed countries, and may also have different relative technological performances.

In this chapter, we will attempt to assess technological efforts and performances of the large and small firms in our sample. As was indicated earlier (Chapter 2), given the complexity of forms of technological change in the Third World and the difficulties involved in measuring them, we will utilise a variety of input and output indicators which are considered relevant to our analysis. Also, where necessary, we will redefine the major concepts used here for our own purposes. We will, first, try to assess the human (and organisational) capacity of firms to conduct technological change, viz. the so-called 'technological capability'; secondly, we will try to identify how the firms acquire technological capability and also how they acquire technology itself-whether developed or purchased- ; and thirdly, we will attempt to evaluate the consequent technological performances of the firms -that is, how much technological change they

have made and what form it takes, i.e. the rate and pattern of technological change. These will be followed by a short summary.

5-1. Technological capability

5-1-1. organisation of R&D activities

Though R&D may not be the only source of technological change of firms in a Third World country (see our discussion on 'technological learning' in Chapter 2), it is still likely to represent the central aspect of technological efforts made by most of them(except those tiny firms which do not perform any R&D at all). So, in assessing firms' technological capability, we can begin by examining the extent of R&D capacities possessed by each firm. Let us first look at the organisational aspect of R&D activities. Whether or not a firm has an independent R&D department can be considered as a basic indicator which shows whether a function of R&D is systematically and consistently pursued within the firm. Such a specialised R&D function, in turn, represents a higher organisational capacity to conduct technological change.

According to our survey results, three out of the nine large firms have their own research institutes while five of the rest have research departments which work exclusively on R&D. The one firm which lacks an independent research department has instead a design department doing the function inclusively. In contrast, none of the small and medium firms have research institutes, though over half of them (i.e. eight among fourteen) have specialised R&D departments. Three of the remaining six are dependent on design or test departments for their R&D work, whereas the other three firms do not have departments which perform either exclusively or inclusively the function of R&D. In the latter, R&D is performed by research personnel as individual(s) or even by a top manager on his own.

So it is clear that the large firms, on the whole, possess larger and more specialised organisational forms of R&D function than the small and medium firms. In fact, this is hardly surprising when we take account of their different scale. It is also likely that the

structure of R&D activities is more formal and systematised in the large than in the small firms. But this does not necessarily imply that the small and medium firms are passive and/or less efficient in R&D. There seems to be a degree of heterogeneity among them in terms of R&D efforts. While the majority of the small and medium firms seem to perform some R&D on a continuous basis, in the rest of them R&D is possibly marginal or at best discontinuous. For these organisations, informal and incremental types of technological change on the shopfloor may be the only source of innovation.

5-1-2. R&D manpower

If "a technology may be purchased but a technological capability is acquired only through the build-up of human capital" (Amsden & Kim, 1986: 99), then an important aspect in comparing technological capabilities between different firms is to examine the technological manpower employed by each firm.

In the survey, we asked firms about number of their employees who were engaged in design and R&D work, assuming that a firm's technological capability will fundamentally depend on these two functions. The term 'R&D staff' hereafter designates these employees. The average size of R&D staff is about 47 in a large firm, compared to 7.8 in a small and medium firm. Against total employees engaged in machine tools production (i.e. excluding those engaged in other production lines), these figures correspond to 6.6 % and 7.1 % respectively. Therefore, it can be said that R&D manpower intensity is slightly higher in the small and medium firms. However, whereas about 70 % of the R&D staff in the large firms are exclusively charged with R&D, the proportion in the case of the small and medium firms is only 46.5 %, i.e. over half of their R&D staff also hold additional task(s). We can read from this again the informal structure of R&D activities in the small and medium firms and the loose division of jobs within them.

But the size is not the only issue. If there is a significant difference in the 'quality' of R&D staff between large and small firms, this may contribute to a great extent to their gap in technological capabilities. Unfortunately, there is no single (or exact)

measure with which we can assess the quality of R&D manpower. However, the level of education can be one of the most reliable measures and is thus often used in this regard. As can be seen in Table 5-1 below, neither group of firms has an R&D employee with a PhD degree. The proportion of those R&D employees with Master degrees in science or engineering is also small in both groups, but is higher in the large firms (i.e. 6.3 %) than in the small and medium firms (0.8 %). Also, the proportion of those with Bachelor's degree in science or engineering is significantly higher in the former: 49.5 % and 24.8 % respectively. Therefore, whereas over half of the R&D staff in the large firms consist of 4-year university graduates, the proportion is only one-fourth in the case of small and medium firms. The most typical stratum(45.3%) of R&D employees in the small and medium firms is graduates of 2-year technical colleges. High-school graduates(or those with the lower educational levels) constitute the next most important group(29.0%), although their proportion is also fairly significant in the large firms(18.5%).

Table 5-1. The proportion of R&D and design staff by educational levels

Educational levels	Large firms	Small & Medium firms
PhD (1)	0.0	0.0
MSc (2)	6.3	0.8
BSc (3)	49.5	24.8
((1)+(2)+(3))	(55.8)	(25.6)
technical colleges	25.7	45.3
high school or lower	18.5	29.0
Total	100.0	100.0

Note: Unless specified, no. of cases included in Tables hereafter corresponds to the whole sample size(i.e. 9 large firms and 14 small and medium firms).

5-1-3. production workers

Though R&D(including design) capability may constitute the centre of a firm's overall technological capability, it is not the sole element or measure of the latter. If a newly developed and designed technology is to be appled to and embodied in a final product either by improving its quality or by increasing productivity, the role of the workers in the production process is crucial because they are the ones who perform such the implementation stage of such a technological transformation. Accordingly, workers'

skills should be regarded as an important factor which can influence the result of a technological change and thus constitute an indispensable part of a firm's technological capability *in the broad sense*. Moreover, production workers sometimes play the role of initiator of technological changes as has been demonstrated by the success of the Japanese quality circle(QC) system (See, for example, Fransman, 1986: 200~201). In particular, incremental forms of technological change tend to depend greatly on this kind of initiatives. The on-the-job experience of production workers means that they, more than anybody else, perceive various technical problems on the shopfloor and hence can have ideas to solve them.

Therefore, skills and other quality aspects of workers are an important factor in considering a firm's technological capability. But there is no objective and reliable way to classify workers into skilled, semi- skilled and unskilled ones. (In a sense, every worker is skilled if his experience in the work goes beyond a certain period and a certain level.) Thus, instead of using such categories as skilled/unskilled workers, to assess the quality of a firm's production workers we used specific criteria which are more relevant in the context of Korea. Two of them are especially important in this regard: the possession of a legal qualification and the length of career.[1] As an official recognition of the level of skills achieved by a worker, the government certificates him as a 1st- or 2nd-class 'Craftsman', or a 'Assistant Craftsman' after an official test. So this can be used to represent an aspect of the quality of workers in terms of skills, though it may not be an exact measure. This criterion is particularly important in the sectors like machine tools in which workers' skills play an especially significant role. Without distinguishing between different classes of the qualification to avoid complexity, we classify the workers simply into two groups: those with qualifications('qualified workers') and those without qualification('unqualified workers').[2] We assume here that the former group

[1] The rest of the criteria considered will be explained later when we discuss 'labour market factors' in Chapter 7.

[2] Here we treat only with those who have work experience of at least one year. We excluded apprentices with less than one-year experience and simple manual workers, because these are not

should be superior to the latter. The other criterion, the length of career, is also related to skill levels because more experience generally means a greater accumulation of skills. Here we distinguished between those workers with less than 3 years of experience and those with 3 years or more.

According to our survey results, the ratio of qualified to unqualified workers is 2.9 : 1 in the large firms, and 0.5 : 1 in the small and medium firms. Or in proportional terms, the average proportions of qualified workers among the total of these two groups of workers are 56.4 % and 28.7 % respectively. So there exists a significant difference in terms of this aspect between large and small firms (p = .0757). Moreover, among the qualified workers, those who have at least 3 years of experience constitute 71.4 % of the total in the large firms and 45.4 % in the small firms (p = .2168). The same difference applies to unqualified workers, where the proportions are 83.9 % and 52.4 % respectively (p = .0418). Taking these results together, the skill level of ordinary production workers seems to be higher in large firms. We will explore later whether this actually contributes to the upgrading of technological capability of the latter.

5-1-4. subjective assessment of technological capabilities

To complement the quantitative indicators which we have reviewed above, we asked the firms to evaluate their own technological capability. Many authors have introduced various classifications of technological capability to distinguish between different 'capabilities' which have more or less independent aspects in contributing to a firm's technological performance (as major examples, Cooper, 1980; Ogawa, 1982; Fransman, 1984; Westphal, Rhee, Kim and Amsden, 1984). As these authors pointed out, 'technological capability' is not a homogeneous concept, but an abstraction of heterogeneous elements which underlie a firm's capacity to induce the improvements in product quality or productivity. According to this recognition, and also for our analytical purposes, we divided technological capability into four different types, by function, as follows:

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considered to be important in technological capability.

-product manufacturing capability, which covers activities like materials processing, assembly and inspection, i.e. activities regarding the manufacture of products themselves;

-process engineering capability, which is concerned with repair and maintenance, adaptation and improvement of equipment, and process control;

- design capability, which includes product design, process design and plant design;

- R&D capability, which refers to the ability to research and develop new products or new processes.

We also included some extra aspects in the questions to supplement and clarify the above items(i.e. the ability of absorption and assimilation of imported technologies, the quality of production facilities and equipment, and the quality of workers' skills). The respondents were senior personnel in technology departments or in management. They were asked to rank, in terms of the above categories, the capabilities of their companies in comparison with those of other firms in the same industry. A five-point scale, ranging from 1(very inferior) to 5(very superior), was used.

As can be seen in Table 5-2, in each type of capabilities the self-evaluation by the large firms is clearly ahead of that by the small and medium firms. Concerning the rankings of

Table 5-2. Subjective evaluation of technological capabilities
(5-point scale: 1 = very inferior ; 5 = very superior)

Types of technological capabilities	Large firms (mean points)	Small firms (mean points)	Significance (Mann-Whitney: two-tailed)
1.product manufacturing	4.3	3.3	*P<.05
2.process engineering	4.0	3.2	
3.design	4.0	3.4	
4.R&D	4.0	3.1	
a.assimilation of imported technologies	4.2	3.0	*P<.01
b.quality of production facilities and equipment	3.9	2.9	*P<.05
c.quality of worker's skills	4.4	3.4	*P<.005

the four different types of technological capabilities, the large firms evaluated their

'product manufacturing capability' highest while the levels of the other capabilities were identical (i.e. average 4.0). Small and medium firms ranked their 'design capability' highest and their 'R&D capability' lowest, though the gaps between the different technological capabilities are moderate. As a result, the gap between the large and the small firms is biggest(and statistically significant) in 'product manufacturing capability'. The next largest gap is in 'R&D capability' though its significance is not statistically established.

The smallest gap is found in 'design capability'. This can be interpreted to mean that while product manufacturing capability and (to a lesser extent) R&D capability are clearly higher in the large than in the small firms, their insignificant gap in design capability reflects the relatively low accumulation of design skills in the former. This is hardly surprising if we consider the fact that until recently most of the major product designs in the large firms have depended on technology imports while designs in the small firms have largely been learned through imitation and reverse engineering. Consequently there are small differences in that design capability.

The ability to assimilate imported technologies seems clearly higher in the large firms, as shown in the above Table. This seems to be not only the result of their greater experience in (formal) technology import but also a reflection of their superior capability of understanding and learning foreign technologies which are more sophisticated and advanced than the Korean standard. But such superiority is in fact based on the capacities of their R&D manpower, which, as we have seen, are superior in quality as well as in quantity.

The superiority of the large firms in product manufacturing capability is confirmed by the results in Table 5-2 about the quality of facilities and equipment and of workers' skills. Because product manufacturing is mostly performed by production workers, it depends first and foremost on workers' skills. The gap in workers' skills between the large and the small firms is statistically very significant, and confirms the similar result, in terms of the quantitative indicators on the composition of production workers, in the preceding subsection. In addition, because product

manufacturing capability is also connected with the hardware, i.e. production facilities and equipment, the significant gap in the quality of the latter further strengthens the gap in skills.

To conclude, the gap in technological capability between the large and the small firms is relatively great in the areas of product manufacturing and R&D(plus technology import) but not so great in design. This feature seems to be closely related to their different patterns of technology acquisition and of technological change as we shall see later. In the next section, we will look into how the firms have acquired such technological capability as we have reviewed above. And then we will also discuss how they acquire technology from various sources.

5-2. Technology acquisition

5-2-1. recruitment and training of R&D manpower

Since R&D(and design) personnel constitute the principal basis of a firm's technological capability, it seems important to consider how they are recruited and subesequently trained when we examine the firm's acquisition of such capability. As we indicated earlier(the section on 'technological learning' in Chapter 2), Bell(1984) also recognises the importance of "learning by hiring" and "learning by training" in accumulating technological capability.

Table 5-3 shows recruiting methods of R&D staff in our sample firms. We can see there are significant differences between large and small firms in this respect. Predominantly, large firms recruit R&D staff by employing new (university) graduates, whereas small and medium firms tend to select production employees and train them to become R&D staff. The second important methods are the opposites to these. Another source of recruits is from 'scouting from large firms'. Both large and small firms do this. 'Scouting from small firms' is rare in large firms but commoner amongst small firms.

Table 5-3. Composition of recruiting methods of R&D staff

(unit: %)

Recruiting methods	Large firms	Small & Medium firms
1.selection from existing production workers and technicians	29.2	53.6
2.employing new graduates	52.7	22.5
3.scout from small & medium firms in the same industry	1.8	8.2
4.scout from large firms in the same industry	5.0	9.3
5.scout from engineers in research institutes or universities	2.1	0.7
6.recruiting engineers(Korean or foreign) from abroad	4.2	0.0
7.other	5.0	5.7

The flow of R&D personnel among the large and the small firms is thus as follows. Personnel in the large firms can move horizontally to other large firms or 'down' into small firms, whereas those in the small firms can only move horizontally and opportunities for upward mobility to large firms hardly exist. This issue will be discussed in further detail when we deal with 'labour market factors'(Chapter 7). All in all, scouting from other firms is more popular in the small and medium firms than in the large firms.

The other methods of recruitment, i.e.'inducing engineers from abroad' or 'scouting from research institutes or universities', are moderately important in the large firms, whereas they are hardly used in the small firms. Since, in the Korean context, these strategies represent the ways to recruit engineers with more sophisticated and up-to-date technological knowledge, the low level of capability to assimilate foreign technologies in the small and medium firms as we have seen before is likely to be related to some degree to this fact. The reasons why the small and medium firms do not use these methods seem to lie not only in the irrelevance of the knowledge such engineers possess to these firms but also (and chiefly) in higher wages which such engineers typically demand. For small firms whose main competitive advantage is in low wages (this will be discussed later), the imperative of saving labour costs may be too strong to allow them to employ such 'expensive' personnel.

Then how are such R&D staff trained after they are employed? Significant differences exist here also between the large and small firms in our sample. The most important methods of training in the large firms were, in order of importance, 'sending staff to licensor(s) and abroad', 'internal technical training', 'teaching by external engineers invited' and 'teaching by technical institutions'. In contrast, in the small firms they were 'internal technical training', 'leaving it to the individual himself'(i.e. no opportunities of training but on-the-job experience by trial and error), 'sending staff to foreign licensor', 'teaching by technical institutions', and 'teaching by external engineers invited'. 'Sending staff to research institutes or universities', which usually lasts a rather long period, is of little importance in both groups. The fact that the most important method of training in the large firms is 'sending R&D staff to foreign licensor(s)' seems to explain the higher capability of these firms in assimilating imported technologies. Even though 'internal technical training' is important in both size groups, there is a qualitative difference in the level and organisation of such 'internal training'. Since many of the large firms have not only their own research institutes but also the separate bodies of internal technical training (especially, in those firms belonging to big conglomerates), the method and content of training are formal and systematic and the duration of training is usually longer (e.g. for months). In contrast, 'internal training' in the small firms is performed mostly, 'on-the-job', by some senior engineers or technicians and lasts only weeks or even days(our interview). After these short initial periods, R&D staff in the small firms must learn by their own efforts, as is revealed from the fact that the second most important method of training is 'leaving it to the individual himself'. In a word, training of R&D staff in small firms has an overwhelmingly *informal* character.

5-2-2. sources of technology

Then where does technology itself come from when it is acquired by a firm ? Before we answer this question, we need to distinguish between two different forms of

existence of technology: technology as information or software and technology as hardware. Though here we focus mainly on the first aspect, we cannot omit some explanation of the second because it is actually a major form of technology acquisition by Third World firms. Thus we will discuss these more or less independent forms separately.

1. software

To answer where and how firms acquire software technology (or in other words, technical knowledge) to improve products or processes, we can look to the following three inter-related, but not necessarily identical, aspects: acquisition of technological(and market) information; sources of ideas for innovation; and sources of technology for new products or processes.

Firstly, let us see how they get *technological information* in general(i.e. not for specific R&D projects). According to our survey, many of information sources are common to both the large and the small firms, though their relative importance to each group is hard to compare. Major sources are government-sponsored research institutes (such as the Korea Institute of Machinery and Metals, the Korea Institute for Economics and Technology, and the Korea Advanced Institute of Science and Technology), professional books or journals, overseas field trips, foreign licensing firms or those with technological ties, technical consultants in universities, and suppliers of equipment/parts. One characteristic source for the small firms is a technical assistance institution established by the government specifically to promote such firms: the Small and Medium Industry Promotion Corporation (SMIPC). This SMIPC was the most important 'external' technical source identified by the sample small firms(although they are not equally satisfied with the services it offers). SMIPC provides not only technical support like management and technical extension services, training and information services, and assistance for R&D and technology transfer, but also financial support through subsidies, equipment leasing and even equity investment (we'll see more about SMIPC in the part on government policy in Chapter 10). Besides this, other public technical assistance institutions and industrial associations(e.g. the Korea Machine Tool

Manufacturers' Association) are also of some help to these firms on technological matters. Moreover, in our interviews both large and small firms identified catalogues by foreign companies and disassembling and/or imitation (i.e. 'reverse engineering') of foreign products as other important sources of technological information.

We also asked firms about their sources of *market information.* Because market information often includes a certain degree of (sometimes crucial) technological information, we need to consider the role of such sources. To cite major sources, excluding the ones duplicated with the above, for the large firms their overseas branches and for the small firms KOTRA (the Korea Trade Promotion Corporation), i.e. a quasi-government organisation, seem to be the most important. Firms' own sales staff, participation in foreign or domestic trade exhibitions, foreign or domestic buyers and customers, industrial associations and trade journals published by them or the government are also important.

Though we do not know how far the firms are satisfied with the quantity and quality of technological information coming from such various sources, the fact that they point to 'lack of technological information' as their third or fourth most important difficulty in technological development(see 5-3-5 later) seems to imply that the information is still either insufficient or irrelevant. We did not find firm evidence that small firms are more wanting in technical information than large firms, though we guess that this may be so because their information sources are more limited.

The second aspect of the acuisition of technical knowledge is concerned with *who proposes the original plan or idea* for technological development. In this regard, the sample firms were asked to list three main bodies in order of importance as original proposers of product or process development. Table 5-4 shows the results.

In the large firms R&D departments proved to be the most important proposer of technological development. This is not surprising considering that in these firms human and material resources for R&D activities are concentrated in such departments with the

Table 5-4. Original proposers of technological development

Sources of ideas	Large firms (rank)	Small & Medium firms (rank)
1.top manager or the executives	2	1
2.R & D department	1	2
3.factory manager	-	4
4.production workers/technicians	4	6
5.sales staff	3	3
6.domestic customers	5	5
7.foreign buyers	-	7
8.technical institutions	-	7
9.suppliers of components or equipment	-	-
10.foreign licensors	4	-

consequence that they possess the best expertise in technological matters. The role of top manager (or the executives) is also crucial and was only the second most important source. This order is reversed in small firms. This seems to stem mainly from the fact that the best technological expert in such firms is often top manager himself or at least one of the executive. Many of the small firms were originally established by engineers or technicians.

It is notable that in both groups the role of sales staff is prominent. We have already noted that they are an important source of (market) information, but they are also a major idea source of ideas for product or process development. Thus co-operation between the two major departments(R&D and sales), especially the active involvement of sales staff in R&D projects, is of great importance to any successful technological development. On the other hand, the role of production workers and technicians is also notable. This seems to confirm our earlier point that they are an important source of technological innovation. That their role is more prominent in the large firms seems to be related, again, to their higher quality in those firms. The reason why foreign licensors (which includes those with technological co-operation) appear important only in the large firms seems to be that most of the small firms do not have particular foreign companies with which they maintain a lasting relationship of technological agreement or co-operation. The few small firms which do have such a

relationship are believed to acquire technical information and know-how from their foreign partners, but but their original ideas for innovation seems to come from other sources.

Finally, let us examine the third aspect of acquisition of software technology : the *sources of technology for new products and processes* developed by firms. Sample firms were asked to indicate the numbers of new products or processes they had introduced into the market (including those developed through technology imports) in the last five years (until the early 1985) and then to classify the numbers into different technology sources. Table 5-5 below shows the percentage result of these numbers in each size group.

Table 5-5. The proportions of sources of technology for new products and processes developed in the last 5 years

(unit : %)

Methods of technology acquisition	Large firms	Small & Medium firms
1.in-house R & D	72.7	71.8
2.licensing agreement	17.7	20.6
3.joint R & D with domestic institutions	3.9	7.5
4.subcontract to domestic institutions	2.7	-
5.subcontract to foreign institutions	3.0	-
6.other	-	-

As can be seen in the Table, in-house R&D is most important(over 70%) to both groups of firms. However, these figures also include the developments by imitation of foreign technologies. Although a large part of the in-house R&D by Korean firms in fact consists of such 'informal' (Bae, 1984) or 'non-market mediated' (Fransman, 1985) technology transfer, this cannot be, or, in a sense, need not be, distinguished from their original innovations in a quantitative measure. Anyhow, it suffices here to note that only formal technology imports are treated separately in the above Table. The second important source is licensing agreements, but its proportion is only around 20 %. From this, we can guess that most of the new product or process developments in the Korean machine tool

firms have been performed by informal methods of technology transfer rather than by formal technology imports. But, considering that firms tend to purchase foreign technologies when they are unable to develop them (or it's too expensive to do so), imported technologies are likely to be of relatively higher sophistication.

All the other sources have only minor significance. Among them, joint R&D with domestic institutions (e.g. research institutes and universities) is most important. This item is closely related to the government influence, because such joint R&D is mostly done with government-sponsored research institutes and is often subsidised by the government. Subcontract to domestic or foreign institutions is used only by the large firms. This seems to reflect the gap in financial capacity between the large and the small firms in that these methods are seldom pursued in Korea without a certain amount of financial reserves. For the reasons of cost and control, firms tend to prefer to choose other methods (say, in-house or joint R&D).

All in all, sources of technology for new products and processes are relatively more diversified in the large firms. But they are not significantly different between the two groups.

2. hardware

Technology is already embodied in capital goods that firms use. Thus the purchase of machinery has become an important source of technology acquisition by firms. As we have seen above, the sources of software or know-how are not significantly different between large and small firms. But the case of hardware is quite different. Table 5-6 indicates the proportions of production machines owned by the firms by their countries of origin.

It is striking that while the large firms are heavily dependent on foreign machines (overwhelmingly Japanese ones) the small and medium firms largely use domestic machines. Moreover, in our field visits, we observed that a considerable part of the machines used by the latter are the ones made in-house. A part of this difference is likely

Table 5-6. The proportions of production machines by countries of origin.

Countries of origin	Large firms	Small firms	Significance (Mann-Whitney: two-tailed)
1.Korea	27.7	62.7	*P<.05
2.Japan (1)	59.2	29.6	*P<.05
3.U.S.A. (2)	3.1	4.0	
4.other countries (3)	9.9	3.7	*P<.05
('foreign': (1)+(2)+(3))	(72.3)	(37.3)	*P<.05
Total	100.0	100.0	

to stem from their different histories: whereas the small firms slowly accumulated their production capacities and skills to make machine tools through their longer history, the large firms, most of which first entered the industry in the late 1970s following government policy, needed a rapid build-up of production capacities and hence had to import foreign capital goods because of either lack of appropriate domestic machines or their low quality. Actually during the latter half of the 1970s, a vast amount of foreign machinery (most from Japan) was imported through the form of loans. However, this is only a partial explanation. Though we don't have any specific figures, it is not unreasonable to suppose that dependence on import when purchasing new equipment is still higher in the large than in the small and medium firms. Thus the other, and probably more fundamental, reason seems to lie in their different needs of production technologies. To meet the higher demand on product quality and to pursue full economies of scale by increasing labour productivity, the large firms tend to choose advanced foreign machines in spite of their higher price. On the contrary, since the small firms tend to be specialised in the production of relatively low-grade and simple products, they often prefer to buy domestic machines because of, primarily, their low price. This argument is supported partly by the average price of production machine per unit in each type of firms: it's about 20 million won in the large firms whereas 5.7 million won in the small firms, i.e. three or four times expensive in the former. But a more detailed explanation about this will be attempted in later chapters.

In short, large firms of the Korean machine tool industry heavily depend on imported

foreign capital goods. The most important source of the latter is Japan.

5-3. Technological change

5-3-1. motives of technological development

It seems to be a more logical order to explain why the firms put their efforts into technological development, before we discuss the performances resulted from such efforts. Moreover, this will give us some hints about determinants of technological change, a subject which we will analyse in full detail in the Part III. By *motives* we mean 'pressures' or 'incentives' but not 'constraints' which influence success or failure of technological efforts. *Determinants* is a broader concept which comprehends both motives and constraints. In other words, 'determinants' of technological change designates all the factors which influence the rate and patterns of the change.

Once again, we asked firms to make a subjective ranking using a five-point scale (1 = very important ; 5 = never important), to measure the relative importance of various motives for technological development. Table 5-7 summarises the results.

Table 5-7. Motives of technological development
(5-point scale: 1 = very important ; 5 = never important)

Motives of TD	Large firms		Small & Medium firms	
	mean	rank	mean	rank
1.increased competition in domestic markets	1.2	1	1.1	1
2.increased competition in export markets	1.6	2	1.7	2
3.demand by customers or foreign buyers	1.9	3	2.2	3
4.policy changes, instructions or directions by government	3.0	6	3.6	6
5.increases in labour costs	2.4	5	2.6	5
6.increases in the costs of materials or energy	2.2	4	2.4	4
7.shortage of skilled workers	2.4	5	2.6	5
8.for more strict control over production process	3.1	7	2.6	5

It can be first noted that the priorities of the motives in both firms are remarkably similar. The single most important motive is 'increased competition in domestic market'. The second (increased competition in export market') and the third ('demand by domestic or foreign customers') are also product market-related factors. Less important than these are input cost factors like 'increases in the costs of materials and energy', 'increases in labour costs' and 'shortage of skilled workers'. On the other hand, 'policy initiatives by the government' or 'purpose of production control' appear relatively less important. The largest differences between the large and the small firms are found in these last two factors. The fact that government policy appears particularly unimportant in the small firms implies a possible bias in such policy against these firms or at least shows that they 'feel' that they have been more alienated by government policy. This seems either because the main effects of such policy has been exerted on the large firms or because the policy towards small and medium firms has been largely irrelevant, or both. This issue will be treated in Chapter 10. The other point is that the above result should not necessarily be interpreted as indicating the relative insignificance of the role of government policy. Though such policy may not be a direct 'motive' of a firm's technological efforts, its influence is more fundamental, though often indirect, i.e. as a major factor which can determine or change other motives listed above. The item 'purpose of production control' is included because of the recent debate about the 'labour process' (e.g. Braverman, 1974) in which the motive of managerial control is regarded as crucial for technological change. In our result, the importance of such 'control' motive is only modest, though a bit higher in the small firms. This issue is closely related to labour relations within firms. We will attempt to explain this in Chapter 11.

How have these motives been translated into targets of technological development?

As shown in Table 5-8, this also appears almost similar between the large and the small firms. In both groups 'developing new products' is overwhelmingly important. But it must be noted that in the Korean context such 'new' products rarely mean new inventions or innovations but refer mostly to imitations of foreign products with minor

Table 5-8. Main targets of technological development

(Order)	Large firms	(Order)	Small & Medium firms
1.	developing new products	1.	developing new products
2.	improving existing products	2.	improving existing products
3.	shortening production process	3.	shortening production process
4.	diversifying products	4.	mass production
5.	mass production	5.	diversifying products
6.	saving materials	6.	saving labour
7.	reducing the number of components	7.	saving materials
8.	diversifying the use of products	8.	developing and utilising new materials

modifications. Any product which is 'new to the firm' is treated as a new product here. The second one is 'improving existing products' and the third, 'shortening production process'. While the fourth and the fifth are 'diversifying products' and 'mass production' respectively in the large firms, the order is reversed in the small firms. Besides these, 'saving materials', 'reducing the number of components' and 'diversifying the uses of products' are important in that order in the large firms. On the other hand, in the small firms, 'saving labour', 'saving materials', 'developing and utilising new materials', 'reducing the number of components', 'diversifying the uses of products' and 'developing new designs' appear more or less important.

Therefore, for both groups 'product innovation' is far more important than 'process innovation'.[3] The only difference we find is that process innovations like 'shortening production process', 'mass production' and 'saving labour' appear more important in the small than in the large firms. At first sight this seems to contradict a common expectation that process innovation is pursued mainly by large firms. But our result would better be interpreted, rather than showing a general trend, as evidence that the small firms are recently trying to increase their labour productivity because of, say, increased domestic competition.[4]

[3] Here we use the term 'innovation' in a broad sense which includes both major and minor forms of innovation.

[4] Actually, in terms of the average numbers of new products and processes during 1980-85, the large firms developed 7.8 new products and 12.6 new processes whereas the small firms did 2.8 new

5-3-2. R&D investment [5]

So how much have the firms invested in R&D? This is not only a most common indicator of technological efforts by firms but also an indirect measure to know how much technological change the firms have achieved. Needless to say, the latter is not in direct proportion to R&D investment, not only because R&D inherently involves risks and thus often fails, but also because it tends to exclude 'incremental' forms of technological change done by shopfloor workers and technicians without separate R&D investment. Bearing these weaknesses in mind, we will look at R&D figures below.

Table 5-9. R&D expenditure in terms of size and proportion to sales

Year	Average R&D expenditure (in million won)		R&D expenditure/sales (%)	
	Large firms	Small firms	Large firms	Small firms
1982	630.8	39.6	2.3	4.5
83	863.6	45.5	3.3	3.8
84	944.8	65.4	2.5	4.1

Note: No. of cases = 7 large firms, 13 small and medium firms.

As can be seen in the Table, the size of the average R&D expenditure is far greater in the large firms. Actually this has been expected from the result of the earlier comparison on R&D manpower. The growth rate of such expenditure, however, shows a different trend. Though between 1982-83 the growth rate was higher in the large firms, between 1983-84 the situation was reversed and the small firms were very active to invest in R&D.

Also, in terms of the proportion of R&D expenditure to sales the small firms are far from stagnant. It has actually been higher than that of the large firms throughout 1982-84. While the small firms have invested around 4 % of their sales in R&D, the large firms have invested about 2~3 %. Moreover, between 1983 and 84, whereas the proportion

products and 1.3 new processes. i.e. in terms of performance, the large firms are 'process- innovative'.

[5] Here as 'R&D investment' we include all the expenditure which is directly related to R&D and design, i.e. pay for R&D and design staff, costs to purchase research materials and equipment, costs to purchase technical literature and journals, training costs, etc. But costs of technology import (e.g. royalties...) are excluded.

decreased in the latter, it slightly increased in the former. Thus R&D investment has been more intensive in the small firms. Moreover, according to Han(1984), the machine tool industry is more R&D-intensive than any other branches of the machinery sector in Korea.[6] So it can be said that the small firms in the Korean machine tool industry are far from stagnant in R&D, but actually more active than any other machine-producing firms. The reason for this might be found in the following statement by Chudnovsky on the machine tool sector: "... it was relatively easier to obtain tangible results in product development in this area of the mechanical industry, at least before the diffusion of NC machine tools."(1986:80).

However, in terms of the average size of R&D expenditure 'per R&D staff' the small firms still lag behind the large firms though the gap is not so great: in 1984 it was 11.9 million won in the latter while it was 9.4 million won in the former. This implies the scale of a R&D project is larger in the large than in the small firms, though it is hardly surprising. This seems to be another example which suggests that their R&D efforts have different character and styles.

5-3-3. typology of technological change

As 'technological capability' is an abstraction of heterogeneous elements, so is the concept of 'technological change'. Various forms of technological change can exist at the level of the firm, of the industry and of the country. Since each of these forms tends to have a more or less specific character, the technological performance of a firm (or an industry or a country) may be uneven between these different forms. Therefore, to measure the rate of technological change concretely we need to classify these different forms and find appropriate indicator(s) for each. In order to assess the rate of technological change of sample firms, we thus divided the various forms of technological change appearing in Korea at the firm level into the following four categories:

[6] In his calculation, the proportion of R&D to sales in 7 machine tool firms (mostly large firms) is 1.89 % (the average between 1979-82). This is higher than those of electrical machinery (1.67 %) and machinery total (0.28 %). See Han, ibid., p. 35.

1. introduction of capital equipment embodying new technology : as we have already stressed, the purchase of new machinery is a major source of technology acquisition by firms. New vintages of capital goods often embody new technology. And this significantly contributes to the increase in labour productivity and also to improvements in product quality. But this does not mean only a change in hardware but also involves significant changes in software technology; that is, in the processes of 'search' and 'choice' of new machinery a firm's technological knowledge changes and is accumulated. Moreover, to 'use' the new machinery chosen, such technological capabilities as 'product manufacturing capability' and 'process engineering capability' play a crucial role and must change;

2. import and absorption of foreign technology : the purchase of foreign technology (excluding simple imports of machinery) is another major form of technological change in the Third World. At the level of the firm, licensing agreements, joint ventures, turnkey projects, management and technical consultant contracts and other technical service contracts are typically used. To import foreign technology successfully, not only are 'search' and 'choice' capabilities are needed but also 'absorption' capability. Thus, besides changes in 'product manufacturing' and 'process engineering' capabilities, changes in 'design' capability are also involved. But the build-up of design capability through technology imports tends to remain at 'detail design' level(Erber, 1986). So 'basic design' capability must be learned through the firm's own efforts;

3. imitation, adaptation and improvement of foreign technology : as we indicated before, in the Third World informal forms of technology transfer such as copying, imitation, adaptation and improvement of foreign technology serve as a very important means of technological change. And they often involve incremental or minor as well as major types of changes in product or process technology. The cumulative effect of incremental changes over time may even go beyond the effect of major changes. The significance of 'learning-by-doing' in this process for long-term technological accumulation has already been stressed by many authors. Actually a large part of the 'R&D' activities of firms of the Third World is devoted to such incremental changes (Katz, 1984). Moreover, the 'new' products and

processes developed by these firms are rarely 'new' in a fundamental sense(Fransman, 1985) but are largely imitations of foreign products and processes. Typically, they develop a product first by imitating a foreign model (though reverse engineering, etc.) and then gradually adapt and improve it over time.

In this form of technological change, though incremental changes by production workers and technicians constitute an important component, 'product manufacturing' and 'process engineering' capabilities alone are not enough. Indigenous 'design' capability is crucial and slowly develops (in 'basic' as well as 'detail' designs) as experience accumulates. Also, to understand the principles behind foreign technology and to modify and improve it, a certain degree of R&D capability is necessary;

4. invention and innovation of new technology : though they are rare in Third World countries, local inventions and innovations which differ significantly from foreign technology do appear. They are largely the result of long and concentrated efforts of technological learning through such processes as we mentioned above. At this point in time the firm comes to experience discrete jumps in its technological evolution. Consequently, the firms can finally become 'internationally competitive' in terms of technology in the real sense. In achieving this highest stage of technological change 'design' and 'R&D' capabilities are the most important. Both basic and detail design skills must be fully mastered. And quite a significant amount of R&D effort is required.

Based on this typology, we will now assess the rate of technological change of our sample firms below. We intend not only to measure the difference between the large and the small firms in the rate of technological change in each type, but also to see and compare which form(s) of technological change each size group puts most emphasis on.

5-3-4. rate of technological change by types

1. introduction of new capital equipment

Table 5-10 shows how new capital equipment is which the firms are using. It shows

that over half of production equipment in a large firm was made between 1975~79, compared to small firms where almost half of their equipment is post 1980. Thus the small

Table 5-10. The average numbers of production machines per firm by year of machine manufacture

Year of manufacture	Large firms	Small firms	Significance (M-W:two-tailed)
1.before '69	21.0 (17.1%)	3.2 (4.7%)	
2.1970~74	27.6 (12.3%)	11.5 (20.6%)	
3.1975~79	145.0 (56.7%)	18.4 (30.1%)	*P<.10
4.after '80	52.4 (13.8%)	20.2 (44.6%)	*P<.05
Total	246.0 (100.0%)	53.3 (100.0%)	

firms own a significantly higher proportion of new vintages of production equipment than the large firms. This result looks interesting when the average year each group started machine tool production is considered: 1968 for small firms and 1973 for large firms. Does this mean the small and medium firms are more 'active' in introducing new capital equipment, contrary to their conventional image? The above result shows that they are, at least, not 'stagnant' in it. But whether it reflects a general tendency needs more careful consideration. In our view, the result should be considered as reflecting conjunctural reasons rather than a general tendency. Most large firms have not needed to expand their production capacity because they were already suffering from an excess capacity of production equipment purchased in the later 1970s, whereas small firms- faced with increasing demand according to the recent business recovery after the recession in the early 1980s- have increased their production capacity (through purchase or in-house making). In addition, the fact that a few of the small firms were established only recently may have contributed further to the above result.[7]

However, it is unlikely that the production machines used by the small firms, though

[7] Among the 14 small firms, four firms were established in or after 1980. Though the proportions of their capital equipment produced after 1980 are not significantly higher than those of the other small firms, they certainly do not lower the average of such proportion in the whole small and medium firm group.

new, embody 'new or advanced technology'. Common sense suggests it is large rather than small firms that have the motive to purchase capital equipment embodying advanced technology. While it is more expensive, it offers higher productivity and economies of scale involved. Our sample seems not to be an exception in this regard. The proportion of numerical control (NC) machines(which can be considered as a typical kind of high technology equipment) is 9.3 % in the large firms, which is significantly higher than 2.0 % in the small firms ($P<.05$). Also, given that the import policy for machine tools in Korea means that only items which are not produced locally can be imported, the higher proportion of foreign machines (in Table 5-6) in the large(72.3%) than in the small firms(37.3 %) seems to suggest that the former own proportionally more equipment embodying advanced technology. This is also supported by the firms' own subjective evaluation of the quality of their facilities and equipment (in Table 5-2). Nevertheless, the fact that the small firms have been active in introducing new - even if not the most sophisticated- equipment should not be underestimated. And this must have contributed to their recent productivity increases.

2. technology import and absorption

Typical forms of technology import in the Korean machine tool industry are licensing agreements and joint ventures. In our samples, there are two joint venture firms both of which belong to the small firms group. One firm (A) was established in 1969 through a joint venture with a Japanese company, and the other (B), in 1981, jointly with an U.S. company.[8] In the case of (A) the purpose on the Japanese part seemed to be to enter the Korean domestic market. And in the case of (B) the U.S. company wanted "to increase competitiveness against, mainly, Japanese firms by exploiting low wages in Korea" (from an interview with the president of (B)). But in both cases Korea's objective was to acquire advanced foreign technologies. Naturally, companies have heavily

[8] The proportions of investment were the following: in the case of (A), 51 % (Korea): 49 % (Japan) at the beginning but now 75 % : 25 %, in the case of (B), 50 % (Korea): 50 % (U. S.).

depended on their foreign partners for the supply of technologies(through licensing agreements, equipment supplies, technical training, management and technical consultants, etc.). Now firm (A), because of its longer history, has accumulated its own technological capability to some degree and thus can develop some conventional types of machine tools via in-house R&D. Recently it decided to enter NC lathe production and again had to import the technology from its Japanese counterpart. Firm (B) is still almost entirely dependent on technology supply from its U.S. partner. It has no record of product development via its own R&D yet, though it is planning to do so. Also, both firms indicated their foreign partners as their major source of technological and market information.

With the exception of joint ventures, foreign technology imports have been largely dominated by the large firms. The total numbers of licensing agreements our sample firms entered into during the last 10 years ('75 ~'85) were 27 in the large firms and 8 in the small firms.[9] Table 5-11 below shows the distribution. Among the large firms, all except one entered one or more licensing agreements. Some big firms had 6 or 7 licenses.

Table 5-11. The distribution of licensing agreements during 1975~ 85*

No. of licenses	Large firms		Small & Medium firms	
	no. of firms	(no. of licenses)	no. of firms	(no. of licenses)
0	1	(0)	10	(0)
1	2	(2)	2	(2)
2	2	(4)	0	-
3	1	(3)	2	(6)
5	1	(5)	0	-
6	1	(6)	0	-
7	1	(7)	0	-
Total	9	(27)	14	(8)

Note(*): Until the time of our survey, i.e. June 1985.

Among the 14 small firms, only four firms had more than one license. If the two joint venture firms are excluded, only two firms in this group had any experience of

[9] Moreover, excluding those by the two joint venture firms, only 4 licenses were done by the other small firms.

licensing agreements.

If we look at the trends in licensing agreements over time(Table 5-12), we see that most of licensing agreements entered by the large firms are concentrated between 1976~79.

Table 5-12. The numbers of licensing agreements during 1975~85 by approval years

Approval year	Large firms	Small & Medium firms	Total
1975	0	1	1
76	7	0	7
77	2	0	2
78	8	0	8
79	2	1	3
80	0	0	0
81	1	1	2
82	1	0	1
83	3	3	6
84	2	1	3
85 (until June)	1	1	2
Total	27	8	35

Since many of these firms entered the industry in that period, they seem to have been largely dependent on technology imports at the beginning. Because of the recession the numbers of licensing agreements were drastically reduced in the early 1980s, but recently numbers have gradually increased again. In contrast, there were hardly any licensing agreements in the small firms until the early 1980s. This seems to suggest that the small firms had depended almost entirely on 'informal' forms of technology transfer (i.e. copying, imitation, and adaptation of foreign technologies) for technology acquisition. More recently the numbers of 'formal' technology imports like licensing are slowly increasing. Besides the joint venture firms, other small firms have also begun to try licensing agreements or at least to show an interest in them (from our interviews with the firms). This suggests that they feel the need to upgrade their products and processes because of pressure from changes in domestic and export markets. But many difficulties still are involved in such technology import by these firms, including high royalties, etc.

Where do the foreign licenses come from? Like the case of capital equipment, the

predominant source of such licenses is Japan. Among 27 licenses held by large firms, 22 came from Japan, 3 from West Germany, and 2 from the USA. Also, among the 8 licenses held by small firms, 5 are from Japan and 3 from the USA. These 3 US licenses were all held by the joint venture firm (B), which means that other small firms are wholly dependent on Japan as their source of licensing agreements. In the 1970s, for both groups of firms, Japan was almost the only source, since 1980 the firms have tried to diversify their sources.

Then how about the capability to absorb imported technologies? As we saw earlier (in Table 5-2), the subjective evaluation of such assimilation capability was significantly higher in the large firms (i.e. 4.2 versus 3.0 on the 5-point scale). This is hardly surprising, considering the greater experience of these firms in licensing agreements. In addition, their superior manpower in R&D and design as well as in product manufacturing and process engineering must have supported the successful absorption of imported technologies.

In short, we can conclude that the rate of technological change via technology imports is, except in the joint-venture small firms, higher in the large than in the small firms.

3. imitation/ adaptation/ improvement of foreign technology

As we already stressed many times, informal technology transfer through imitation, adaptation and improvement of foreign technology is a predominant, if not the most important, form of 'indigenous' technological change in the Korean machine tool industry. However, the problem in an empirical study is the lack of reliable indicators to measure such informal forms of technological change. To develop such an indicator(s) is very difficult because of the subtle character of this type of technological change. Thus we will only try to identify some major features and comparisons below, using the data available to us.

Firstly, on the question of which firms have concentrated on (and succeeded in) the imitation of foreign technology, we will examine the origins of the first model of machine tool produced by them. Not unexpectedly, most of the large firms' first models

Table 5-13. Origins of the first models produced by the sample firms

(unit: no. of firms)

Origins of 1st models	Large firms	Small & Medium firms
1.copy and imitation	3	8
2.foreign licenses	5	1
3.assistance by foreign firms	1	2
4.joint ventures	-	2
5.joint R&D with universities	-	1
Total (no. of firms)	9	14

Source: interviews with the sample firms

were developed under foreign licenses. The few large firms which relied on imitation were rather medium-sized when they developed their first models. Thus large firms which were already big when they entered the industry depended on foreign licenses(or assistance) to develop their first products. These firms are also 'newer' : they are typically less than 10 years old. They are believed to have chosen the foreign licenses strategy in order to compress their learning time. In contrast, the small and medium firms largely relied upon copying foreign models. With the exception of the joint venture firms, only those firms which already had special relationships (e.g. through personal relations, etc.) with foreign companies depended on their assistance(our interview).

In the last 5 years (i.e. 1980 ~ early 1985) the average number of new products and processes developed by the large firms was 21.3, while that by the small and medium firms was 4.2. Over 70% of these in both groups- 15.8 and 3.2 respectively- were developed by in-house R&D (see Table 5-5 earlier). But, given that in the last 10 years the numbers of patents or utility models registered were minimal in both firms (see Table 5-14 later), a majority of these 'new' products and processes are copies or

imitations of foreign models. So, at the present stage Korean machine tool firms, regardless of their size, have not developed a truly 'original' technology in international standards but still direct their main efforts into the assimilation and imitation of foreign technologies. While small firms have hardly changed their methods of new product development, large firms, growing out of their initial dependence on foreign licenses, are now also concentrating on imitative developments. Their larger number of new products and processes does not necessarily imply a superior capacity to imitate, but may merely reflect their larger scale of R&D expenditure, R&D manpower and sales.

This notable change in the large firms' method of new product development can also be seen in the way they entered the production of NC machine tools. The first Korean NC model was developed by Whacheon Co. jointly with KIST (KAIST) in 1977. Since then other large firms have also tried to develop NC machines via in-house R&D. In-house R&D was preferable to licensing agreements because foreign licensors tended to offer only old models (Jacobsson, 1984 : 233; *Machine Tool*, No.10: 47), and also because of 'expensive royalties', 'territorial restrictions on export' and 'prohibitions on adaptation and improvement of the design'. Although their technological accumulation through earlier technology imports was of some help, they faced enormous difficulties in the in-house development of NC machine tools because they had to study specifications and prepare drawings and manufacturing know-how by themselves(which used to be supplied by foreign licensors). Even when they succeeded in developing a model, it often turned out to be unsaleable. But in general they learned a lot through such a process of trial and error. So now large firms have reached the level to develop, though mostly imitations, not only CNC lathes, CNC milling's and machining centres but also (in a few cases) such high technologies as FMC and FMS, *by their own R&D efforts.*

Small firms faced many more difficulties when they decided to enter the NC area.[10]

[10] According to our interviews, the typical reason why they decided so was their perception of the importance of the international technological trends rather than the existence of demand.

Their problems were both financial and technological.[11] In particular, they suffered from a lack of knowledge and experience about the electronic parts of NC machine tools, e.g. controller and interface. Though they had almost mastered the technology of the mechanical parts through their long experience, they were totally unfamiliar with electronic technology like NC. To understand this new technology a substantial R&D effort was necessary. Thus those small firms which started to develop NC products early received technological help from KIST. Other small firms which had foreign technological ties (through joint ventures, etc.) relied on their foreign partners. This is a contrast to the case of the first models of conventional machine tools, where the small firms largely depended on copying and the large firms on foreign licenses. Such a difference in the case of NC stems not so much from the gap in imitation capability *per se*, as from the large firms' superior financial and R&D (not design) capabilities. This must be an issue in terms of the advantages of large firm size. However, as the small firms increasingly accumulate their knowledge about NC technology and with financial and technological support from the government, they are expected to be more and more interested in, and decide to enter, NC production. Up until now, 7 large firms

Table 5-14. Methods of the development of the first NC models

Methods of development	Large firms	Small & Medium firms
1.imitation by in-house R&D	4 (1)	- (1)
2.joint R&D with KIST	1	2
3.licensing agreements	- (1)	-
4.joint ventures	-	1 (1)
5.assistance by foreign firms	-	1
Total (no.of firms)	5 (2)	4 (2)

Note: The numbers in brackets are those firms which are currently developing a first NC model or planning to do so.

[11] The problems identified by a top manager of a medium firm are (1) lack of technological manpower, (2) lack of technological and market information about NC, (3) large R&D costs (e.g. 100-1000 millions won per model) and (4) burden of continuous R&D costs to diversify NC products. *Machine Tool*, No.6, p. 24.

and 6 small and medium firms are either already in production NC products or planning to do so (see Table 5-14).

Secondly, which firms have shown higher performance in 'adaptation' and 'improvement' of foreign technologies? This is really difficult to answer, because we have actually no measure to compare such performance between firms. But what is relatively clear is that those firms which possess higher 'indigenous' design capability through a long experience of learning-by-doing are likely to have achieved better performance in this type of technological change. This is because adaptation and improvement necessarily involve numerous modifications of original designs by trial and error. In this respect, the large firms would seem to be disadvantaged relative to the small firms: while they have developed many new products within a short period of time, their heavy dependence on foreign licenses for their initial models and their inevitably short experience of learning-by-doing seem to have limited 'the depth' of their design capability. Moreover, as we noted before, the fact that foreign licenses typically involve 'prohibitions on adaptation and improvement of the design' has further exacerbated this and deterred technological accumulation. Therefore, small firms, which have concentrated on imitation and have longer experience of learning, seemed to have achieved more adaptations and improvements. This judgement is partly supported by the firm's own evaluation of their design capability(Table 5-2), where the gap between large and small firms is smallest. The design capability of the large firms does not seem to be much greater than that of the small firms, at least for comparable product models.

According to our interviews, small firms are proud of their design capability. They indicated that they were completely self- reliant in design on most of their currently produced items, excluding perhaps NC products. And they stressed that the design content and product quality of their conventional models have already reached international standards. This implies that they have made great efforts to adapt and perfect their products. This design capability seemed to be embodied in a few 'core designers'

who have over 10 years of design experience in their same firms. These people are believed to have the ability to do 'basic' as well as 'detail' designs. So, design self-sufficiency for their current products is higher in the small than in the large firms. Although the latter have superior design manpower in terms of numbers and educational levels, indigenous design capability embodied in the few core designers of the former seems to be one of the major competitive strengths they can rely on.

Lastly, and associated with 'adaptation' and 'improvement', there are still other, minor types of technological change performed by production workers and technicians on the shopfloor. These have most incremental nature and hence are also hard to measure.[12] They are related to 'product manufacturing' and 'process engineering' functions rather than to design or R&D. Due to the lack of data, we cannot judge here which firms have been more active in such technological changes. But if we assume that the firm's own evaluation of their capabilities in these aspects include an assessment of their employees' ability to perform such changes, we can possibly use these evaluations as an indirect indicator. As we saw in Table 5-2, large firms are superior in both product manufacturing and process engineering capabilities. The quality of workers' skills is also significantly higher in the large firms. On these indicators alone, therefore, large firms are likely to have been more successful in such incremental changes. According to our interviews, many small firms complained about the high turnover rate of production workers and general technicians (see Table 7-5 in Chapter 7), and indentified this as one of their main difficulties in technological accumulation. So in spite of their longer histories small firms have been relatively poor in this kind of technological change.

[12] As examples of output measures of such technological changes, we can think of 'the rate of defect' or 'output per man-hour (i.e. Labour Productivity Index)'. But we do not have the data about such measures.

4. new invention and innovation

It is well-known that local inventions and innovations which differ significantly from foreign technology are generally rare in Third World countries. These are the most radical and higher form of technological change, and are usually based on a considerable amount of technological learning and R&D.

Though it is rather tricky to decide the boundary of this category of innovation, we can identify its major trends by reviewing some visible indicators. Let us first examine the numbers of patents and utility models owned by the firms. (These are recognised as the most original form of innovations in Korea.)

Table 5-15. Total numbers of patents and utility models applied or registered during 1975 ~ 85

Categories	Large firms	Small & Medium firms
1.no. patents applied	7	0
2.no. patenets registered	0	0
3.no. utility models applied	37	3
4.no. utility models registered	2	3

As can be seen in table 5-15, patents are very rare in both groups of firms. No patent has been registered in the last 10 years. Moreover, the 7 patents applied for by large firms are all from one big firm which belongs to a large conglomerate. The situation is not very different in the case of utility models. These 37 models applied for by large firms are done by the same firm we have just mentioned. Since this firm has also shown the highest proportion of R&D investment to sales (4.7 % between '82 - '84) among the large firms, we can infer a possible correlation between R&D investment and the numbers of patents or utility models. Only one medium-sized firm has any performance in utility models, all of the 6 utility models applied and registered were done by this firm. It developed the first Korean model of EDM (electrical discharge machine) jointly with the Seoul National University with financial support by the government. It is notable that this firm has the largest number of R&D (and design) staff

and has also shown an exceptionally high rate of R&D investment (about 19 % of sales) among the small firm group.

Another indicator which seems to represent local original innovations is the scheme of 'First Korean Machine' (or 'Newly Developed Innovative Machine'). This was established by the government in 1979 to stimulate local innovation in the machinery industry and promote the use of locally made machines (S. Kim, 1983). If a new product is designated as a First Korean Machine by the government, preferential loans are provided for its engineering and production costs and the technology is protected. To secure the market for such machines, measures like import prohibition, government procurement and preferential loans for its purchase are also applied. To be eligible for First Korean Machine, the product should be developed via local R&D and differ significantly from foreign products in its design. It must use over 60% (in value) of locally made components, and should be internationally competitive in terms of its quality and price (ibid.:17). In this sense we can use it as an indicator of original innovation in Korea. To our knowledge, the achievements by the machine tool firms in this regard are the following:

- 'W' firm (large): 1984. CNC copy milling, 4-axes CNC lathe and other(total 3 items)
- 'K' firm (large): 1979. special purpose machine
- 'T' firm (large): 1980. machining centre
- 'S' firm (large): 1983. automatic lathe
- 'J' firm (medium): 1979. electrical discharge machine

In total, 5 firms - 4 large and 1 small- have 7 First Korea Machines. Again we can see the effects of the large firms' superior R&D capability.

To conclude, as yet local invention and innovation remain insignificant in the Korean machine tool industry. But the recent overall increase in R&D investment, changes in international and domestic market conditions due to radical technical change (e.g. CNC technology), and the government policies like import liberalisation

of machine tools and export promotion make it likely that more original innovations will appear in the near future.

5-3-5. difficulties in technological change

Finally, we will briefly review what kinds of difficulties the firms have in conducting technological change. This will give us a summary look at the immediate constraints of technological change. By considering these together with the motives for technological development, we may get some basic knowledge of the factors which shape and condition technological efforts and performances by each size group. Different forms of technological change may have different kinds of constraints, however, so we will only look at the constraints of new product development (including the one through licensing), because the latter is generally considered as the most important form of technological change by the firms (see the section 5-3-1).

Our sample firms indicated their principal difficulties in developing new products as follows (see Table 5-16).

Table 5-16. Main difficulties in developing new products

(Order)	Large firms	(Order)	Small & Medium firms
1.	backwardness of related industrial technologies	1.	lack of R&D funds
2.	shortage of technical manpower	2.	shortage of technical manpower
3.	difficulties in securing the market	3.	lack of technical information
4.	lack of technical information	4.	difficulties in securing the market
5.	evasion of technology transfer by	5.	shortage or outdatedness of production facilities
6.	lack of R&D funds	6.	backwardness of related industial technologies
7.	customer's preference for low priced products	7.	lack of manager's interest and support
8.	difficulties in technology import (high cost, disadvantageous terms, etc.)	8.	difficulties in technology import

An interesting contrast can be found between the large and the small firms. While 'backwardness of related industrial technologies' is the primary difficulty in the large firms, its importance is at best moderate in the small firms. The backwardness of basic

industrial technologies related to raw materials and components has long been recognised as a major weakness of the Korean machine tool industry. In particular, large firms have been suffering form a lack of local firms to produce key components related to NC products (e.g. NC units, DC motor, motor control, servo system, etc.). The greatest difficulty for the small firms is, not surprisingly, 'lack of R&D funds'. This implies a possibility of bias in the Korean capital market. Both size groups experience a 'shortage of technical manpower', although its meaning may be different. In smallfirms it seems to be closely related to 'lack of R&D funds'. In large firms it is more likely to be concerned with a lack of experienced technical experts (due partly to the high mobility of engineers) rather than to the technical manpower levels possessed by them. 'Difficulties in securing the market' and 'lack of technical information' are important in both groups,which implies that they are both suffering from lack of demand. The problem is more severe in the large firms because they probably need a larger size of market. In the small firms, their limited marketing network may be one of the main reasons for both problems.

It is interesting that the large firms indicated 'evasion of technology transfer by advanced countries' as important. Recently technology transfer has become a source of conflict in trade between Korea and Japan. Korea businessmen have increasingly complained that Japanese firms are reluctant to transfer their technologies and will only sell old designs to Korean firms for fear of the latter's 'catching-up'. The machine tool industry has not been an exception to this. However, as we saw before, this is not regarded only as an obstacle, but may actually stimulate the firms' own R&D efforts (imitation, in particular) as well. Other difficulties like 'customer's preference for low priced products' in the case of the large firms and 'shortage or outdatedness of production facilities', 'lack of manager's interest and support' in the case of the small firms are typical for each size group. The preference for low priced products in both foreign and domestic markets means that large firms feel difficulties in securing markets for new and sophisticated products which tend to be expensive. Poor production

facilities and manager's passive attitude towards new product development are typical for 'conservative' small firms, but they often seem to stem from financial problems and market conditions.

5-4. Summary

As regards technological capability, we have found that large firms are far ahead of small firms not only in the size of R&D (including design) manpower and skilled workers but also in their educational or skill levels. In the firms' subjective assessment of their technological capability, the gap between large and small firms was biggest in 'product manufacturing' and 'R&D' capabilities and smallest in 'design' capability. The meaning of this was sought in the later part of this chapter. Secondly, in terms of the modes of technology acquisition, large and small firms use different methods of recruitment and training of their R&D(and design) manpower : while large firms depend mainly on 'external' sources, small firms rely on 'internal' (and probably more 'informal') ones. In order to identify sources of technology itself, we distinguished between technology as software and technology as hardware. Among the former, large firms tended to use overseas sources (e.g. their overseas branches, foreign licensors, etc.) for technological (and market) information, whereas small firms (except the joint venture firms) relied upon domestic sources (SMIPC, particular). Proposers of product or process development were largely similar but the most important idea source was different: it was R&D department in the large firms, top manager (or the executives) in the small firms. We did not find any significant differences in the methods of new product or process development: both groups depended mainly on in-house R&D. Meanwhile, the sources of hardware (i.e. production equipment) were quite different: the proportion of foreign machines was significantly higher in the large firms.

Lastly, and most importantly, we tried to compare the rates and patterns of technological change between the two groups. First of all, we found that the rate of R&D investment had been relatively higher in the small and medium firms,which meant that all

the above differences and gaps small firms in the Korean machine tool industry had not been stagnant in their R&D efforts. This was confirmed and further specified when we analysed their performances in the four different types of technological change that we suggested. In the first type, i.e. the introduction of capital equipment embodying new technology, though the large firms appeared superior (e.g. in the proportion of NC machines), the small firms surpassed them in introducing new vintages of machines. In the import and absorption of foreign technology, the large firms were clearly ahead of the small firms. Most interesting was the third type, i.e. imitation, adaptation and improvement of foreign technology. This has traditionally been a major type of technological change in small firms, which appear to have accumulated considerable competence for it. But in recent years, since the beginning of NC era in particular, large firms have put great effort into this form of technological change. So they could rapidly improve their capability for such indigenous minor innovation. But it is thought that, because of the long experience and the consequent accumulation of indigenous design capability, small firms still do not far lag behind the large firms in this area. In particular, they are self- sufficient in the design of their current conventional products. As regards new invention and innovation, we did not find much difference between the two groups, but the large firms appeared slightly, if any, superior to the small firms.

Overall then, large firms are considered as relatively superior in the rate of technological change, although small and medium firms also have not been stagnant in technological efforts. They have shown different patterns of technological change, however. While the former have pursued imitation in parallel with technology import, the latter have mainly relied on imitation. So, in general, we can conclude that the large and the small firms show considerable differences in both the rate and pattern of technological change.

This chapter has been devoted to an empirical examination of the comparative performances of large and small firms in technological change in the Korean machine tool industry. As specified in the introductory chapter, this was an attempt to explore the

first of the three questions defined as the main focus of our study. Then what theoretical implications do the above results have for the study of technological change in the Third World ? Where was the specificity of Korea, as an NIC, in the relative roles of large and small firms in technological change? What lessons can other developing countries possibly learn for their technology policy from the experience of Korea ? These and other questions arise from the findings we have made so far in Chapters 4 and 5. But we will not suggest answers to these yet. This is because the meanings of our present findings are likely to become more clear after we proceed to analyse what led to the results such as above in the Korean machine tool industry. So we will now move to the second question posed in our introductory chapter, i.e. factors which operate as relative advantages and disadvantages of large and small firms in technological change in the Third World context. To identify these advantages and disadvantages in the Korean machine tool industry, one has to investigate the factors which determined the differences between large and small firms in technological performance which we have identified. Part III, which follows, will be devoted to this. As suggested in our analytical framework in Chapter 2, we will examine those factors in the following six aspects: size effects, labour market factors, capital market factors, product market structure, state policy and firms' internal organisation.

PART III

Determinants of Firm Size Differences in Technological Performance

Chapter 6
Size Effects

Size has long been associated with both advantages and disadvantages for a firm's performance. Advantages include both those accruing from large-scale of plant itself and those which are largely derivative from large-scale but do not necessarily coincide with it. A major concept which has been widely used to describe them is 'economies of scale'. It is well-known that economies of scale are closely related to technological change, though the two are not, of course, identical.[1] So we will briefly look at the major features of economies of scale, and will then focus on their implications for size advantages and disadvantages in technological change. Since our concern here is to see how size itself influences a firm's technological performance, we will only concentrate on the effects of those attributes which seem to pertain to firm size *per se*. Effects which do not result purely from size but are thought to operate through various third factors will be dealt with separately in later chapters.

6-1. Economies of scale and technological change

By definition, the term `economies of scale' designates "the gains in output and/or costs from increasing the size of plant, firm or industry" (Seldon & Pennance, 1976: 120). Economies of scale may be of two kinds, internal and external. The former result largely from imperfect divisibility of the factors of production, the latter from expansion of the industry as a whole (ibid.). Here we are concerned only with internal economies of scale. It is thought that "generally, large `indivisible' units of, e.g., capital equipment or expert advisers or education, market research or other highly specialized departments in a firm, can be employed with maximum profitability only if the scale of activity is large

[1] On the relationship and distinction between economies of scale and technological change, see B.Gold (1981) and A. Heertje (1977), pp. 219-233.

enough to occupy them fully" (ibid.). Some of the principal (internal) economies of scale are as follows (Hanson, 1977: 148-149; Staley & Morse, 1965: 98-99): (1) like Adam Smith's insights on dexterity and speed, greater output will make possible a greater division of labour and specialisation, which will, in turn, lead to increased speed through repetitive performance of standardised or specialised tasks; (2) the capacity of much equipment, machinery and factory space increases more rapidly than the costs of their materials and construction; (3) a critical minimum size of equipment or plant is needed to process some materials and energy, and to balance production operations (i.e. `indivisibility' of capital goods); (4) there will be economies in administration, since it is unlikely that to double its output a firm will need to double its office staff; (5) marketing economies are possible, both in the form of lower prices for buying raw materials in bulk, and in the selling costs of the firm; (6) a large firm often has access to many more channels of finance than a small firm, can spread its risks more widely, and is thus advantaged with respect to both availability and cost of finance; (7) only a large firm can undertake a costly research project on its own account; (8) brand preferences and a big market share with its consequent merits (i.e. monopolistic-oligopolistic advantages) are often connected with large-scale.

On the other hand, large-scale is not always advantageous. Not only can some `diseconomies' of scale appear when production size goes beyond a certain point (e.g. administration tends to be very complicated and more expensive), but also there are several advantages associated with small- scale production. The comparative advantages of small firms are thought to stem from the following characteristics (KFSB, 1985; Rothwell & Zegveld, 1982): (1) small firms generally need a shorter period of capital circulation because of small investment size and hence can achieve efficiency of investment; (2) small firms can respond more flexibly to volatile and diverse market demand due to, e.g. fashion, seasons, or business fluctuations; (3) because of relatively simple administration and maintenance, they need lower overhead costs; (4) their less (or lack of) bureaucratic structure makes internal communication easier and more direct, which can facilitate close manager-worker relations; (5) through their intimate

relationships with customers, small firms can focus special attention on the latter's requests and can respond quickly and efficiently to them; (6) dynamic entrepreneurship of small firm managers enables rapid response to (or even opens) growth opportunities by initiating new products. Owing to these and other advantages, small firms tend to be particularly strong or appropriate in the following areas (Staley & Morse, op.cit.: 100-101):

- products which are light, small and requiring only moderate precision -- these are frequently made on light equipment or by relatively simple assembly operations;
- products which are skill-intensive and hence are hard to automate;
- mass production of 'specialised' components or end items --- e.g. production of components for several large firms, no one of which requires a volume sufficient to sustain a specialised production facility of its own;
- products made in small lots and short runs because of varying customer needs or small total markets;
- specialised products in which technical excellence in design or innovation of a founding engineer can play a great role.

Therefore, although it is true that economies of scale provide large firms with major advantages *vis-a-vis* small firms, the latter do have relative strengths in at least some areas. Which of the two firms will be stronger in the end seems to depend on the characteristics of the industry concerned. The importance of economies of scale varies from industry to industry. In the case of the machine tool industry, scale merits tend not to be so big because the industry has the following characteristics: (i) it depends on small batch production of diverse end items according to diverse customer demands (in terms of product types, standards, etc.), (ii) production is thus conducted mainly to order, (iii) the impact of business fluctuations is great and so expansion involves high risk, and (iv) capital-intensity is relatively low but, instead, high skill-intensity is needed because of the requirements of high precision (UNIDO, 1974; SMIPC, 1984). This must not be interpreted to mean that economies of scale cannot be realised in this sector, but

only that small firms can play an active role and are not particularly disadvantaged.

The development of NC (and CNC) technology has greatly changed the traditional characteristics of this industry and hence the conditions of its economies of scale. Though NC technology itself is not necessarily disadvantageous to small firms (Sabel, 1982; Watanabe, 1987), it is generally agreed that the *manufacture* of NC machine tools *per se* involves greater economies of scale (see S.Jacobsson, 1983; E.Vogel, 1985). Also, a larger R&D size is needed for innovation on a NC product. Not surprisingly, in advanced countries the trend has been for firm size to grow (through merger, etc.) and specialisation among firms has become notable in the industry since the production of NC machine tools (UNIDO, op.cit.). Thus with the advent of NC technology the importance of economies of scale seems to have increased in the machine tool industry.

What are the implications of economies (and diseconomies) of scale for size advantages (and disadvantages) in technological change? Limiting our discussion to those characteristics which directly stem from size, we can assume that a firm's technological performance would be influenced by its size in the following respects:

- in terms of *size advantages*,

(i) since the absolute size of R&D is bigger in large firms, only they can perform a risky and costly projects;

(ii) R&D itself will involve economies of scale, e.g. once a firm develops a new product, it will be easier and less costly to develop another similar one through the effects of accumulated knowledge;

(iii) only large firms can introduce and use advanced equipment economically;

(iv) large output facilitates more learning-by-doing;

(v) large output facilitates greater division of labour, hence greater specialisation;

(vi) large output increases the possibility of standardisation;

(vii) there are many organisational advantages of large firms in terms of, e.g., information acquisition, marketing network, brand image, etc., which in turn are useful for new

product development.

- in terms of *size disadvantages*,

(i) the high overhead costs of large firms tend to push up the price of a new product;

(ii) large demand is needed to justify the commercial viability of a new product by a large firm;

(iii) large firms are less flexible in response to demand fluctuations;

(iv) large firms' bureaucratic structure tends to stifle the innovative and creative ideas of their employees, and to make difficulties in internal communication.

We will look into the validity of the above hypotheses by using our data in the following section. But due to the limitation of our data this will inevitably be selective and partial.

6-2. Evidence of size effects

6-2-1. size advantages

Firstly, as we saw in the last chapter, large firms have larger R&D efforts, and this certainly gave them a major advantage in developing new machine tool products which required large amounts of R&D investment. A typical example of this is NC products. For small firms one of the most important barriers to entry to NC production is the burden of R&D costs. The president of one small firm said: "to develop a model of NC or CNC machine tools, since it needs expensive and special manufacturing and testing facilities and has to use a large proportion of imported components, hundreds to thousands of million won must be invested ..." (from *Machine Tool*, No.6, 1984: 24). So it is hardly surprising that while most of large NC producing firms had relied on in-house R&D to develop their first NC models, the few small firms which had entered NC production had depended upon the help of external sources, either domestic (e.g. KIST) or foreign (e.g. joint-venture partners) (see Table 5-14 last chapter). The use of such external sources allowed small firms not merely to fill the gap in their knowledge about NC technology but also to save on the heavy burden of R&D

costs which they could not afford by themselves. Without financial as well as technological support from government or foreign partner firms, small firms will have great difficulties (if it is not virtually impossible) in entering the NC machine tool industry. Though NC is the most prominent example, it is quite likely that for many other new products the most important barrier to entry of small firms is the burden of R&D costs. As we saw at the end of the last chapter, for small firms, unlike large firms, the primary difficulty in developing new products is their lack of R&D funds. This looks even more striking when we consider that small firms have been far from stagnant in terms of R&D investment but have actually shown a higher R&D intensity than the large firms (see Table 5-9). A clear implication is that it is *absolute* rather than *relative* proportion of R&D in the industry, which matters most. Thus it can be said that one of the most important advantages of large size in technological change is confirmed by our data.

Secondly, the question of economies of scale in R&D itself. It is actually quite difficult to find quantitative evidence of such economies in our data. Apart from the inherent difficulties involved in measuring the inputs and outputs of R&D, we have no means to distinguish between the effects of economies of scale in R&D and those of other, more qualitative factors like, say, the educational levels of R&D manpower. Nevertheless, we did find some evidence (though not quantifiable) of such economies through the interviews. A most interesting example of this is `D' firm. This firm belongs to a major conglomerate and is one of the largest machine tool producers in Korea. Besides machine tools they produce a variety of items such as diesel engines, rolling stock, construction equipment, industrial vehicles (fork-lift trucks, etc.), precision machines, foundries and forgings, defence and aircraft parts, and so on. The proportion of machine tools among total sales is around 5 %. Their main plant is in Inchon (west of Seoul) but they also have several plants in other cities, including those in Changwon in which machine tools are produced. Their main R&D organisation is the central research institute in Inchon, though development and engineering work on specific new products is based in a specialised technology department in each plant. The

central research institute is responsible for more basic and innovative research, and the main area on which they are currently concentrating is `mechatronics' technologies like robots, laser and factory automation. Not surprisingly, there is a close network of cooperation between this central body and every technology department, which not only includes exchanges of personnel and information but also collaboration on a project basis. For example, the firm developed a laser machining centre and a laser marking system in 1983, which was the result of collaborative work between the CNC machine tool technology division and a research team of laser application technology. So the firm could exploit their own experience already accumulated in the production of CNC machine tools in this case. The same pattern was utilised in the development of FMCs, in which case development was divided between a factory automation team and the machine tool division. Their in-house development of an industrial robot and a robot controller was largely the result of existing experiences in various branches of mechanical products, and technological know-how acquired from such robot technologies will be in turn utilised in other products, say, NC controllers for machine tools.

We could find similar examples in other large firms. Most of our sample large firms are not exclusively specialised in machine tools but are diversified into other related products, notably automobile parts and arms production. And some of their machine tool products were developed for in- house use, to process those related products. Therefore, technological know-how accumulated through the development and manufacture of such products stimulated, and was effectively applied, to the development of new machine tools as well as the improvement of existing ones. Once a pool of technological knowledge covering these products was formed within the firms, a joint utilisation of such a knowledge for different purposes (different products) became possible easily and without much additional investment. And the fact that the users of their machine tools exist inside their own firms implies that there can be a significant saving of time and money in learning about technological problems that their machine tool products have. These economies which stem from both diversification and large size

involve a critical effect of technological learning, i.e. knowledge acquired in one sector can be easily applied and stretched to a related sector with little marginal cost. Our sample large firms seemed to exploit such economies related to R&D through their diversified product lines.

Thirdly, it is rather self-evident that large firms can introduce and use advanced equipment, which is usually expensive and labour-saving, more easily and more economically than small firms. Only large output justifies the use of such expensive and sophisticated equipment. From our data, as we already saw in the last chapter, it seems certain that the large firms possess a higher proportion of capital equipment embodying advanced technology (e.g. NC machines). However, it is doubtful whether this resulted from their large output or their technological needs (e.g. upgrading of product quality). Until recently all the large firms have suffered from excess capacity, mainly because their capacity level was not so much a response to market signals as a decision following government incentives. In spite of the government boosts for domestic demand as well as for export growth, the total demand of machine tools did not justify such a big capacity or such sophisticated equipment.[2] This does not deny the relative advantage of the large firms in introducing and using such an equipment in the long run though. Because of recent increases in demand (mainly from the automobile industry) and increased competition among the large firms themselves, the need to use advanced equipment has increased. In contrast, we found that most of the small producers still think that sophisticated equipment such as NC machines is too expensive or is not appropriate to them with regard to their current output level or product quality. Therefore, the size advantage in introducing advanced equipment is largely confirmed in our data.

Fourthly, there is the thesis that large output facilitates more learning-by-doing, specialisation and standardisation. In fact we have no data to support (or refute) this. In

[2] Those firms engaged in arms production according to government orders had the necessity to introduce such a sophisticated equipment because of the required high precision and large scale of the arms products. But after this arms demand was largely saturated, those firms soon faced excess capacity.

that all of these effects ultimately amount to the accumulation of technological capabilities and the increases in productivity, the higher level of technological capabilities(Table 5-2) and of labour productivity[3] of the large firms seems to indirectly confirm those effects. However, given the relatively small size of the domestic market and the excess capacity of the large firms, such effects, if they exist at all, must have been significantly reduced. Also the short histories of the large firms in the sector seem to have further limited them. For example, the fact that low standardisation of components is still indicated as one of the most serious weaknesses in the Korean machine tool industry seems to justify these doubts. So it remains to be seen whether those effects will finally prevail in the future.

Lastly, there is relatively clear evidence to support the thesis that large firms tend to get many advantages from their organisational superiority, especially as regards information acquisition, marketing networks, and brand image. For instance, many of our sample large firms have their own overseas sales branches as well as their domestic branches and A/S (after-service) centres. Besides machine tools, these branches deal with many other products that their firms produce and hence can economise marketing costs. Moreover, they are used as an important source of technological and market information. Firms belonging to large conglomerates use the marketing networks of their parent or sister companies as well. It is clear that this is one of the important factors which upgrade the brand image of their products. These advantages are closely related to other factors which we will discuss in the later chapters, so a more detailed explanation will be omitted here.

6-2-2. size disadvantages

The hypotheses about size disadvantages will be examined below. Firstly, are the overhead costs of large firms actually higher (whether per product or per worker) than those of small firms, thereby leading to higher prices of products? Though we have no

[3] In 1984, value-added per employee was 6.4 million won in the large firms, while it was 3.0 million won in the small firms.

exact data to answer this question, we can examine the proportion of overheads among the total manufacturing costs in each group of firms.

Table 6-1. The composition of manufacturing costs during 1982~84

Cost items	Large firms			Small & Medium firms		
	'82	'83	'84	'82	'83	'84
materials costs (average)	62.5	59.3 (61.4)	62.5	53.9	57.2 (55.5)	57.3
labour costs (average)	20.3	21.8 (21.0)	20.8	21.5	20.5 (20.8)	21.8
overhead costs (average)	17.2	18.8 (17.6)	16.7	24.7	22.3 (23.7)	20.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

Contrary to our expectation, the proportion of overhead costs appeared lower in the large firms. But if we look at the Table carefully, we can see that this largely results from the higher proportion of materials costs in these firms. There is little difference in the proportion of labour costs between the two groups of firms. The reasons why materials costs occupy a higher proportion in the large firms seem to be as follows: first, they produce a higher proportion of NC machines than the small firms do, which generally incur a higher proportion of material costs than conventional items do.[4] ; secondly, because large firms produce relatively more sophisticated products (including NC machines), they depend heavily on foreign components which are usually expensive. Therefore, we cannot determine in which group overhead costs are actually higher `for a comparable product'. We must also include `administrative and marketing costs' in order to see the total overhead costs of a firm. Considering that these costs are usually higher in a large firm and also that among competing products (though with different

[4] According to S. Jacobsson (1983), while a conventional lathe attributes about 40 % of its manufacturing costs to the purchase of materials and components, it is about 75 % in the case of an NC lathe.

qualities) those produced by large firms are often 20~30 % more expensive than those produced by small firms, it is quite likely that overhead costs per product (or per worker) are higher in large firms. In fact, in our interviews, many small firms indicated that their price competitiveness (against large firms) in, at least, conventional products stemmed from their low overhead costs. Most of them agreed that they could successfully compete with large firms in these products because they could avoid the latter's high costs of operating and maintaining huge facilities and organisation.

Secondly, it seems almost self-evident that large firms need a larger volume of demand for the viability of a new product and can respond less flexibily to demand fluctuations, because they possess substantial fixed capital and employees who are also often more strongly protected memberships of trade unions. The fact that the large firms in our sample have suffered from excess capacity, as we already indicated, partly confirms these relative disadvantages of large firms. The effects of scale economies have been significantly reduced by the relatively small market size for their products. Though the large firms, therefore, produce diverse items in order to raise their rate of capacity utilisation, this results in a low degree of specialisation, hence low productivity. However, this does not seem to have deterred them very much from developing new products and processes. Although `securing the market' is certainly one of the major difficulties of the large firms in developing new products (see Table 5-16), their investment in new products has been conducted not so much because of existing demand but because of future prospects and often in response to government incentives. Thus the actual importance of these disadvantages for technological performance is only partially confirmed in our data.

Other size disadvantages related to bureaucratic structure will be dealt with in a later chapter on ' firms' internal organisation'.

To sum up, the importance of size effects is found in almost all the forms of technological change.[5] On the whole, size advantages seem to overwhelm size

disadvantages in our data. Among the former, large R&D size, economies of scale in R&D, and economies in using advanced equipment appeared most important, and they seem to have facilitated higher performance by the large firms in, above all, NC product development, interdisciplinary R&D, and introduction of capital equipment embodying new technology.

[5] Those which were not referred to here are also often closely related to size. For example, it seems certain that only large firms can afford to pay expensive royalties for several foreign licenses. But in this case, the key seems not size itself, but financing capability above all. So this will be treated in later chapters.

Chapter 7
Labour Market Factors

It has already been pointed out by many authors (e.g. Rothwell & Zegveld, 1981: 180-184) that one of the major disadvantages of small and medium firms in technological development is their lack of specialised technological manpower or, in other words, their difficulty in recruiting superior technical employees. Our sample small firms identified `shortage of technological manpower' as their second most important difficulty in new product development (see Table 5-16). This reflects not merely their lack of funds to recruit such manpower, but also, and more importantly, their weaker position in the labour market compared to large firms. Moreover, they often have handicaps even in recruiting production workers, and their technological capability on the shopfloor tends to be hampered by this. So, small firms seem to be located in a disadvantageous position in the labour market as a whole, which may be one of the main reasons for the differences in technological performance between them and large firms.

A theoretical approach which might be helpful to explain the relationship between firm size, labour market and technological performance is the dual labour market theory (e.g. Doeringer and Piore, 1971). According to this theory, the labour market is divided into a `primary' and a `secondary' market. "The former offers jobs with relatively high wages, good working conditions, chances of advancement, equity and due process in the administration of work rules, and, above all, employment stability. Jobs in the secondary sector, by contrast, tend to be low-paying, with poorer working conditions and little chance of advancement; to have a highly personalized relationship between workers and supervisors which leaves wide latitude for favoritism and is conducive to harsh and capricious work discipline; and to be characterized by considerable instability in jobs and a high turnover among the labour force. "(M. Piore, 1975:126). Although this division between jobs in the labour market does not exactly correspond to categories of

firm size, primary jobs are typically found in large firms whereas a majority of secondary jobs are supplied by small and medium firms. This division is also closely related to the distinction between the `internal' and the `external' labour market, which was suggested and developed in the internal labour market theory expounded by almost the identical authors (Doeringer & Piore, ibid.). It was argued in this theory that most workers were not involved in a competitive (i.e. external) labour market but rather in an internal labour market, where the market process was internalised to a specific enterprise which had a limited number of (lower level) entry posts for workers and filled its vacancies at other levels internally. According to Doeringer and Piore, primary jobs are associated with internal labour markets while secondary jobs are a mixture of jobs belonging to internal labour markets and those to external markets (ibid.: Chapter 8).

What is interesting, and relevant to our analysis, in these theories is their explanation of the sources (or determinants) of such labour markets. In both cases, technology seems to be given a central role. The internal labour market develops because of, above all, the increasing specificity of skills and training, and such specificity is concretely expressed in job specificity and technological specificity. To meet the needs of specific technologies or the related skills that each firm uses, firms have to develop the internal labour force. A similar explanation is applied to the dual labour market (M. Piore, ibid.). In an industry there are mainly two kinds of available technologies: one is highly specialised and sophisticated and the other utilizes a much more general set of skills. Specialised technology gradually evolves from general technology over time, but most industries seem to use the two technologies simultaneously. The choice between these two technologies is largely determined by the characteristics of demand, in terms of standardisation, stability and certainty. So a firm which has standardised, stable and predictable demand for its products tends to choose a more specialised, capital-intensive technique rather than a general one. And the use of such a technology generates the jobs which require the characteristics typical of the primary labour market, whereas most of the jobs generated by a general technology tend to constitute the secondary

labour market.

One implication we can develop from these explanations is that if different technologies lead to a dual structure in the labour market, such a dual structure can be considered as a contributing factor to the use and development of the different technologies. Similarly, if skill specificity stimulates the internal labour market, this is because the formation of an internal labour market in a firm is helpful for the accumulation of its specific skills. In this sense, therefore, the dual labour market theory can be utilised to explain the different technological performance of the firms with different labour market conditions.

7-1. Hypotheses

Based on the approach of the dual labour market theory, with some modifications, we will propose a few main hypotheses on the relationship between labour market structure and technological performance, and then examine their validity.

- Hypothesis 1: there are significant differences between large and small firms in their job characteristics , which can be adequately described by the term `dual labour market'. These lead to differential access by these firms to the labour market: large firms are generally more advantaged in employing a superior labour force.
- Hypothesis 2: such differential access to the labour market results in different levels of technological capability of those firms, and hence their different technological performance.
- Hypothesis 3: large and small firms show different levels of development of the internal labour market, and this is a reason for their differences in their accumulation of skills and technological capabilities.

In the next sections we are going to test the validity of these hypotheses. To do this, our analysis will include the following logical steps: first, we will see if the large and the small firms really do have the different labour market conditions that have been

suggested above; secondly, whether these supposedly different conditions influence the firms' technological performance; thirdly, whether such relationships between labour market conditions and technological performance are real or spurious when `size' is controlled. This last step is necessary in order to distinguish between the influence of size and the independent influence of labour market conditions. Though size and labour market conditions may be closely related, we need to know if a firms' technological performance is actually influenced by its position in the labour market or not. This three-step approach will be applied in considering all the subsequent factors which we will review in relation to firms' technological performance (i.e. capital market, product market, state policy, etc.) in later chapters.

7-2. Features of the dual labour market

In this section, we will simply try to examine whether there are any significant differences between large and small firms in their job characteristics and employment conditions (as suggested in dual labour market theory). We will review all the major aspects in which we can confirm the features of the dual labour market and the levels of development of the internal labour market.

7-2-1. overall composition of employees

To begin with, let us compare the manpower composition of our large and small firms. Table 7-1 shows the composition of employees by their functions and their length of career (here `length of career' means the total duration in which a worker is engaged in an industry, regardless of by whom he was employed).

In both groups of firms, over two-thirds of all employees are ordinary production workers, and among the rest, similar proportions are occupied by administrative employees and engineers/technicians. However, the internal composition of these categories of employees appears significantly different between the two groups. It may be against common expectations that the proportion of administrative employees appears greater in the small and medium firms. This stems largely from the reason

Table 7-1. The composition of employees by functions and by length of career

Size groups		Administartive functions		Productive functions					Total
		managers	ordinary administrators	1) engineers	2) technicians	3) qualified craftsmen	4) unqualfied craftsmen	5) others	
Large	(persons)	20.7	32.0	68.0	21.5	187.7	208.0	27.8	565.7
	(%)	(3.4)	(4.9)	(8.2)	(4.1)	(39.5)	(33.7)	(6.3)	(100.0)
Small & Medium	(persons)	5.7	11.1	3.4	9.7	21.7	46.5	5.7	103.9
	(%)	(6.1)	(10.0)	(4.0)	(9.7)	(17.5)	(46.3)	(6.4)	(100.0)
	By length of career (unit:%)								
Lagre	(less than 3 years)	1.1	32.3	24.8	9.4	28.6	16.1	?	21.6
	(more than 3 years)	98.9	67.7	75.2	90.6	71.4	83.9	?	78.4
Small & Medium	(less than 3 years)	13.5	53.7	28.8	20.1	54.6	47.6	?	42.1
	(more than 3 years)	86.5	46.3	71.2	79.9	45.4	52.4	?	57.9

Note 1: 1) `engineers' = those who are engineering graduates of a 4-year university or who acquired an equivalent or higher official qualification of `1st-class Engineer'.

2) `technicians' = those who are graduates of a 2-year technical college or who acquired on official qualification equivalent to `2nd-class Engineer'.

3) `qualified craftsmen' = skilled workers who acquired such official qualifications as `1st-class craftsman', `2nd-class craftsman' or `Assistant craftsman'.

4) `unqualified craftsmen' = those skilled workers who do not have any of the above official qualifications but have experiences of more than one year in a job which needs a skill.

5) `others' - other production workers such as apprentices, simple manual workers, etc.

Note 2: In the case of large firms, the above employees only include those who are involved in machine tools production.

Note: No. of cases = 9 large firms, 12 small and medium firms.

that the numbers of employees in the case of the large firms only includes those in their machine tool divisions (see `Note 2' below the Table). Since machine tools production is often only a part of their business, the large firms seem to be able to reduce the size of their administrative employees for machine tools (i.e. a kind of scale economies). The small numbers of ordinary office workers (i.e. 32.0 persons) against those of managers (i.e. 20.7 persons) seem to confirm this.

Though the proportion of engineers/technicians to total employees is similar between the two groups, the ratio of engineers to technicians is significantly higher in large than in small firms (p = .0002). Also, the ratio of qualified to unqualified craftsmen is significantly higher in the former (p = .0757). But since we already mentioned about these in Chapter 5, we will not repeat here.

In terms of `length of career', it is remarkable that in all the categories of employees the proportions of those with career of more than 3 years appeared higher in the large firms. In particular, the gap is salient in the cases of administrative employees and craftsmen. This seems to be an additional evidence that the employment patterns of the large and the small firms are significantly different.

7-2-2. wage levels

We saw above that the internal composition of employees is different between the large and the small firms. Now let us see one of the most important job characteristics underlying the conception of the dual labour market: wage levels. We have no detailed data on wage levels from our sample firms[1], so we will use data from other sources.

Table 7-2 shows the trends of annual average wage per employee in the Korean machine tool firms

Table 7-2. Annual average wage per employee in the Korean machine tool firms during 1974-82 (unit : thousand won)

Year	Large firms (A)	Small & Medium firms (B)	Ratio (A/B)
1974	463	326	1.42
75	611	496	1.23
76	821	572	1.44
77	918	723	1.27
78	1,815	1,226	1.48
79	2,217	1,563	1.42
80	1,903	1,894	1.00
81	2,629	2,024	1.30
82	2,978	2,332	1.28

Source: calculated from EPB, *Report on Mining and Manufacturing Survey*, various years.

[1] Although we included the question items on the pay levels of the employees, most of the firms were unwilling to answer them. And also, this is one of the most sensitive questions to which we cannot expect frank and reliable answers from the respondents.

Except in 1980[2], the average wage of the large firms has been 1.2~1.5 times as much as that of the small and medium firms. If we divide the firms into several smaller groups by their size, we find that the larger the firms are then the higher their average wages. For instance, in 1982, if we take the average wage of firms with 5-9 employees as 100 %, the figures of the other size groups are 102 % (10-19 employees), 120 % (20-49 employees), 106 % (50-99 employees), 145 % (100-199 employees), 154 % (300-499 employees) and 163 % (over 500 employees) respectively (EPB, 1984). Of course, such differences will not be uniform between different types of employees. Though we do not have such data on the machine tool sector, the following Table on manufacturing industry as a whole shows that the wage gap between large and small firms is greatest in technological and managerial jobs and smallest in ordinary office work, and especially in production jobs. Only in the case of female workers in ordinary office jobs and in production jobs, is such a gap negligible.

Table 7-3. Wage(monthly) differentials by firm size and job functions in the Korean manufacturing industry in 1980

(unit : thousand won, %)

Job functions	(sex)	Size groups (no. of employees) 10~29	30~99	100~299	300~499	over 500
managers	(male)	372.9 (100.0)	421.6 (113.1)	387.3 (103.9)	586.3 (157.2)	503.6 (135.0)
engineers /technicians	(male)	168.7 (100.0)	169.2 (100.3)	182.5 (108.2)	225.8 (133.9)	241.0 (142.9)
ordinary administrators	(male)	181.6 (100.0)	199.4 (109.8)	206.0 (113.4)	219.3 (120.7)	229.1 (126.1)
	(female)	94.1 (100.0)	94.6 (100.5)	97.5 (103.7)	98.4 (104.6)	103.4 (109.9)
production workers	(male)	122.6 (100.0)	131.1 (106.9)	140.2 (114.4)	144.9 (118.1)	150.6 (122.8)
	(female)	74.6 (100.0)	73.8 (98.9)	74.1 (99.3)	72.5 (97.1)	77.7 (104.2)

Source : Chung, 1986 : 177.

[2] The reason(s) why the gap in average wage disappeared only in 1980 can be considered in several ways. But a most plausible explanation is that because of the severe recession in that year the large firms had to curtail their working hours and hence reduced their total wages.

The above results, at first sight, seem to confirm the hypothesis that wage levels are higher in large firms, as we suggested by dual labour market theory. However, since the above wage figures do not specify the working hours involved, actual wage rates (i.e. wage per hour) may show different results. According to a study on the Korean labour market (Chung, 1986), in the case of production workers the working hours of large firms are longer than those of small and medium firms in the Korean manufacturing sector. This is also true of the machine tool branch, as we will see in the next section. The longer working hours of production workers in large firms are due to their longer `overtime' - either imposed or voluntary (ibid.). And wage rates for such overtime is usually 1.5 times per hour that of normal working time. Accordingly, the actual wage rates of production workers are not very different between large and small firms in the manufacturing sector: in 1980, if we take the wage rate of production workers(male) of the firms with 10-29 employees as 100 % , the wage rates of the other firms are 98.7 % (30-99 employees), 101.5 % (100-299 employees), 99.0 % (300-499 employees) and 112.8 % (over 500 employees) respectively (ibid.: 181). The situation is likely to be very similar in the machine tool industry. Therefore, at least in the case of production workers, our hypothesis on wage level does not seem to be valid. However, in the cases of technological and managerial employees it is more plausible that the hypothesis may be sustained, because in large firms such employees usually have higher educational levels and longer length of career than those in the small and medium firms.

7-2-3. working hours

`Working hours' is another important aspect of a job, by which we can compare working conditions in different firms. It has been generally recognised that because of higher labour productivity and the stronger power of organised workers (trade unions) the working hours of large firms tend to be shorter than those of small firms, especially in advanced countries. The dual labour market theory also seems to assume this. However, we have already indicated that this was not the case in the Korean

manufacturing sector, at least in the case of production workers. Turning to the situation in the machine tool industry, Table 7-4 compares of working hours in our sample firms.

Table 7-4. Working hours per week by job functions

(unit : hours)

Functions	Large firms	Small & Medium firms
production workers	58.6	52.9
ordinary administrators	55.3	53.5
managers	57.0	57.3
chief executive	57.3	55.3

The Table clearly indicates that the working hours of production workers are longer in large firms. Moreover, contrary to common expectations, working hours tend to be longer in the large firms for other types of workers, too, though the difference is not as large as in the case of production workers. Since engineers and technicians usually have the same working day as ordinary office workers in Korea, working hours of such technological employees also seem to be longer in the large firms. A striking example is `D' firm. As we already introduced earlier, this firm belongs to a conglomerate and is one of the largest machine tool producers in Korea. They have a trade union and probably maintain the highest level of labour productivity in the industry. Nevertheless, their working hours are the longest throughout our sample firms (both of the large and the small ones): they are 72 hours per week for production workers and for ordinary office workers, 78 hours for managers and 84 hours(!) for the chief executive, according to our survey. On the other hand, the small and medium firms, most of which are non-unionised and remain at lower labour productivity, typically have around 48-50 working hours per week for their production and office workers. This contrast seems to disprove the general recognition that large firms, with trade unions and high labour productivity, tend to have shorter working hours. Why is this so? Is this a special exception or the one that reflects a general condition throughout Korean industries?

The most plausible reason is that because large firms have secured relatively large

and stable demand (and try to do so) they can enforce a lot of `overtime' on their employees, but in many small and medium firms unstable demand often means a reduction of operation or even a shutdown. Since large firms entered the sector, excess competition between small and medium firms in the market of conventional machine tools has become inescapable, and thus they have probably had to reduce working hours in order to avoid large scale lay-offs. Thus the shorter working hours in the small firms far from reflecting their workers' strength, in fact reflect their weakness. On the other hand, for the workers in the large firms, under the general conditions of labour repression and weak trade unions in Korea, to accept a higher level of `total wage' (in spite of long working hours) may have been preferable to a smaller wage with shorter working hours. Their trade unions seem to have been powerless to reduce working hours by raising wage rates. We believe that the situation is similar in other industries because this reflects a general labour condition in Korea (see chapter 11). In this sense, it can be said that the Korean industries lack one strong momentum of the dual labour market. Nevertheless, the Korean example does not necessarily refute the validity of the thesis that large firms, when equipped with higher labour productivity and strong trade unions, tend to have shorter working hours than in small firms. If the power of the Korean trade unions gets stronger, higher labour productivity will probably be linked with shorter working hours. So it remains to be seen whether the thesis will be validated or not.

7-2-4. employment stability

We have seen that even though large and small firms are composed of qualitatively different workforces, two important aspects of their working conditions–wage rates and working hours-do not show any firm evidence to support the `dual labour market' hypothesis. Now, let us consider employment stability, another crucial indicator to decide whether the dual labour market exists or not. The term `employment stability' here means `less turnover of employees' (and is thus distinguished from `job security'). Employment stability is especially important in skill- and technology-

intensive sectors like the machine tool industry, because to meet the requirements of high precision for their products these sectors need the long experience and accumulated knowledge of technologists and skilled workers for, e.g., design, precision processing, assembly and so on. However, in the case of the Korean machine tool industry, it has already been reported in several surveys (e.g. KOMMA, 1982: 47; SMIPC, 1984: 44-46) that firms have suffered difficulties in technological accumulation because of high turnover of their employees. If this situation is worse in the small and medium than in the large firms, there are good grounds for believing that in spite of no significant difference in wage rates and working hours there will be other reasons which make the large firms preferable from the workers' point of view. These other attractions should bring about the latter's advantages in access to the labour market as well as their higher employment stability.

Table 7-5. Length of service* and turnover rates ('84)** of employees by functions

(unit : %)

Size groups		managers	ordinary administra.	engineers	technicians	qualified craftsmen	unqualified craftsmen	TOTAL
Length of service								
Large firms	0~3 (years)	13.9	39.0	43.4	22.2	40.1	29.7	32.8
	3~5	2.4	38.1	27.9	12.5	23.3	23.0	30.1
	5~10	68.9	19.8	23.9	52.1	24.7	26.6	28.8
	over 10	14.8	3.1	4.8	13.2	11.9	20.7	8.3
Small firms	0~3 (years)	15.5	57.2	29.2	33.7	59.3	48.4	46.2
	3~5	34.7	29.4	26.8	42.7	31.8	25.4	30.0
	5~10	26.5	13.0	25.1	12.2	6.9	19.5	17.1
	over 10	23.3	0.4	18.9	11.4	2.0	6.7	6.7
Turnover rates								
Large firms		18.8	21.4	27.6	7.3	36.2	24.0	30.3
Small firms		26.8	61.4	19.8	22.1	65.3	56.4	48.8

Notes(*) : `length of service' = the total period in which a worker is employed by the current company.

(**) : `turnover rates' = the proportion of new entry or resignment(or redundancy) of employees to total employees. This was calculated in the following way: {(new employees in `84 + resigned employees in `84) / sub- total of employees in each type concerned} x 100. For example, the turnover rate of engineers = {(newly employed engineers + resigned engineers) / sub- total of engineers} x 100.

Table 7-5 above shows the composition of employees by length of service and the

turnover rates in each category of employees and total. It is easily observed that in all categories but `engineers' the length of service is longer in large firms. The differences look especially striking in `ordinary administrators', `qualified craftsmen' and `unqualified craftsmen'. In these categories, the length of service is clearly longer in large firms. Though the situation is also similar in `managers' and `technicians', in these categories small and medium firms have relatively high proportions of employees with length of service of 'over 10 years' . In contrast to all of these categories of employees, it is clearly shown that the length of service of `engineers' is shorter in large firms. We will speculate about the possible reason(s) for this later.

Not surprisingly, there is almost the same pattern of `turnover rates'. Except in `engineers', the turnover rates of the small and medium firms are higher in all categories, than those of the large firms, especially in `ordinary administrators', `qualified craftsmen' and `unqualified craftsmen'. (Since `length of service' and `turnover rates' are in inverse correlation to each other, these latter results support the reliability of the above results on `length of service'). The only differences are in the order of the categories in each group. For example, in the small and medium firms,`managers' have the longest length of service, turnover rates are lowest among `engineers' and `technicians'. Similarly, in the large firms, while length of service is shortest among `ordinary administrators' (probably due to their young age), the latter's turnover rate is only modest whereas `qualified craftsmen' and `engineers', have high rates of turnover.

Through the above results, we can see that the dual labour market may possibly exist between large and small firms in the Korean machine tool industry, in spite of the negative evidence of wage rates and working hours. Employment stability seems to be clearly higher (except for `engineers') in the large firms. Then why does such pattern of employment stability appear? In general, employment stability is thought to depend on two kinds of forces: on the demand side, fluctuation of market demand, the

firm's market power and so on; and on the supply side, labour mobility and workers' job satisfaction. While both of these two forces seem to have worked in our case, the latter factors are considered as more important, at least for the turnover rates in 1984. Though the faster growth in sales in small firms (40.3 %) than large firms (16.5 %) during `83 - `84 may have led to the former's higher rate of recruitment (28.1 % against 13.4 %), this cannot explain their also higher rate of resignations (24.2 % against 16.2 %) in the same period. As employers normally want to keep their employees in periods of increasing demand, most of the new employees must have been recruited to fill the jobs vacated by resignation rather than as a response to the increased demand. Therefore, the higher turnover rates of the small firms are mainly due to the voluntary migration of their employees. So, we think that even though large firms do not offer better wage rates and working hours (at least for production workers), there are other important aspects of working conditions and job characteristics which influence workers' preferences for jobs, and the large firms seem to be better than the small firms in such respects.[3] The following are thought to be important in this regard: job security, chances of advancement, labour relations, welfare facilities (including accommodation, medical insurance, industrial accident insurance, etc.) and fringe benefits (family allowance, retirement pay, etc.), work environments (regarding safety and health), and, perhaps, social reputation. Though we will not look into these various aspects in detail here, there is much evidence to suggest that large firms are preferable in such respects. We will discuss some of them later when we will examine the main features of the internal labour market. Anyhow, because of such reasons, employees of large firms tend to remain in their companies whereas those of the small firms, without such attractions and incentives, tend to move quickly from one company to another. Also, small firms themselves may be less strongly motivated to keep their employees because long length of service leads to high wages, which is not desirable for them given their major

[3] A point must be clearly stated here. We are here focusing on the reasons for the `gap' in turnover rates between the two groups. But, in fact, the primary `cause' of turnover in both groups can still be `wages'.

competitive advantage of low labour costs. This seem to be partly confirmed by their higher rate of temporary and casual employment (28.4 % against 4.6 % in the large firms).

Then why is the gap in employment stability most prominent in ordinary office and production workers, and why are only `engineers' more stable in the small and medium firms? One of the reasons might be that the difference between the large and the small firms in terms of the above employment conditions is great (or is perceived so) in ordinary office and production jobs, whereas it is only moderate in technological jobs. In a sense, this may reflect a strategy of the small and medium firms: since they have to secure the conditions of low wages and high technological capability simultaneously, they may prefer a cheap labour force for ordinary office and production jobs but want to keep experienced engineers and technicians by offering relatively favourable conditions. On the other hand, since these technological employees possess lower educational and career levels than those in the large firms and thus have little chance to move to large firms, most of them tend to remain in their own firms. Or when they do move, it is largely to other small and medium firms.

7-2-5. sources of employment

We now consider another aspect of the dual labour market hypothesis, namely `sources of employment'. If large firms acquire their employees from significantly different sources to small and medium firms, competition in the labour market between these two kinds of employees will be reduced and hence a structure of the dual labour market emerges. Let us first see the accession routes of our sample firms (Table 7-6).

A clear contrast can be found between the large and the small firms. In the large firms, regardless of type of employees, the most important route is `public notice', whereas it is `personal connection' in the small and medium firms. The difference between them is particularly prominent in the case of engineers/technicians, which is likely to have implications for their different pattern of technological efforts. The reason

Table 7-6. Routes of accession by functions of employees

(unit : %)

Functions	Size group	Accession routes 1.public notice	2.employment agency	3.school's recommend.	4.personal connection	5.scout from other comp.	Total
engineers/ technicians	Large	74.3	0.0	17.1	5.0	3.6	100.0
	Small	21.8	2.7	9.1	64.5	2.3	100.0
production workers	Large	55.0	4.3	27.1	7.9	5.7	100.0
	Small	25.0	12.5	23.8	37.9	0.8	100.0
managers	Large	68.3	0.0	3.3	0.8	27.5	100.0
	Small	14.5	2.7	9.1	69.1	4.5	100.0
ordinary administr.	Large	71.7	0.0	14.2	9.2	5.0	100.0
	Small	15.0	1.7	20.8	53.3	0.8	100.0

why the small and medium firms depend heavily on personal connections for employing engineers/technicians is probably because they are especially disadvantaged in this segment of the external labour market, in comparison with the large firms. Public notice may be sufficient and good for the large firms, for they can easily get superior technological workforce even without offering better conditions compared with those of the small firms, mainly because of their reputation as well as their large R&D effort. But for the small firms, which are not generally favoured by such high-quality manpower as engineers/technicians, it may be difficult to get good technological employees without relying on personal relations which the employers or existing employees have.

A considerably different picture is shown by production workers. In general we can see that their accession routes are more dispersed particularly in the small and medium firms. To recruit production workers the firms seem to use whichever routes available, including schools' recommendations and employment agencies (which are seldom used in recruiting other types of employees). This contrast between technological and production employees seems to suggest another reason why the former showed the lowest turnover rates and the latter the highest, in the small and medium firms. It is not difficult to imagine that those who were employed through personal connections

cannot easily move to other companies. A reason for the relatively low turnover rate of managers in the small firms seems to lie here too. In fact, we found in many of those firms that higher managerial staff were often family members or relatives or friends of the owners of the firms. Even ordinary office workers are often recruited in this way. Therefore, such accession through personal connections has become customary in the small and medium firms, especially for white-collar jobs. This seems to reflect both their disadvantaged position in access to the labour market and their efforts to overcome it. However, this pattern of employment also has a danger of favouritism, and thus can result in a personnel stagnation and a low technological and managerial performance.

Secondly, we explored the movement of workforce between large and small firms. We asked the firms about the proportion of their employees who had work experience in other firms and, in such cases, the types of their former companies. The proportion is 26.0 % in the large firms and 72.3 % in the small and medium firms. This result is consistent with our former results on employment stability. It also offers indirect evidence of a higher degree of development of internal labour markets in the large firms, an issue we will return to later. Table 7-7 shows where these employees had worked

Table 7-7. Types of former employers by functions of employees (unit : %)

Functions	Size groups	Types of former employers 1.large/same[1]	2.small/same[2]	3.large/other[3]	4.small/other[4]	5.other[5]	Total
engineers/ technicians	Large	69.2	17.5	9.2	0.8	3.3	100.0
	Small	12.3	52.7	8.3	20.5	6.2	100.0
production workers	Large	51.4	35.7	4.3	5.7	2.9	100.0
	Small	5.0	56.1	2.9	30.0	6.1	100.0
managers	Large	53.0	13.0	9.0	4.0	21.0	100.0
	Small	24.4	31.5	20.4	16.9	6.8	100.0
ordinary administr.	Large	44.0	16.0	20.0	10.0	10.0	100.0
	Small	17.4	41.3	7.7	22.1	11.6	100.0

Notes : 1) 'large/same'= other large firms in the same industry

2) 'small/same'= other small and medium firms in the same industry

3) 'large/other'= large firms in other industry

4) 'small/other'= small and medium firms in other industry

5) 'other'= those organisations which do not belong to any of the above(1)~4)) categories

before they moved to the current companies. There are different patterns in large and small firms. While most of such employees in the large firms had come from other large firms in the same industry, in the small firms they had come from other small and medium firms in the same industry. As in the case of accession routes, differences are found between different types of employees. Engineers/technicians are one of the most extreme cases. Here there is little movement of staff between the large and the small firms. Most movement is between large firms (78.4 %) or between small firms (73.2 %) themselves. Technological and other differences seem to make movement of such technological workforce between large and small firms very difficult.

In the case of production workers, the pattern is somewhat different. Here a considerable proportion of the workers in the large firms had come from small and medium firms in the same industry. Very few workers in the small firms had large firm experience however (7.9 % in total). This pattern seems to stem from the fact that large firms have entered the industry more recently and hence may have recruited a large number of production workers from existing small and medium firms. Also, since the lack of downward (i.e. from large to small firms) mobility suggests that most production workers want to work in large firms, we can understand how the wage levels and working hours of production workers in large firms can be kept at the levels not much better than those of small firms.

One interesting contrast between large and small firms is that, for both engineers/technicians and production workers, in small firms a far higher proportion came from `small firms in other industries' (i.e. 20-30 %), whereas in large firms those from `large firms in other industries' are only minor (i.e. 4-9 %). Since these employees are most directly related to the technologies their firms use or develop, this points again to the relatively simple and general character of technology in the small firms, compared to its sophisticated and specific character in the large ones.

In the case of managers and ordinary office workers, the proportions are relatively more dispersed over different types of employers in both size groups. This is probably

because not only they are not directly related to technological activities but also they include many who were pushed out of large firms (in particular, among managers in the small firms).

The high proportion of ` other' in managers of the large firms is likely to reflect, the special employment of former government officials or ex-army personnel, which is a specific phenomenon in Korea. However, generally speaking, the mobility of managerial and administrative workforce between large and small firms is also limited here. Therefore, we can conclude that there seems to be a segmentation of the labour market between the large and the small and medium firms.

7-3. Aspects of the internal labour market

Finally, we will review some of the major aspects of the internal labour market in order to see the latter`s different levels of development in large and small firms. We will focus on three aspects: personnel policy and promotion system, internal training system, and incentive system. First, let us consider a simple indicator which may be helpful to estimate the relative degrees of development of the internal labour market in the two size groups. We asked the firms what proportion of employees in such high-echelon jobs as engineers/technicians and managers were recruited from existing employees by promotion, training, acquisition of qualifications and so on. In the case of engineers/technicians, it was 2.1 % in the large firms and 10.0 % in the small firms. But in the case of managers, it was 76.4 % and 40.0 % respectively. Therefore, although it is hard to decide which firms have a more developed internal labour market only by this result, we can roughly consider the large firms as the more developed of the two because promotion to manage.ment is a most typical example of the internal labour market.

Turning to personnel policy and promotion system, first, there seems to be no

fundamental difference between the personnel policies of the large and the small firms. We asked the firms about which of the following personnel policies they were closer to: A = employees are hired on a merit basis and fired whenever they perform below expectations; B = employees are hired for life, become part of a business family, and are seldom released. A 5-point scale (1 = the same as A ; 5 = the same as B) was used. We assumed that firms whose personnel policy is closer to B would have more developed internal labour markets, because such firms were thought to offer not only greater job security but also to fill many jobs by the promotion or transfer of existing workers, rather than by external recruitment. However, both large and small firms placed their personnel policies closer to B, regardless of different types of employees, though the score of the large firms (4.0) was slightly higher than that of the small firms (3.8 to 3.9). Therefore, at least the basic character of personnel policy is not so different as to lead to a significant gap in their internal labour markets. The slight difference in job security seems to stem not so much from their different personnel policies as from their different market power.

Then how about their promotion systems? In considering promotion system, we must take into account one fundamental difference between the two size groups: whereas all the large firms are joint stock companies, only half of the small firms are.The rest are individual businesses. Even the small firms which are joint stock companies are owned and managed by families. Thus there are limited numbers of high-echelon positions both due to small size, and to limited opportunities for non-family members. But, apart from this it cannot be said that the small firms offer less chances for advancement for ordinary and middle echelon jobs. On the contrary, promotion to such posts is often more rapid in the small firms. For instance, to become a foreman ('Banjang' in Korean) who supervises a section of production lines (e.g. assembly, painting, inspection...), usually takes about 3 to 5 years in a small firm whereas it takes 5 to 8 years in a large. However, it is generally observed that the job ladder is more subdivided and systematised in the large firms, and thus they can use this as a powerful means of labour control and incentives to achieve high productivity and low turnover

rates. Especially in white-collar jobs (including engineers and technicians), not only is the promotion system highly sophisticated but the possibility of becoming high echelon managers or even top managers, offers the employees in these firms the motivation to stay. In contrast, since small firms have a simpler job ladder and fewer high echelon jobs to offer their employees, more rapid advancement can be, paradoxically, a factor which facilitates their turnover. Moreover, in terms of promotion criteria, though both size groups largely follow job records (i.e. performance) and seniority rules, the application of such criteria is often arbitrary and susceptible to favouritism in the small firms.

Finally, opportunities for the training and education necessary to get promotion or to find better jobs may be different between the two groups. Some authors suggest `on-the-job training' as a major factor generating internal labour markets (Doeringer & Piore, op. cit.), The training system, more broadly, is closely related to the promotion system as well as to technological development. Through training and education, firms not only want to improve the technological and managerial capabilities of their employees but also try to foster and select superior personnel for senior jobs. Table 7-8 next sums up the answers to our question on training and career development facilities provided by the firms.

Table 7-8. Training and career development facilities

(unit: no. of firms)

Codes of availability [1]	Internal vocational training		Formal courses [2]		Training visits [3]	
	Large firms	Small firms	Large	Small	Large	Small
0	-	6	-	3	-	5
1	-	-	4	2	-	1
2	4	-	-	-	-	-
3	2	1	-	-	-	-
4	-	-	-	-	3	-
5	2	7	4	8	5	7
(no answer)	1	-	1	1	1	1
Total	9	14	9	14	9	14

Notes: 1) The code numbers indicate the following:

0 = not available to employees

1 = available only to engineers/technicians

2 = available only to ordinary workers
3 = available to all production workers (i.e. 1 + 2)
4 = available to all employees except ordinary workers
5 = available to all employees

2) Here `formal courses' only include those with minimum 2 weeks.
3) These include dispatch for training, visits to overseas firms for study, etc.

It can be seen that while all the large firms provide more or less all of the three types of training opportunities, some of the small firms don't provide any, though over half of them have some or all of such programs. However, even in those small firms which have training programs, their content and scale is often considerably different from those of the large firms. Most of the large firms have their own training centres in which collective and continuous education and training for their employees is systematically conducted by internal training staff or invited external experts. A major part of their formal vocational training (e.g. orientation for new employees, management techniques training, quality control training, etc.) is provided here. Besides this on-the-job training(OJT), which takes more informal forms, is widely practiced for production workers under the charge of foremen and senior workers. For new employees, it typically takes 2-3 months.

Small firms do not have training centres and there are few formal training programs. In most of them, some basic and general education is given by production managers and technological staff or sometimes by external lecturers, several times throughout a year, but it is very fragmentary and takes only dozens of hours in annual total. Though OJT is popular in many firms, this also takes a short time compared with the large firms, typically days or a week. One characteristic common to both large and small firms in Korea is that training and education programs are usually pursued as a part of or in parallel with Total Quality Control (TQC) activities. Originally imported from Japan, TQC became prevalent in the 1980s throughout Korean industries, including the machine tool sector. So, in our sample firms, many QC circles are organised either voluntarily or by stimulation of the government, and a major part of the firms'

training programs is performed in these circles.

In terms of formal courses, opportunities for long-term education such as degree courses are only found in the large firms, limited to some selected employees. But relatively short-term courses are available in both size groups. In this case, the large firms use both their own training centres and some external technical institutions, whereas the small firms rely only on external institutions such as SMIPC, KSA (Korea Standard Association)[4], KIMM and so on. Training expenses in the latter are jointly sponsored by the government and the small firms concerned. However, considering the fact that many of the small firms still complain about the gap between the content of such training courses and their actual technological levels (for instance, typical complaints for such courses are "too theoretical", "too sophisticated", etc.), the real effect of the training may be different from the case of the large firms. Lastly, training visits are made by employees of the large firms for field observation of foreign companies, technical training connected with licensing agreements, etc., whereas they are very rare in the small firms. In the latter, visits to R&D institutes for technical consultation, participation in exhibitions, seminars and so on are used as opportunities for training visits. An interesting difference between large and small firms is that as many of the large firms offer technical training for their subcontracted firms which produce parts or end items, some small firms receive such training and guidance from their subcontractors or large customers. As such subcontracting relationships increase in the industry, opportunities for such training visits to and from large firms will increase for the small firms.

Finally, let us consider incentives and the welfare system. Incentives are devised in order to enhance the morale and performance of employees. We focused on the following three forms of incentives: pecuniary incentives (e.g. wage increases or a special allowance)[5], special promotion, and special commendation or reward. Table 7-9

[4] KSA is a semi-government organisation, which is in charge of implementation (training, publicity, etc.) of TQC movement, as the secretariat of the Industrial Advancement Administration.

shows how many firms implement these incentives in each group of our sample firms.

Table 7-9. Incentives implemented by size groups

(unit: no. of firms)

Yes/No	Pecuniary incentives		Special promotion		Special commendation	
	Large firm	Small firm	Large	Small	Large	Small
Yes	3	10	7	8	8	9
No	5	4	1	6	-	5

We can note that while the large firms tend to use special promotion and special commendation rather than pecuniary incentives, the small firms depend mainly on the latter. This seems to be because the large firms can utilise their long and complex promotion ladder as an effective means of incentives, whereas the small firms, which have a relatively simple job ladder, may have to resort directly to pecuniary rewards. Also, for employees in such small firms, the latter may be more preferable as their firms are unstable and provide harsh working conditions.

In terms of welfare systems, there are especially marked differences between the large and the small firms. The large firms provide a variety of welfare systems. Typical examples are: medical insurance, industrial accident insurance, free meals, regional allowance, company accommodation, commuter buses, supplements for educational expenses of employees' children, credit unions, profit sharing scheme, employee share ownership scheme, expenses for congratulations and condolences and various sports facilities. One large firm even has its own hospital. In contrast, welfare systems in the small firms are meager. Though most of them provide industrial accidental insurance (this is compulsory for firms with over 10 employees), medical insurance is hardly found in these firms. Only a few firms provide marriage allowances, educational supplements and some other benefits for employees. This considerable gap in welfare systems seems to play a great role in workers' views of job and hence in the firms' differential

[5] We excluded `bonus' as a pecuniary incentive because it is univeralised throughout Korean firms and is thus almost regarded as regular pay rather than a special incentive.

access to the labour market. The large firms enjoy clear superiority over the small firms in this regard.

7-4. Relationships between labour market factors and technological performance

We have examined above some major features of the dual and the internal labour market, and have found some evidences to confirm the existence of such segmented labour markets in our sample firms. So, do such differences in labour market conditions influence the relative technological performance of the firms? To answer this, we must look into the relationship between labour market factors and technological variables in our data and see whether there is correlation between them or not.

For reasons of availability and reliability of our data, and in order to avoid complexity, we will only focus on two typical aspects of the labour market structure for illustrative purposes: turnover rates and the proportion of internal recruitment by promotion. Each of these is assumed to represent features of the dual labour market and the internal labour market respectively. And as a technological variable, we will use firms' subjective evaluation of their technological capabilities described in Chapter 5 (Table 5-2). Table 7-10 below summarises the results of a correlation analysis on these

Table 7-10. Correlations between labour market factors and technological capabilities(Spearman' rho)

Size group	Types of technological capabilities	Turnover rates			Internal recruitment pro's	
		engineers	technicians	craftsmen	engineers/ technicians	managers
Large firms	product mfg.			.2582	.5217	.0307
	process cont.	.0000	.9428 *		.6600	.4759
	design	.3162	.8333		.8250*	.3885
	R&D	-.1054	1.0000*		.8250*	.6119
Small & Medium firms	product mfg.			.2627	.4860	-.2476
	prcess cont.	-.4447	-.1347		.6027	-.2374
	design	-.4318	-.2848		.2769	-.4323
	R&D	-.5282	-.3625		.1874	-.5734*

Note : The sign ' * ' indicates P<.10(two-tailed).

variables. The correlation coefficients used are Spearmen's rho, and we controlled the variable `size' by calculating the coefficients in each size group in order to avoid `spurious' correlations due to size effects.

As can be seen in the Table, the correlations are different in the two size groups. The turnover of engineers is inversely related with technological capabilities in the small firms, whereas it has no particular relationship with them in the large firms. Since it is only in this category (i.e. engineers) that turnover rates in the small firms are lower than those in the large firms (see Table 7-5), those small firms which have `stable' engineers seem to show relatively higher levels of design and R&D capabilities, almost comparable to the levels in the large firms. But among the latter, the stability of their engineers seems to have no notable effects on their levels of technological capabilities. Other factors, for instance, the size or experience of such engineers, may be more important. The contrast is even more striking in turnover of technicians. Surprisingly, the turnover shows strong positive correlations with the technological capabilities of large firms, while it is negatively related in the small firms. In the case of the large firms, the result seems to disprove the hypothesis that low turnover rates of employees have positive effects on the accumulation of technological capabilities of firms. However, the result may just reflect the fact that in some technologically stagnant large firms there is little retirement or new recruitment of technicians. In any case, since it is `engineers' rather than `technicians' who constitute a major part of the technological staff in the large firms, the relationship between turnover rates and technological accumulation is not considered as being positive in these firms. Meanwhile, turnover of craftsmen (i.e. both of `qualified' and `unqualified' skilled workers in our preceding definitions) has no particular relationship with product manufacturing capability, in which they are thought to play the most important role, in either group. Therefore, product manufacturing capability does not depend on workers' stability, but on other factors which are not shown here. A significant gap in this capability between the large and the small firms must thus be explained by other reasons such as experience, training, etc.

Internal recruitment of engineers and technicians seems to have a positive effect on

technological capabilities in both size groups. It is especially important for design and R&D capabilities of the large firms. However, since the small firms showed a little higher figure in such internal recruitment, such a result cannot be used to explain their lower levels of technological capabilities. Nevertheless, the result seems to confirm the importance of developing internal labour markets for engineering and technical jobs through training, promotion and so on. This has a positive effect on technological accumulation, especially in the case of the large firms.

On the other hand, the effect of internal recruitment of managers is quite different between the large and the small firms: in the former it is positively correlated with technological capabilities, whereas it is the opposite in the latter. What does this imply? As we have already indicated, `internal recruitment of managers' is not only related to internal markets for managerial jobs but also, and more importantly, represents the extent of internal labour markets as a whole within a firm. So, the higher proportion shown by the large firms in this respect seems to imply their higher levels of development of internal labour markets, and this seems to be helpful for their technological accumulation (as can be seen in our Table). In contrast, in the small firms internal markets for managerial jobs seem to be inversely correlated with technological accumulation. To explain this, we need to consider some specific conditions which these firms have. As we pointed out before, they recruit most of their employees through personal connections rather than public notice (i.e. free competition). Thus a high proportion of internal recruitment of managers `among' these firms tend to reflect not so much a developed internal labour market (with broader opportunities of promotion based on achievement, etc.) as simply a promotion of personnel who have personal relations with the owners. In this case, such a high proportion of internal recruitment of managers can lead to low motivation of employees and hence low productivity and technological performance. But this would not disprove the hypothesised positive correlation between the internal labour market and technological accumulation.

To sum up, the relationship between labour market factors and technological capabilities is more complicated than we first assumed. The importance of employment stability is generally confirmed in the small firms but not in the large firms. Product manufacturing capability has no relationship with employment stability of skilled workers in both groups. Internal labour markets are in general positively correlated with technological capabilities, especially in the large firms. The small firms seem to suffer in improving their technological capabilities, from their underdeveloped internal labour markets. In conclusion, the hypotheses we outlined at the beginning of this chapter are only moderately confirmed in our analysis. Of course, since we confined ourselves to only a few variables here, the correlation between the dual labour market and levels of technological performance may be either disproved or reinforced in further analyses.

Chapter 8
Capital Market Factors

As we mentioned at the end of Chapter 5 (see 5-3-5), the small and medium firms in our sample indicated `lack of R&D funds' as their biggest difficulty in developing new products, whereas the large firms ranked it 6th. It is true, as we noted in Chapter 6, that costly R&D projects can be undertaken only by large firms because of the sheer scale of investment. However, since many small and medium firms want to invest in small or moderate R&D projects appropriate for their production scale, the fact that they felt the lack of funds so seriously implies that they can hardly afford even such a moderate scale of R&D expenditure. From this we can suppose that there will be significant differences in the financial conditions of large and small firms. Such financial gaps may be one of the major sources of the differences in their rate and patterns of technological change. Does the financial gap reflect differential access to the capital markets? Is there also a gap in their internal financing capabilities? And how do these gaps (if any) influence their relative rate and pattern of technological change? These are the questions which we will address in this chapter.

8-1. Hypotheses

In the literature, it has long been recognised that large firms are generally more advantaged with respect to both the availability and the cost of finance (Staley & Morse, op. cit. ; Rothwell & Zegveld, op. cit.). This tendency is particularly acute in developing countries and is described as `financial dualism' by some authors (e.g. H. Myint, 1980). The weakness of small firms in financing is thought to stem from the following reasons (Park, 1983: 16): (i) their small capital size often sets limits to the levels of loans available; (ii) financial institutions tend to avoid loans to small firms because of the latter's low credibility and unstable business; (iii) since size of funds demanded by them

is small per firm, a high credit cost is necessary; (iv) because of their high failure rates and uncertainties, loans tend to have complicated conditions and to be rather short-term; (v) since there are a large number of small and medium firms, competition to get loans is especially fierce. In short, because of their inherent characteristics and the prospensity of financial institutions to seek safety and efficiency, small and medium firms tend to be alienated by institutional financial markets. Moreover, their financial difficulties are aggravated by large firms which use credit transaction with small and medium firms as a cushion for their own financial problems, especially during recessions. For instance, by prolonging the period of payment for their credit purchase and/or by tightening the terms of their sales, large firms try to transfer their financial burden to the small and medium firms with which they do business (e.g. subcontracting relationships). As a result, the financial capability of small and medium firms becomes more restricted, and their financial gap with large firms is widened. In order to redress or alleviate such a gap, governments have prepared special policy measures for finance of small and medium firms. However, in the case of Korea, such policies have been of doubtful effectiveness, not merely because of the rigid inertia in the capital market, but more because throughout the 1960s and the 1970s the Economic Development Plans by the government were heavily in favour of large firms, which made the latter the major beneficiary of government loans. This fact is particularly significant in the Korean situation where virtually all the major banks were under tight control by the government until very recently.[1] Therefore, the role of the government in finance has been regarded as, far from a protector of small and medium firms, facilitating the financial gap between large and small firms.

Based on this background, we would like to establish the following hypotheses as

[1] After the military government took power and initiated industrialisation policy in the early 1960s, banks were taken under government control or have been newly established by government investment. So, the government could exercise control over interest rates, credit, foreign exchange and the allocation of financial capital. Though the government began to divest its equity share in the five major banks, the Ministry of Finance has retained supervisory responsibility for all commercial banks.

regards capital market factors.

- Hypothesis 1: large firms have more advantageous access to capital markets, and especially to credit, than small and medium firms.
- Hypothesis 2: large firms have more diverse channels of finance, especially for technological developments, and hence can spread their risks.
- Hypothesis 3: large firms have a superior internal financing capability to small and medium firms.
- Hypothesis 4: the above financial superiority of large firms provides a major advantage for them in most `formal' forms of technological change, whereas small and medium firms tend to concentrate on `informal' forms of technological change which do not need a large investment.

We will investigate the validity of these hypotheses in the following sections.

8-2. Sources of finance

Let us first see the sources of finance for technological developments (both of R&D and licence imports) in our sample firms. Table 8-1 shows the relative proportions of the financial sources for developing new products and new processes in the last five years.

Table 8-1. Sources of finance for technological developments in the last 5 years

(unit: %)

Types of financial source	Large firms	Small & Medium firms
1. internal finance	64.4	59.2
2. bank credit	18.1	29.2
3. private loans	4.1	0.8
4. government subsidies	4.6	0.0
5. foreign loans	0.0	0.0
6. contract deposit by customers	1.3	1.7
7. others	7.5	9.2

Though, at first sight, there is no big difference between the two groups, there are some interesting points to note concerning their patterns of financing technological

developments. In both groups, internal finance and bank credit are the predominant sources of technological finance, and together constitute more than 80 % of the total. The importance of internal finance, the foremost financial source in both groups, is more notable in the large firms, while that of bank credit is certainly greater in the small than in the large firms. The average figures for the small and medium firms conceal, however, a significant difference among the firms within the same group. If they are divided according to size, in terms of employment, we find that larger firms tend to depend more on bank credit and smaller firms on internal finance. For instance, in firms with more than 100 employees the proportion of internal finance is only 40.0 % and that of bank credit is 43.3 % ; in those with less than 100 employees the figures are 78.3 % and 15.0 % respectively. Therefore, the latter show a proportion of internal finance even higher than that 64.4 % in the large firms. The reasons for these high proportions of internal finance, however, are likely to be different between the large firms and these smallest firms. In the case of the former, the main reason seems to lie in their higher profits, in that the availability of internal finance must basically depend on profitability.[2] In contrast, in the case of the latter, they more likely to have to depend on their own funds since access to bank and other credit may simply be difficult for them, especially when it is for technological purposes. (The reasons for this will be explained later). Accordingly, their high proportion of internal finance seems to reflect not so much their superior internal financing capability as their difficulties in external finance. On the other hand, the high proportion of bank credit in those firms with between 100-299 employees

[2] Though the large firms may not make much profits from their production of machine tools, they seem to have been more profitable than the small and medium firms because they have been successful in other product lines. See the Table below.

Year	Rates of value-added 1)		Net profit rates 2)	
	Large firms	Small firms	Large firms	Small firms
1982	29.7	16.9	- 5.2	- 6.9
83	30.7	20.7	3.1	2.4
84	28.6	18.2	4.6	3.0

Note : 1) = (value-added/sales)x100 ; 2) = (net profits/sales)x100

seems to reflect their relatively favourable access to such credit. Nevertheless, we do not think that this can be taken as evidence that they are better than the large firms in terms of access to credit. Not only is their actual amount of credit far smaller than that of the large firms, but most of them also cite `lack of funds' as their most serious problem in developing new products. Their high proportion of bank credit can thus be ascribed more to their paucity of internal finance, which in turn reflects their poor internal financing capability.

In terms of other financial sources, large firms show a relatively even pattern of use, while small and medium firms hardly use these sources except the category `others' in the Table. In this last source, loans from their stockholders (or joint-owners) occupy a major part. If we include this in the category of `private loans', the proportion of such loans will be higher than is shown. Large firms seem to utilise a variety of sources, including government subsidies, private loans, contract deposit, and `others' (in this category, financing through the securities market is included). So we can see that large firms not only have a superior internal financing capability but also access to more diverse channels of finance for their technological developments than small and medium firms have. Therefore, they are believed to be able to spread their risks more widely and to reduce their financial costs.

Since the above Table is confined to finance for technological investments only, it does not show the whole financial pattern of the firms. If we are to look at the real financial conditions of those firms, we need to consider the a whole picture because technological finance is not independent but usually a part of it. Unfortunately, we do not have such data for our sample firms or for the machine tool sector. Instead, we have the data for the whole manufacturing industry and thus would like to look at this, assuming that it can be taken to represent the general pattern of finance throughout the industry, irrespective of sectoral differences. Table 8-2 below shows the composition of financial sources of corporate firms (i.e. excluding individual businesses) in the Korean manufacturing industry in 1979 and 1982. In terms of the comparison between internal and external finance, it is found that the proportion of internal finance is much

smaller than in Table 8-1. We do not know whether this difference is a sectoral difference or whether it reflects the difference between technological finance and finance in total. Nevertheless, the pattern is consistent, the proportion of internal finance in the large firms is higher than in the small firms. Since internal finance primarily depends on the size and rate of profit, its lower proportion in the small firms is likely to reflect their low net profit rates. The fact that in 1982 they scored minus in the sub-category `internal reserves' among internal financial sources seems to confirm this. Meanwhile, among external sources, direct finance (i.e. without the mediation of financial institutions) is more important in the large than in the small firms, whereas the opposite

Table 8-2. Composition of financial sources in the manufacturing industry in 1979 and 1982.

(unit : %)

	Manufacturing total		Large firms		Small firms	
	1979	1982	1979	1982	1979	1982
A. internal finance	**23.2**	**31.8**	**23.6**	**33.4**	**20.5**	**23.4**
1. internal reserves	5.5	3.1	5.4	3.9	6.7	-1.0
2. depreciation	15.5	25.0	16.0	25.5	11.8	22.3
3. appropriation	2.2	3.7	2.2	4.0	2.0	2.1
B. external finance	**76.8**	**68.2**	**76.4**	**66.6**	**79.5**	**76.6**
1. direct finance	9.4	22.4	9.5	23.7	8.7	15.5
a. capital increase	4.1	6.8	3.6	6.1	7.1	10.9
b. company bond	5.3	15.6	5.9	17.6	1.6	4.6
2. indirect finance	36.4	13.0	35.0	9.9	44.9	28.8
a. bank loans	26.3	10.8	24.9	9.1	34.7	19.3
(long-term)	(12.0)	(0.9)	(9.9)	(1.8)	(25.2)	(-4.4)
b. foreign loans	2.2	-1.2	2.8	-1.9	-1.5	2.4
c. others	7.9	3.4	7.3	2.7	11.7	7.1
3. credit purchase	14.3	15.1	14.3	13.2	14.0	25.4
4. others	16.7	17.7	17.4	19.8	13.4	7.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Note: Only corporate bodies are included in the above survey, i.e. individual businesses are excluded.

Source: Bank of Korea, *Financial Statements Analysis*, various years; quoted from Park, 1983.

applies in indirect finance (i.e. through the mediation of financial institutions). Direct finance tends to be difficult for small and medium firms, because they cannot use the

stock market to raise funds by selling shares or bonds, due to their small capital size and stringent rules and procedures in the market. So, most of their new shares and bonds are bought by the families and relatives of their owners or by a few special financial institutions set up for small and medium firms (e.g. the Small and Medium Industry Bank, the Citizens National Bank, and Trust Guarantee Funds). Moreover, since only `corporate' firms can issue shares and bonds, the proportion of direct finance in small and medium firms will be much lower when we include all the firms which are individual businesses. As a result, small and medium firms tend to depend heavily on financial institutions, especially banks. This does not mean that they have advantageous access to such institutions but merely that, access to other sources is even more difficult. Though we will compare large and small firms' access to credit specifically later on, it is not difficult to imagine that small firms have disadvantages in this form of financing as well. A main reason for such disadvantages resides in their weakness in terms of security and credibility. This can be proved by the fact that even among small and medium firms there are significant differences in their access to credit according to their firm size: the larger the firms are then the easier their access to financial institutions is. For instance, according to a survey on `external' financing of small and medium manufacturing firms (SMIB, 1983, quoted in Park, 1983), the proportion of credit from financial institutions is 79.6 % in firms with 5-9 employees, while it is 93.5 % in firms with 100-199 employees and 96.8 % in firms with 200-299 employees. In contrast, the proportion of private loans is 20.4 %, 1.5 % and 1.1 % respectively. And the most important reasons for such private loans are `temporary borrowing for urgent funds' and `refusal or delay of loans by financial institutions'(ibid.). In a word, since financial institutions prefer larger companies even among small and medium firms because of better security and credibility, smallest companies cannot but depend private loans in spite of the latter's high interest rates (usually 2-3 % per month, in contrast to 1-2 % per month for bank credit during early 1980s. See Park, ibid.). As, due to government control, banks must apply largely equal interest rates for borrowing firms regardless of

their size differences, it is natural for them to prefer larger firms.

Lastly, let us take a brief look at the role of credit transactions between firms. As was shown in Table 8-2, the proportion of credit purchase among total financing was largely similar between large and small firms in 1979, but became far more important in small firms in 1982. However, if we want to see the relative advantages/disadvantages of different size firms in credit transaction, we must compare their conditions in credit sales with those in credit purchase. While credit purchase plays a role as a source of finance, credit sales can be considered as a provision of credit. If a firm purchases raw materials and parts mostly by cash but sells its products mainly on credit, it will have financial difficulties. In this regard, it has been pointed out that small and medium firms typically suffer from the gap between their high proportion of credit sales and their low proportion of credit purchase (Park, ibid. ; KFSB, 1985). For example, in 1984 the proportion of credit transactions was about 50 % of total purchases of raw materials, but more than 67 % of sales of their products (KFSB, ibid.). Moreover, 55 % of purchase credits had to be settled within two months compared to less than 30 % of sales(ibid.). These imbalances in credit transactions seem to have become a serious financial problem for small and medium firms. A main reason for these imbalances is thought to be that while the raw materials bought by these firms are usually monopolistic-oligopolistic products of large firms, their own products are mainly sold in competitive markets or in subcontracting relationships (ibid.). In this respect, the position of large firms is likely far more favourable because they can exert a considerable degree of control over their customers as well as their suppliers. A survey on the machine tool industry (SMIPC, 1984) seems to confirm the existence of the above pattern of credit transaction in the industry as well. As is shown in Table 8-3 next, the smaller the firms are, the lower their proportion of credit purchases, but the higher the level of credit sales. The average settlement period is also disadvantageous for smaller firms. Large firms (i.e. with over 300 employees) enjoys favourable conditions in their credit transactions, because the

proportion of their credit purchase is higher than that of their credit sales. Therefore, though the importance of credit purchase among all financial sources may be higher in

Table 8-3. Credit transaction by firm size in the machine tool industry in 1983

Size of employees	Proportion of credit transaction(%)		Average settlement period(days)	
	purchase(materials)	sales	purchase (materials)	sales
5 ~ 19	42.1	76.8	57	109
20 ~ 49	56.6	74.7	62	89
50 ~ 99	66.0	87.2	70	91
100 ~ 199	69.9	79.5	90	69
200 ~ 299	82.1	85.0	81	73
over 300	68.6	65.7	84	90
Total	60.6	75.5	70	85

Source: SMIPC, 1984, p.81.

small and medium firms, the actual effect of the whole credit transaction between firms as a method of finance is more beneficial to large firms.

To summarise, in general the sources of finance are more diverse in large than in small and medium firms. Large firms tend to depend more on internal finance than small and medium firms. Among the external sources of finance small and medium firms are especially weak in direct financing through the stock market. are also disadvantaged in indirect financing through financial institutions and in credit transaction between firms. Only the larger small firms seem to have relatively easy access to bank loans. Consequently, smallest firms tend to considerably depend on private loans even though they must pay high interest rates. These overall financial difficulties of small and medium firms are likely to have severely restricted their investment capacity in technological developments and have influenced their pattern of technological change.

8-3. Access to credit

Now let us see how much there has actually been a difference between large and small firms in their access to credit (especially, that through institutional financial

markets). Has the distribution of credit really been unfavourable to small and medium firms or has it been relatively even or favourable to them thanks to government intervention in the credit market ?[3] A rough answer can be found by comparing the share of credit by small and medium firms with their share in other major input or output indicators like employment, sales and value-added. Table 8-4 below shows such a comparison during 1970 to 1981.

Table 8-4. Share of small and medium firms in credit, employment, sales and value-added: 1970~81

Year	Share in total loans[1)]	Share in total domestic private credit[2)]	Share in employment	Share in shipments	Share in value-added
1970	25.9	24.0	55.4	36.4	28.0
75	29.8	21.2	45.2	30.8	31.3
76	39.0	23.5	43.9	29.5	29.8
77	40.2	23.6	45.7	30.7	32.2
78	41.6	22.4	47.0	32.4	34.9
79	43.1	23.5	47.7	32.3	35.2
80	43.9	23.1	49.4	32.1	35.1
81	45.2	24.7	50.7	32.4	34.7

Note: 1) Annual survey by the Small and Medium Industry Bank(SMIB). Institutional coverage includes 5 Commercial Banks, the Citizens National Bank and SMIB. Only loans in Korean currency are included.

2) These figures are `loans for small and medium industry' divided by `total private domestic credit'.

Source: L. Jones, 1980, p.101 and KFSB, 1985, p.203.

In terms of the `share of small and medium firms in total loans' (i.e. column 1), we can certainly notice a steady increase throughout the period. It has increased more rapidly than their share in employment, in shipments and, more importantly, in value-added. This seems to disprove our earlier argument that the credit market has operated in favour of large firms and to undermine the criticism that the government has been, at least partly, responsible for such bias in the credit market. On the contrary, it appears that

[3] As L. Jones(1980:99) indicates, the semi-official answer is decidely `favourable'. This is based on the standard statistics on `loans to small and medium firms as a share of total loans' surveyed by the Small and Medium Industry Bank(SMIB). However, the judgement based only on this statistics involves some problems, which will be discussed later.

credit has actually been distributed in favour of small and medium firms, even more than their contribution to `returns to investment' (i.e. value-added). However, `total loans' in column 1 ignores a number of substantial sources of private credit; for instance, the Korea Development Bank, the Securities Market, and Foreign Currency Loans. Since large firms dominate in these markets, the share of small and medium firms in total domestic private credit (i.e. column 2) has actually remained roughly constant during 1970-1981. Though in the 1980s it has also risen up to 25~26 %, it is still far below their share in the other indicators.[4] Therefore, there are no ground to reject the argument that the credit market is biased against small and medium firms. The recent increase in the credit for these firms can be recognised, and this seems to be a result of the active involvement of the government in promoting the small and medium industries since the early 1980s. For instance, in October 1980 the new government decided to raise the rate of obligatory loans to small and medium firms from 30 % for commercial banks and 40 % for local banks to 35 % and 55 % respectively (i.e. they must allocate at least these proportions of their total loans to small and medium firms. KFSB, op. cit.). Moreover, to extend the access of small and medium firms to such non-bank financial institutions as short-term financing companies, the government also set the latter's rate of obligatory loans to small and medium firms at 35 % from May 1983 (ibid.). Accordingly, it seems certain that the gap between large and small firms in their access to the credit market has been gradually reduced in the 1980s. From this point, it can be said that the role of the government is slowly changing from the bias in the credit market against small and medium firms to one of redressing the bias. This changing role of the government will be discussed in more detail when we deal with state policy.

[4] According to KFSB(1985), their share in total private domestic credit is 25.2 % in 1982, 26.6 % in 1983 and 26.4 % in 1984 respectively. On the other hand, small and medium firms occupied 54.3 % of total employment, 34.7 % of total shipments and 37.5 % of the total value-added in 1983.

8-4. Relationships between capital market factors and technological performance

In the above discussion we found that large firms had enjoyed considerable advantages in the capital market in terms of both their access to credit and their diversity of financial sources. In particular, their internal financing capacity tends to be clearly superior to that of small and medium firms. Though these findings are largely based on the data concerning the whole manufacturing industry, they are consistent with our interview results and other surveys of the machine tool sector(e.g. SMIPC,1984).[5] How do such characteristics of the capital market influence the technological performance of firms in the machine tool sector? Since our data is not appropriate for a quantitative correlation analysis, we will just point out some major observations here.

First, the weakness in the internal financing capability of small and medium firms, which stems from both their small capital size and their low profit rates, seems to fundamentally restrain their capacity to invest in technological developments. Since they compete fiercely both with each other and with some of the large firms, in the small domestic market for conventional machine tools, mainly by exploiting their price advantage, it is not surprising that they can hardly make any significant margin of profits (see our next discussion on product market structure). Nevertheless, in the case of the smallest firms (e.g. with less than 100 employees), they have to depend on internal funds simply because of their difficulties in getting access to external finance. However, since these firms are mostly individual businesses, the limitations of owned capital as well as their difficulties in capital, tend to make any large scale investment for technology by internal finance very difficult even when they put most of their profits into it. Consequently, the technological development by these firms tends to take the form of the accumulation of minor improvements and adaptations on production lines.

[5] Though `metal cutting machinery' is one of the 154 `Priority Industrial Subsectors for Small and Medium Firms' selected by the government in March 1985 and thus a special support can be provided for small and medium firms, this does not seem to have such an importance as to negate or above general findings.

And when they try relatively major technological development projects they depend on of in- house development, mainly `copying' and `imitation', rather than technology imports which necessiate expensive royalties. In this sense, they can be said to devote themselves to `informal' forms of technological change.

On the other hand, in the case of medium-sized firms (e.g. with 100- 299 employees), though their internal financing capability is not much better than that of smaller firms, their access to external finance (especially, bank credit) seems to be comparatively better. This is largely the effect of recent government support for small and medium industries, of which they are the main beneficiaries. Therefore, these firms can cover their weak internal finance by relying on external finance, and are thus able to initiate some sizable technological projects through either their in-house R&D or technology imports. This implies that the availability of bank credit and other external finance determines the opportunities for small and medium firms to pursue `formal' forms of technological development, and that for this reason medium-sized firms are more able to do this. For example, all five firms which had any experience of licensing agreements among our sample small and medium firms are ones with more than 100 employees, and two of them are joint-ventures. The average proportion of bank credit among their financial sources of technological development is 42 %, while that of internal finance is only 38 %. Therefore, to get access to bank credit (or such external finance as joint-ventures) seems crucial for small and medium firms if they are to import foreign licences. In short, though a weak internal financing capability is common to both small and medium firms and is thus a major constraint on their technological performance in general, their differential access to external finance tends to differentiate the scale and pattern of the technological effort of smaller firms from those of medium firms. However, compared with large firms which enjoy both a strong internal financing capability and a favourable access to external finance, they still remain largely pursuing informal forms of technological development.

Secondly, if handicaps in access to credit is one of the important factors which

make small and medium firms incline toward informal forms of technological development, this pattern of technological effort in turn tends to hinder their chances of getting credit to finance their technological projects. For instance, minor improvements and modifications on the production lines, a typical form of technological change in small and medium firms, are mostly not eligible for the bank loans allocated for supporting technological development. Since banks usually provide such loans only when the technology concerned is recognised as `new technology', even copies or imitations of foreign products which are regarded as new products from the standpoint of small and medium firms, are often beyond the category for such loans. Moreover, the loose organisation of R&D in small and medium firms makes a precise calculation of R&D expenses and preparation of formal documents to support such expenses difficult. Both of these are necessary for banks to grant loans. It is also difficult for small and medium firms with limited R&D manpower and facilities, and with usually weak market positions, to verify not only the technical feasibility of a new project but also its expected economic returns. To grant loans to these firms may thus involve too high risks for banks which must ensure short-term interests. Even when the development of a new product is successful, with or without bank loans, the commercialisation of such a product often proves to be even more difficult. Commercialisation needs larger amounts of funds for equipment and working capital, and small and medium firms will face difficulties in getting bank loans for these because of their poor security and credibility. Besides these problems derived from the peculiarities of R&D by small and medium firms, the capacity of the banks themselves to assess to superiority and the marketability of (new) technology proposed by such firms is also problematic. They often do not have any expertise on the technology concerned, and thus tend to be unwilling to give loans for technological projects.

Thirdly, technological change by the introduction of capital equipment embodying new technology is also closely connected with access to credit. In this case it is not just the opportunity to get credit but also the type of credit that firms can get access to. According to our interview results, many small and medium firms indicated that though there were

some special bank loans to promote the purchase of domestic machines, in which small and medium firms could receive a relatively favourable treatment, access to foreign currency loans from branches of foreign banks and local banks, to finance the import of foreign equipment and facilities tended to be available only to large firms. For instance, two of the most important loans to promote the purchase of domestic machines are those included in the National Investment Fund and the Korea Development Bank loans. Both of them grant to firms loans of up to 80 % of total cost of purchases of domestic machines. In the former, in particular, it was prescribed in 1984 that at least 80 % (up from 70 % in 1983) of the total loans available for this purpose should be allocated to small and medium firms (as either purchasers or suppliers). In contrast, there is no such regulation in foreign currency loans, most of which are, granted to large firms. Moreover, the terms of such loans are often more favourable than those of loans for domestic machines. In the case of foreign currency loans by the Korea Development Bank, for example, up to 100 % of total funds needed to import foreign machines can be loaned. The period of the loan (i.e. up to 10 years) is longer than that of their loan for domestic machines (i.e. up to 8 years), and the rate of interest is often lower in the former.[6] For example, according to S. Kim(1983), during 1978-1981 the interest rates of the National Development Fund loans were over 5-10 % higher than those of foreign export-import bank loans. These big differences are said to have disappeared after the domestic interest rate reduction measure enacted on 28 June 1982 (ibid.: 20). Not surprisingly, large firms prefer these foreign currency loans to the loans for purchasing domestic machines. In consequence, an increasing division has appeared between large and small firms in their patterns of equipment purchase throughout the manufacturing industry: large firms tend to rely heavily on the import of foreign machines (where they are allowed to import these items), whereas most small and medium firms have to be

[6] For example, according to S. Kim(1983), during 1978-1981 the interest rates of the National Development Fund loans were over 5-10 % higher than those of foreign export-import banks loans. But these big differences are said to have disappeared after the domestic interest rate reduction measure enacted on 28 June 1982 (ibid.:20).

satisfied with purchases of domestic machines (whether made by large machine producers or by small ones). In the machine tool sector, even though many firms, regardless of their size, tend to use some of their own in-house made machines, the above patterns of equipment purchase appear distinctively between firms of different size. Given the assumption that foreign machines should embody relatively new and more sophisticated technology (especially, under the Korean policy for import of machine tools), such a fact means that larger firms better access to foreign currency loans seems to contribute to their acquisition of new technology embodied in capital equipment. This point can also be confirmed by their higher rate of introduction of NC machines, most of which are actually foreign products. In Table 8-5 below, we compared three different size groups of our sample firms in terms of their use of foreign equipment and NC machine tools.

Table 8-5. Use of foreign equipment and NC machines by firm size.

	Size of firms (no. of employees)		
	less than 100	100 ~ 299	300 or more
1.Proportion of foreign equipment (%)	29.5	45.2	72.3
2.Numbers of NC machines per firm	0.3	2.1	27.6
3.Proportion of NC machines (%)	1.0	2.9	9.3

Note: compare with Table 5-6 earlier.

As we can see in the Table, there are clear differences between the three groups of firms on all three indicators. A consistent pattern can be seen: the larger the firms the more extensive their use of foreign equipment and NC machines. Though the difference between the two groups of small and medium firms is not as big as that between these two groups and large firms, it can still be certainly recognised. This is not accidental because, as we have seen, the second group has, among the small and medium firms, more access to foreign currency loans for supporting import of foreign equipment.

Of course, the availability of foreign currency loans is not the only reason why larger

firms have higher proportions of foreign equipment. In general, access to direct foreign financial or technological sources, in which larger firms predominate, also seems to be closely connected with imports of foreign equipment. For example, loans from foreign countries are often provided in goods rather than in cash (even in the latter case, conditions of buying equipment from the suppliers of the loans are often attached). Licensing agreements can also be accompanied by imports of foreign equipment when new production equipment is required for new products based on such licenses. A few sized firms with 100-299 employees have experience in either import of foreign loans or joint ventures with foreign companies. Therefore, together with access to foreign currency loans supplied by domestic banks, this direct access to foreign financial or technological suppliers seems to have facilitated the purchase of foreign equipment by large and medium-sized firms. Though firm size is important here too, the need for higher productivity and higher precision by such `larger' firms cannot alone explain their higher proportions of foreign equipment, such as shown in Table 8-5.

To conclude, our findings can be summarised as follows: financial capability is a major factor in determining a firm's rate and pattern of technological development. Because of their superiority in both internal and external finance, the large firms in our sample tended to have shown higher performance in, especially, formal types of technological change, while the small and medium firms on the whole have concentrated more on informal types of technological change which do not need large expenses. Since the limitations of internal finance prevent the small and medium firms from attempting expensive technological projects, the availability of external finance significantly influences whether these firms can launch formal and relatively major types of technological change. Though the government has recently tried to promote favourable conditions of external finance (especially, bank credit) for these firms, its effects seem to be confined to some medium-sized firms. Therefore, most small firms still depend on their own funds to finance technological developments and hence have to be satisfied with informal types of technological change. Meanwhile, in explaining

the rate of technological change by introducing capital equipment which embodies new technology, we needed to differentiate the kinds of credit that the firms can get access to. We found that foreign currency loans and other means to get foreign machinery play a crucial role in the acquisition of the new technology embodied in such equipment. As large firms, again, enjoy a more advantageous position in such loans, they have thus shown higher performances in the introduction of foreign equipment and NC machines. Small and medium firms are largely content with using domestic machines. However, since they own `newer' vintages of machines than large firms (as we saw in Chapter 5) as domestic machines become more technologically sophisticated then the gap between large and small firms in this type of technological change may well reduce in the near future.

Chapter 9
Product Market Structure

In Table 5-7 in Chapter 5, we saw that our sample firms, regardless of their size, indicated `increased market competition' as their primary motive for technological development. In the section on their difficulties in developing new products (5-3-5), both size groups indicated `difficulties in securing the market' as one of their major obstacles to further technological development. This suggests that the firms themselves perceive product market structure as an important factor influencing their technological development activities. This is hardly surprising in that the assessment of a technological success is ultimately made by market sales. The goal of technological innovation is to secure a larger market by winning competition with other firms through such innovation. However, if market demand is not sufficient or remains inadequate (in terms of stability, customer preferences, etc.), the stimulation from competition can be offset by these negative aspects of the market. Therefore, in order to understand the effects of product market structure the technological performance of firms, we must look into various aspects of such market structure. Our focus in this chapter is not on the general importance of market structure for innovation per se but only on whether market structure is an important variable in bringing about differences between large and small firms in their rate and patterns of technological development. Although we are dealing with a single industry, large and small firms within it can face different degrees of competition and different demand characteristics, (as we briefly mentioned in Chapter 7) according to their products. Consequently, the pressures of these market forces upon the technological efforts of large and small firms can take with different degrees and forms. Here lies the focus of attention in analysing the role of market structure.

9-1. Hypotheses

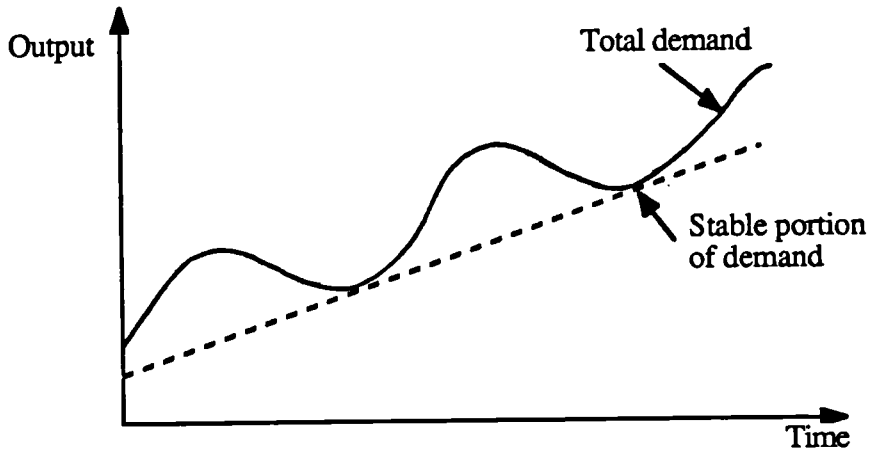
Many authors have studied and emphasised different aspects of product market structure with regard to its relationships with technological change and innovation.[1] We have selected a few of the but major aspects which are most relevant to our study. First, Stigler(1968) and Amsden(1977, 1985) have developed Adam Smith's pioneering theorem that "the division of labour is limited by the extent of the market". According to Amsden(ibid.), the division of labour is limited not only by the size of the market, but also by the type of market and by its rate of growth. She found that to achieve technological progress and increases in productivity demand for higher product quality and/or a fast rate of growth of demand/output are required. Taking the case of the Taiwanese machine tool industry, she identifies the significance of the demand preferences of users for improvements in product quality (ibid., 1977) and the effects of fast demand growth on technological change through new capital investment, greater technological learning and increased specialisation (ibid., 1985).

From a slightly different standpoint, Piore(1980) also attempted to develop the Adam Smith's theorem as regards the explanation of `dualism' in industrial structure. According to Piore, the division of labour is not only a function of the extent of the market, but also a function of its stability and the uncertainty. He postulates that demand for any product can be separated into stable and unstable portions, the two portions being separated by the floor to which demand falls at the trough of its cycle (see Figure 9-1). Then the division of labour will be fully exploited for the stable portion of demand, while it cannot be so developed for the unstable portion (This is the logical extension of the Smith's model). Uncertainty works in the same way. Firms pursue the division of labour only for the predictable demand. As a result, a dual product market appears: large-scale enterprises with the technologically most advanced division of labour cater to the predictable and largely stable segment of demand, while smaller scale firms with the less sophisticated production techniques cater to the unpredictable and/or fluctuating portion of

[1] As a general introduction to the literature on this issue, see Kamien & Schwartz, 1982.

demand. Therefore, Piore proposes demand stability as a main independent variable determining the level of the division of labour and hence of technology.

Figure 9-1. Piore's model of dual structure of demand along stability



Source: M. Piore, ibid., p.66

Secondly, it has long been recognised that market competition is a powerful source of technological change. Schumpeter(1942) was a champion of this position. Recently Fransman(1985) summarised such a position well in the following sentences: "every firm is `compelled' to change by the fact, or threat, of cheaper and/or `better' products being made available by competing firms. Failure to change will result in reduced revenues, or revenues increasing at a slower rate than they might if change were undertaken." (ibid., p.592). Therefore, many studies have suggested that the level of innovation is directly related to the degree of competition (ref. Kamien and Schwartz,1982). According to Fransman(ibid.), the question of competition assumes a special significance in the Third World context, because most developing countries have had, and continue to have, high rates of protection, especially from import of foreign products, in many industrial sectors. However, as he pointed out in another study (Fransman, 1986b: 189), it is possible for the lack of domestic competitive pressure to be compensated for by competition in export markets, and vice versa. So we need to distinguish between competitive pressure in domestic and export markets and to see how much of pressure is

actually brought to bear on firms through competition in either, or both, of these markets. It is also conceivable that competitive pressure might, under some circumstances, be regarded as excessive and harmful. Cut-throat competition tends to lead to dumping and bankruptcies rather than to technological change. In fact, the protection of local infant industries in Third World countries is an example of government intervention to avoid the harmful effects of foreign competition.

Based on the above theoretical considerations, we will set the following hypotheses concerning market structure.

- Hypothesis 1: the rate and patterns of technological change of firms is significantly determined by such market-related factors as (i) their market size, (ii) demand types, (iii) rate of demand growth and (iv) demand stability. So the differences between large and small firms in their rate and patterns of technological change result from their differences in (either or all of) these latter aspects.
- Hypothesis 2: degree of competition is also significantly different between large and small firms, and this is a source of their differences in rate and patterns of technological change.

Before turning to the exploration of these hypotheses, we must be clear about one thing here. Since the literature we referred to above did not arise from a theoretical concern to explain differences between large and small firms (except in the case of Piore's), the negative results for these hypotheses do not disprove the validity of the original theses proposed by the above authors. Negative results will simply mean that the factors concerned are not important in explaining differences between large and small firms in technological performance.

9-2. Overall structure of the market

Before we discuss detailed features of market structure, it is helpful to consider the overall structure of demand in the machine tool industry by product and by firm size. This will give us a concise picture of how the market is organised between different product

items and how the market for each item is distributed between different size groups of firms. Fortunately, in their journal Machine Tool, KOMMA (the Korea Machine Tool Manufacturers' Association) regularly publishes figures for `production and shipment of machine tools by commodity and company'. Though only their member companies are covered in such statistics, these firms include virtually all significant machine tool producers (except some tiny ones), so the KOMMA's data is extremely useful and also highly representative. Table 9-1 has been prepared from this data. It shows not only the distribution of firms of different sizes for each major product item, but also their relative market share in terms of both units and value of machine tool sales for the year 1984.

Table 9-1. Size distribution of firms and market share by product in 1984

Product items	No. of firms		Total sales		Market share by large firms(%)	
	Large	Small	units	value(million won)	units	value
lathe	7	10	5,969	35,446	66.8	66.1
milling m/c	6	6	2,020	16,004	76.5	74.8
drilling m/c	4	6	2,713	4,947	11.5	57.2
boring m/c	2	1	38	2,418	92.1	98.3
grinding m/c	6	13	1,122	7,900	26.6	46.5
EDM	0	3	151	2,516	0.0	0.0
sawing m/c	0	4	1,123	2,108	0.0	0.0
hobbing m/c	1	1	43	1,374	14.0	36.5
tapping m/c	0	2	598	412	0.0	0.0
special-purpose m/c	2	3	70	2,648	71.4	87.4
NC lathe	5	1	222	8,764	99.5	99.7
NC milling m/c	4	2	67	2,932	79.1	84.2
machining centre	5	0	107	7,697	100.0	100.0
shaper	1	0	167	872	100.0	100.0
planer	0	1	8	485	0.0	0.0
others	2	5	111	3,847	21.6	53.5
Total	10*	35*	14,529	100,370	46.9	68.7

Note(*): These total numbers of firms are smaller than the sum of the numbers of firms in the Table, because a firm often produces several product items.

Source: KOMMA, *Machine Tool*, No. 9, 1985.

As seen in the Table, it seems that large and small firms compete together in all the

major markets of machine tool products, except in items like electrical discharge machines(EDM), sawing machines, tapping machines, and planers, which are produced only by small and medium firms, and machining centres and shapers,which are produced only by large firms. Among the latter, shapers and planers are monopoly items, but they do not seem very important considering their small demand size. We can also note that NC items (i.e. NC lathes, NC milling and machining centres) are almost exclusively produced by large firms. The most important items for the industry as a whole are lathes and milling machines. Taken together, these two items occupy 55.0 % of total units or 51.3 % of total sales value. If we add the figures of their NC models to them, these figures rise to 57.0 % (units) and 62.9 % (value) respectively. Therefore, it can be seen that Korean machine tool firms have concentrated on producing these items and are thus engaged in their most fierce competition over these items. In other sizeable markets such as drilling machines and grinding machines, both large and small firms also seem to fiercely compete with each other. So, in general the level of specialisation between large and small firms is still low in the industry, although small and medium firms do specialise in some relatively minor some relatively minor markets, e.g. EDM, sawing machines, tapping machines, etc.

The total market for large firms is a little smaller than that for small and medium firms in terms of units, but clearly bigger in terms of value. This discrepancy suggests that large firms are concentrated more on expensive types of products or expensive items (e.g. NC machines) than small and medium firms do, i.e. they seem to serve different `demand types'.

The Table, does not show how the market is distributed between domestic sales and exports. According to (KOMMA, No.9), the total amount of exports of metal-cutting machine tools in 1984 was $21.1 million dollars, i.e. about 17 % of total sales, and 72.7 % of the exports were made by large firms. Since this proportion is higher than the share by large firms in total sales in the Table, i.e. 68.7 %, it can be safely argued that large firms are more export-oriented than small and medium firms. To be able to establish

the actual size of the domestic market for machine tools, we also need figures about imports. Table 9-2 below is a part of the statistics provided by the Ministry of Trade and Industry (1985).

Table 9-2. Production and trade of metal-cutting machine tools in 1984

Product types	Production	Import	Export	Self-sufficiency ratio (%) *	Export ratio(%)
NC items	24.1 (20.4%)	43.2 (47.7%)	6.7 (37.0%)	28.7	27.8
conventional items	93.9 (79.6%)	47.5 (52.3%)	11.5 (63.0%)	63.5	12.2
TOTAL	118.0 (100.0%)	90.7 (100.0%)	18.2 (100.0%)	52.4	15.4

Note 1(*): `Self-sufficiency ratio' means the level of demand fulfilment of domestic markets by locally produced machines. It equals to (production - exports) / (production + imports - exports). Its opposite concept, i.e. `import dependence', can be calculated by (1 - self- sufficiency ratio).

Note 2: The minor discrepancies found between the above figures and the KOMMA's data shown earlier (e.g. in export figures) stem from the difference of the sources.

Source: the Ministry of Trade and Industry (KOMMA, No. 9).

We can calculate from the Table that the size of the domestic market for NC machines in 1984 was about $60.6 million, while that for conventional machine tools was $129.9 million; thus the size of the total domestic market $190.5 million. Export markets in contrast, are much smaller, about one tenth of the domestic market. So the Korean machine tool industry is still very much an industry for import substitution rather than an export industry. Its export ratio remains much lower than its self-sufficiency ratio.[2] This implies that the main arena of competition for the Korean machine tool firms is the domestic market rather than the export market (actually, the

[2] This contrasts with Taiwan where the industry is highly export- oriented (i.e. the export ratio was 78.2 % in 1984), but shows at the same time a high dependence on imports (67.7 % in 1984); and also with Japan whose export ratio far surpassed her import dependence (i.e. 36.2 % versus 5.1 % in 1984). Source: *American Machinist*, 1985.

importance of exports has consistently decreased from a top level of over 30 % reached in the early 1980s. The Ministry of Trade and Industry, ibid.). However, there are some differences between NC and conventional items in this regard. While the export ratio of NC items is relatively higher than that of conventional items, the self- sufficiency ratio is much lower. This implies two things: first, export markets are more important for NC producers than for the producers of conventional items; Second, the domestic market for conventional items is almost saturated by domestic producers[3], while that for NC items seems to have a considerable room for import substitution, The higher proportions of NC items among total exports (37.0 %) and imports (47.7 %) than among total production (20.4 %) seems to support these points. Considering that large firms virtually dominate the production of NC items, we can expect that the present conditions, and the prospects, of market competition of these large firms must be significantly different from those of small and medium firms which largely remain in domestic markets.

9-3. Size, type, growth and stability of demand

First we would like to compare large and small firms in terms of their demand size and the characteristics of this demand (our hypothesis 1). Since individual firms are thought to attempt technological change in response to these variables at the firm level, we will examine firm level data. Table 9-3 below summarises average demand size, unit price and export ratio per firm by size group in our sample firms. We include export ratio as an indicator to show type of demand, because it is expected that exports, in order to meet international standards, involve higher quality products than domestic sales.

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[3] Especially, according the same source (i.e. the Ministry of Trade & Industry), items such as conventional lathes, milling machines, sawing machines and drilling machines show high self-sufficiency rates (70~80%), whereas grinding machines, EDM and tapping machines show very low rates (around 30%). Only those small and medium firms producing these latter items seem to have significant chances of further import substitution in the domestic market.

Table 9-3. Sales*, unit price and export ratio per firm in our sample

(unit : million won)

Year	Average sales		Average unit price		Export ratio (%)	
	Large firms	Small firms	Large	Small	Large	Small
1982	5521.6	900.3	7.7	5.4	41.0	31.8
83	7108.0	1084.9	8.6	5.7	24.5	14.9
84	8410.6	1618.3	9.3	6.5	20.5	14.4

Note(*): Here `sales' include those of metal-cutting machine tools, i.e. excluding sales of the other types of products by our sample firms.

It is generally found (i) that average sales of machine tool products are bigger in large than in small firm s (though the gap has diminished somewhat); (ii) that large firms produce more expensive models or items; and (iii) that the export ratio has been higher in the large firms (although the overall significance of exports has decreased for both groups). Therefore, according to our hypothesis these findings can be interpreted in the following ways. First, the high level of demand for products from large firms permits and stimulate them to develop higher degrees of the division of labour, thereby facilitating technological change. Second, since it seems apparent from their higher unit price of products and higher export ratio that they rather than small and medium firms serve the demand for products with higher quality. Seeking to meet this demand will lead them to seek more sophisticated technologies. Both of these interpretations will be tested later on.

Meanwhile, how about growth patterns and the stability of demand? It is not difficult to imagine that even if the present level of demand is high or the demand preference for quality is high, if growth prospects are gloomy or if demand is unstable firms will not easily invest in technological development. And as Amsden(1985) points out rapidly growing demand is likely to have several positive effects on technological change. So, the patterns and prospects of demand growth must be considered, as well as size and types of demand. Our sample data covers only the period 1982- 84. The only source of longer term data and trends which enable a comparison between large and small firms is

the annual *Report on Mining and Manufacturing Survey* published by the Economic Planning Board(EPB). In this source the figures of production and shipments (in both quantity and value) are specified by product item and by firm size. Unfortunately the numbers of firms involved are not specified. So while we cannot compare the changing trends of demand by firm, we can compare the overall trends of demand growth between large and small firms as groups. We will illustrate these trends by two major items, lathes and milling machines. These have been selected not simply because they are most important items in the industry (see Table 9-1) but also because a clear contrast between large and small firms can be more clearly demonstrated in single items rather than in total. Bear in mind that they do not, of course, represent the whole industry and thus there may be considerable variation of the trends of other items.

Tables 9-4 and 9-5 next show the trends in sales of lathes and milling machines during the period 1972~82. Since no distinction was made between domestic sales and exports or between conventional and NC types in the original source, the figures in the Tables seem to include all of the sales made regarding the products concerned. In both cases, we can clearly see a trend in which large firms have come to play a dominant role at the expense of small and medium firms, especially in the case of lathes. To see the patterns of demand growth more clearly, we graphed the Tables into Figures 9-2 and 9-3. Though there are some differences between lathes and milling machines, there are at least two things they share in common: first, the growth curves in terms of units have more ups and downs than those in terms of value; second, while the curves of large firms by and large show smooth and stable upward trends, those of small and medium firms tend to be fluctuating and unstable (this second point is more appropriate in the case of lathes). A noticeable difference between the two items is that while demand for milling machines made by small and medium firms seems to have been growing (though slowly, compared with the case of large firms), demand for lathes made by small and medium firms has decreased not only in relative terms but also in its absolute size (both in units and value) since 1978. Many small firms are believed to have gone out of business or

to have switched into other areas of production. The important point here is that for both lathes and milling machines the rate of demand growth appears higher in large than in small and medium firms. This, as Amsden(1985) suggested is likely to have significant implications for their relative technological performance. In terms of demand stability, it is also generally confirmed that small and medium firms have faced more unstable demand than large firms, especially for lathes. Therefore, Piore's model on the dual structure of demand (Figure 9-1) seems to be valid, at least in the case of lathes.

Table 9-4. Trends in sales of lathe during `72~`82

Year	Sales in units				Sales in value (million won)			
	Total(A)	Large(B)	Small	(B)/(A)	Total(A)	Large(B)	Small	(B)/(A)
1972	2565	26	2539	1.0(%)	445	30	415	6.6
73	7780	37	7743	0.5	1302	245	1057	18.8
74	8192	769	7423	9.4	2124	1151	973	54.2
75	2984	765	2219	25.6	2241	903	1338	40.3
76	3503	1275	2228	36.4	4832	1480	3352	30.6
77	5181	1935	3246	37.3	11257	5428	5829	48.2
78	10673	3470	7203	32.5	24637	13594	11043	55.2
79	5150	2132	3018	41.4	16479	9669	6810	58.7
80	6404	3651	2753	57.0	22918	18830	4088	82.2
81	4415	3594	821	81.4	25501	22055	3446	86.5
82	4819	3164	1655	65.7	30763	24840	5923	80.7

Source: EPB, *Report on Mining and Manufacturing Survey*, various years.

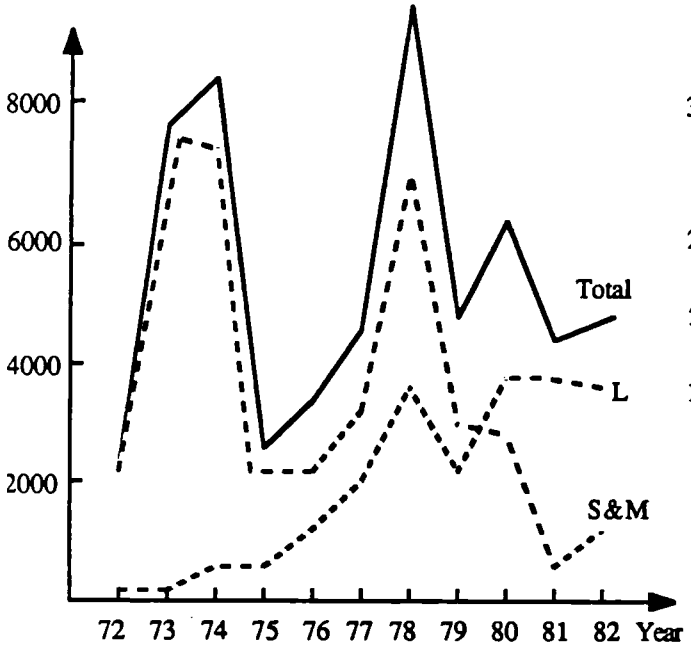
Table 9-5 Trends in sales of milling m/c during `72-`82

Year	Sales in units				Sales in value (million won)			
	Total(A)	Large(B)	Small	(B)/(A)	Total(A)	Large(B)	Small	(B)/(A)
1972	180	-	180	0.0(%)	21	-	21	0.0
73	?	-	?	0.0	91	-	91	0.0
74	323	-	323	0.0	132	-	132	0.0
75	428	-	428	0.0	124	-	124	0.0
76	958	29	929	3.0	686	58	628	8.4
77	523	85	438	16.3	959	320	639	33.3
78	?	?	?	?	3015	999	2016	33.1
79	1869	1193	676	63.8	4800	1801	2999	37.5
80	1213	346	867	28.5	4329	1963	2366	45.3
81	1831	667	1164	36.4	7786	4493	3293	57.7
82	1739	1039	700	59.7	11649	6428	5221	55.2

Source: the same as Table 9-4.

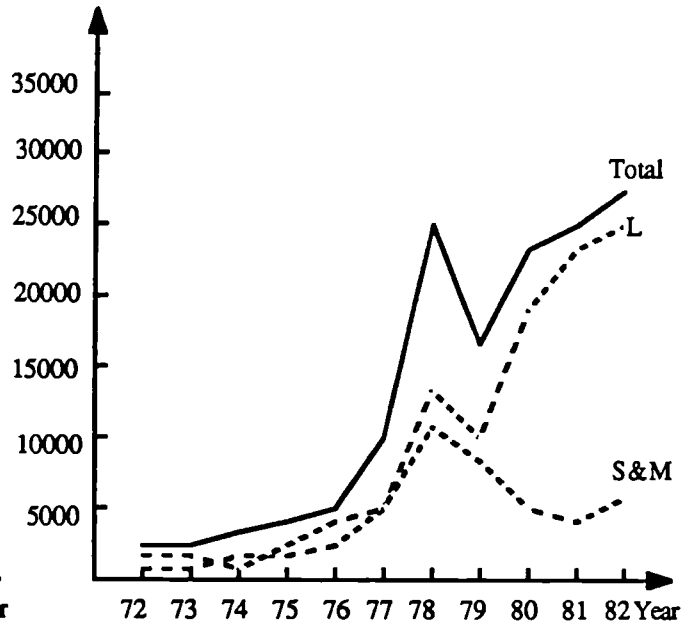
Figure 9-2. Growth patterns of demand for lathe during '72 - '82.

(a. Sales in units)



Source : Table 9-4

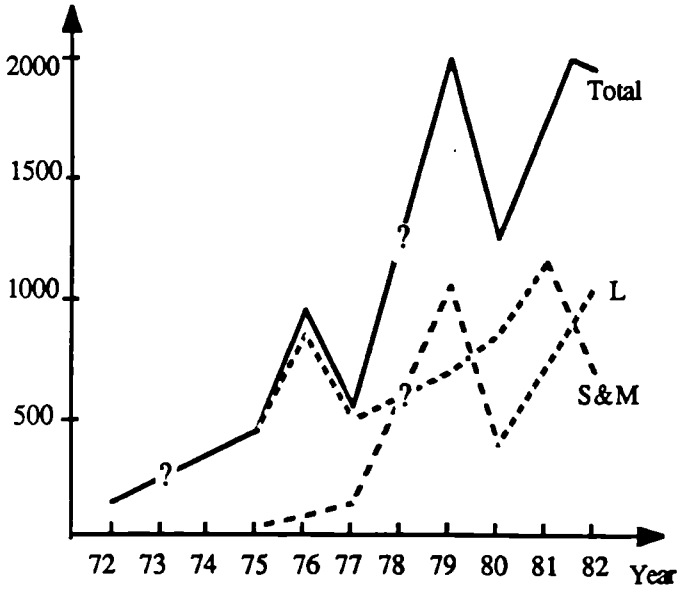
(b. Sales in value)



Source : Table 9-4

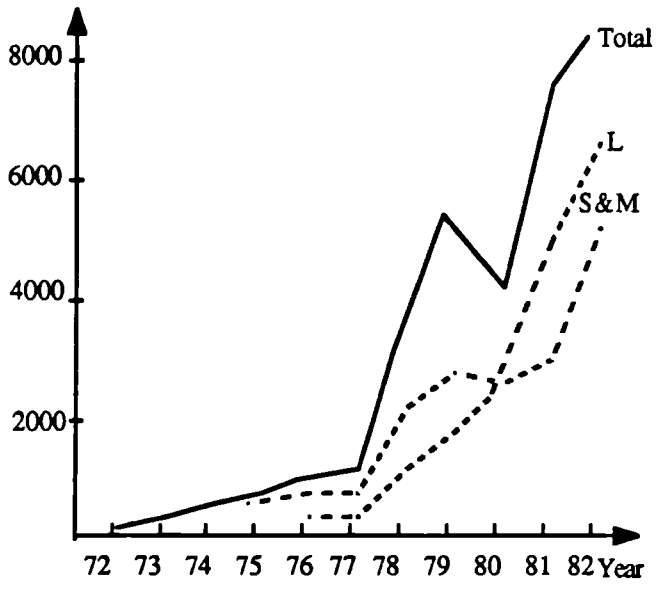
Figure 9-3. Growth patterns of demand for milling m/c during '72 - '82.

(a. Sales in units)



Source : Table 9-5

(b. Sales in value)



Source : Table 9-5

In fact, aspects of demand growth and stability can be seen not only through the past trends like above but also through the perceptions of future prospects. We asked our sample firms to assess the prospects for their major products in the near future. The results are summarised in Table 9-6 below.

Table 9-6. Prospects for demand growth by market types(7-point scale)*

Market types	Large firms	Small & Medium firms	Significance**
a. domestic market	5.4	4.1	P=.0158
b. export market	5.6	3.5	P=.0062
c. total (i.e. $\frac{a+b}{2}$)	5.5	3.6	P=.0003

Notes(*): 1 = drastic decrease; 2 = a little decrease; 3 = little change; 4 = 10% increase; 5 = 10~30% increase; 6 = 30~50% increase; 7 = more than 50% increase.
(**): Mann-Whitney test (two-tailed)

It seems clear that the large firms are more optimistic about a growth in demand for their products in both domestic and export markets. The difference between the large and the small firms is particularly striking concerning export markets. Large firms predict an increase on average of about 30 % , whereas small and medium firms forecast no change or at best up to a 10 % increase. These prospects seem to be consistent with the past trends we have seen. In any case, what is important is not whether such prospects will prove right or wrong, but rather that firms tend to decide on technological efforts on the basis of them. Firms' own assessment of market growth significantly influences their investment in technology and hence their technological performance. In this respect, the optimistic prospects perceived by the large firms is likely to help accelerate their pace of technological change.

9-4. Degree of competition

As far as competition is concerned, the machine tool industry seems to be representative of Korean industries in that it is characterised by intense competition.

As we indicated before (see Table 9-1), with the exception of a few minor items there are no monopolistic products. In most major products, there is competition not only between large and small firms but also amongst large firms and amongst small and medium firms. Therefore, although it is true that there are a few dominant large firms, the industry as a whole cannot be regarded as monopolistic, at least by the Korean standards. As Table 9-7 below shows, the market share of the firm with the largest total machine tool sales is a modest (21.1 %) and the share of the top three firms is just over 50 %.[4]

Table 9-7. Structure of market share (in terms of value) in major product items

(unit : %)

Product items	No. of firms	The top-ranked firm	The top two firms	The top three firms
Total	**45**	**21.1**	**38.4**	**54.3**
lathe	17	24.5	47.4	57.4
milling m/c	12	34.3	48.3	61.5
drilling m/c	10	36.7	53.9	66.7
grinding m/c	19	18.5	31.6	43.1
EDM	3	52.9	92.9	100.0
sawing m/c	4	43.5	79.4	99.7
NC lathe	6	58.6	97.2	99.7
NC milling m/c	6	59.1	73.9	86.4
machining centre	5	69.2	87.1	95.3

Source: the same as Table 9-1.

This pattern is similar in for all items produced by a large number of firms and which have a relatively large markets. Only in items which are produced by few small firms (like EDM, sawing m/c) or large firms (like NC machines), is considerable degree of concentration found. But even in these items the dominant position of the largest firm tends to be threatened by the other competitors or by new entrants.

Then, between large and small firms, which ones are facing (or feel as if they are facing) the strongest competitive pressures? It is not easy to answer this question, because we cannot measure the intensity of competition by simply resorting to such

[4] However, these figures seem to be certainly higher than the equivalent figures in the Taiwanese machine tool industry. See Amsden (1985: 273-274).

quantitive indicators as numbers of competing firms or their relative market share. Even if numbers are small or degree of market concentration is high, firms may be under fierce competition because of, say, tightening market size, radical technological change, aggressive challenge by new competitor(s), etc. Conversely, even if numbers of firms are large, if the market is segmented by regions or by more specialised sub-items the competition is not necessarily fierce. Thus we must consider the whole complex nature of competition in order to appreciate the degree of competitive pressure firms actually face. Any measure of competition cannot help but containing an arbitrary element because of the complexity of the problem concerned. Again we relied on firms' subjective assessments, assuming that their judgements are a reliable indicator and can be compared with each other. We asked our firms to assess the degree of competition with respect to their major products by using a 5-point scale (1 = no competition; 5 = very intense competition). We distinguished between domestic and export markets because, as we have suggested, lack of competition in the former may be compensated by competition in the latter and *vice versa*, and also between two aspects of the competitiveness of a product, i.e. price and quality/performance, because it seemed helpful to understand the nature of the competition. The results are summarised in Table 9-8 below.

Table 9-8. Degrees of competition by market types and aspects of competitiveness

	Large firms	Small firms	Significance*
a. domestic market:			
in terms of (i) price	4.0	3.0	P=.0230
(ii) quality/performance	3.8	3.0	P=.0956
b. export market:			
in terms of (i) price	4.4	4.3	P=.5962
(ii) quality/performance	3.7	3.8	P=.7242
c. domestic market competition combined (i.e. $\frac{a(i)+a(ii)}{2}$)	3.9	3.0	P=.0130
d. export market competition combined (i.e. $\frac{b(i)+b(ii)}{2}$)	4.1	4.0	P=1.0000
e. price competition (i.e. $\frac{a(i)+b(i)}{2}$)	4.4	3.6	P=.0114
f. quality/performance competition (i.e. $\frac{a(ii)+b(ii)}{2}$)	3.7	3.5	P=.4789

Note(*): Mann-Whitney test (two-tailed)

In the domestic market, the competitive pressure felt by the large firms appears significantly higher than that felt by small and medium firms, both in terms of price and quality/performance. And it seems that the degree of pressure on price is similar to that on quality/performance, for there is little difference between the scores for the two aspects in both groups of firms. In contrast, in the export market the strength of competition is similarly felt by both large and small firms, and in this case the competitive pressure on price seems more important than that on quality/performance. Actually both types of firm identified price competition in export markets to be the most intense among the four categories suggested in our question above (i.e. a(i) - b(ii)). It is especially notable that the small and medium firms perceived different competitive pressures in the domestic and export markets. There are several points to be made about the above results. First, if we compare large and small firms, the former seem to operate in a fiercer competitive environment than the latter in the domestic market. This is understandable in that the small and medium firms tend to deal with more specialised and more segmented markets than the large firms in the domestic market, whereas they have to face many foreign competitors in the export market. Since the domestic market has been protected from foreign competition (at least for items which can be produced by domestic producers), many small and medium firms can flourish in small regional markets despite their less efficient production techniques. Moreover, as they tend to specialise in low price and low quality/performance products, a head-on competition with large firms is avoided. Competition among small and medium firms themselves tend to be reduced because regional divisions lead them to serve their own segmented local customers because of transport costs, existing personal and business relations and so on. In contrast, large firms tend to compete with each other as well as with small and medium firms, since not only is the level of specialisation among themselves low but they also have to deal with a nation-wide, market. Consequently, their perceived competitive pressure in the domestic market seems to be much higher than that of small and medium firms. In export markets, however, these differences between

them disappear. Both of them have to face fierce competition with foreign firms in every product. Relating this with the demand prospects reviewed before (in Table 9-6), it seems reasonable to say that the large firms are operating in rapidly expanding and highly competitive markets (both domestic and international), whilst the small and medium firms largely remain in more slowly growing and less competitive domestic markets because , probably, competitive pressure for them in the export market are too harsh. We will explore the implications of this for their technological performance later.

Second, even though it appears that the strong competition in the export market could compensate for the relatively weaker competition in the domestic market, such a role seems to be limited because of the low ratios of exports among total sales (see Table 9-3). This is particularly the case for small and medium firms, i.e. the high competitive pressure in the export market is likely to have little importance to these firms because of their low export ratio. Therefore, although the degree of competitive pressure in export markets may be similar for the large and the small firms, we must consider wheater its significance is different. The firms which face the lowest overall competitive pressure are small and medium firms which produce only for domestic markets. They feel only `moderate' pressure in these markets and have no compensating pressure from competition in export markets. On the other hand, in the case of the few small and medium firms which are active in exports, the intense foreign competition is likely to have a significant influence on their behaviour.

Third, the reason why both size groups commonly identified price competition in the export market as the most intense may be considered in two ways: it is either because foreign customers for Korean machine tool products prefer low prices or because foreign competitors are superior to Korean firms in terms of product price, or perhaps both. A brief look at conditions in export markets is helpful in order to understand this. Korean machine tool firms have mainly exported to North America, Asia, Europe and the Middle East. The main items which they export are lathes, milling machines, NC lathes, NC milling's and machining centres. To see the relative importance of each export

market, in 1984 among the total exports of machine tools 41.5 % went to North America, 36.1 % to Asia, 12.7 % to Europe and 3.3 % to the Middle East (KOMMA, No.10). In particular, the U.S.(41.0 %), Japan (29.1 %), West Germany (5.8 %), U.K. (5.4 %) and Indonesia (3.9 %) were the major countries for export (ibid.). In these markets Korea competes mainly with Taiwan, Japan and China. According to a study (Han, 1985), of total imports of machine tools into the U. S. in 1982 Japan had 39.9 %, Taiwan 5.5 %, and Korea 1.2 %. On the other hand, of Japan's imports in 1983. Korea had 4.3 %, Taiwan 2.6 %; and among Indonesia's imports in 1981 39.2 % were produced in Japan, 11.3 % in Taiwan, 2.5 % in China and only 1.1 % in Korea. So Korea's market share in its export markets is very small except in Japan. In the same study, a comparison of competitiveness was made between Korean machine tools and comparable Taiwanese, Japanese and Chinese products in terms of price and quality/performance. The study concluded that, in general, Korean machine tools are 20-40 % more expensive than the products of Taiwan and China but appear superior to the latter in quality/performance, while compared with the Japanese products they are 10 % cheaper but inferior in quality and after-service. In our own interviews, our sample firms also expressed opinions similar to this assessment. Therefore, it seems that the overall competitiveness of Korean machine tools is in between that of Taiwan and Japan. However, the dilemma of such a position is that Korea may lose to both sides, because customers preferring low price will choose Taiwanese products while those preferring high quality will buy Japanese ones. Since most of the (potential) customers for Korean machine tools belong to the first type, it means that be price competition with Taiwan is the most important and intense in export markets. This is so despite the fact that higher quality is required for export than for domestic markets. Though there will of course be some differences between the situation of large firms and that of small and medium firms in this regard, our survey results shown in Table 9-8 seem to confirm that both have similar problems in competition with other countries in foreign markets.

In short, a difference of competitive pressure between the large and the small firms is found in the domestic but not in the export market. And price competition is generally

stronger than quality/performance competition.

9-5. Relationships between product market structure and technological performance

We have so far reviewed many aspects of product market structure in order to identify the different positions of large and small firms. As before, we will now inquire into relationships between these aspects and the technological performance of firms. We will use statistical correlations to examine the significance of these relationships and thereby to test the validity of our two hypotheses. To do this, we have to select appropriate variables about market structure as well as about technological performance. We decided to select the following variables of market structure: the sales volume (in value) of machine tool products in 1984 to represent `demand size'; the unit price of such products and the export ratio to represent `demand type'; firms' own assessment of demand prospects for representing `growth rate and stability of demand'; firms' own assessment of degrees of competition to represent `intensity of competition'. Though some indicators are not thought to be satisfactory (especially in the case of `demand prospects'), the limited availability of data does not permit us a better selection for statistical tests. As regards technological performance we selected the following variables: R&D intensity (in terms of manpower, i.e. R&D staff per employee), the overall technological capabilities (a mixed indicator of firms' assessment of their own technological capabilities), the proportion of foreign machines and the proportion of NC machines among the firms production equipment, the number of foreign licences imported during the last 10 years, and the total number of new product (or new process) developments in the last 5 years. Among these, the first two variables are concerned with firms' capacities to initiate technological change, while the others represent their actual performance in different types of technological change. The results of a correlation analysis (Spearman's rho) on our first hypothesis, i.e. relationships between size, type, growth and stability of demand and technological performance, are

shown in Table 9-9 below.

Table 9-9. Correlation coefficients between demand variables and technological performance (Spearman's rho).

Size group	Technological variables	Sales size('84)	Unit price	Export ratio	Demand prospect (domestic)	Demand prospect (export)
Large firms	R&D intensity	.8000	.7000	1.0000*	.3586	.6172
	Tech. Cap.[1]	.9747*	.6156	.8721*	-.3626	-.3411
	For. Eq.[2]	.1000	.6000	-.1000	.9487 *	.2236
	NC Eq.[3]	.7000	1.0000*	.7000	.5270	.6708
	Licenses	.5000	.9000*	.6000	.5330	.4395
	New Products	.9000*	.5000	.9000 *	-.2599	-.1826
Small & Medium firms	R&D intensity	-.1636	.2000	-.4550	.2459	.3073
	Tech. Cap.	-.5823*	.0338	-.0132	-.4859 *	.1005
	For. Eq.	.2606	.4909	.2634	-.3617	-.0750
	NC Eq.	.4111	-.3743	.6579 *	-.1619	-.7913 *
	Licenses	.1348	.3146	.2698	-.5560 *	.2130
	New Products	.1553	-.2175	.5579 *	-.1295	-.3071

Notes 1) 'Tech. Cap.': firms' own assessment of technological capabilities.

2) 'For. Eq.': the proportion of foreign production equipment.

3) 'NC Eq.' : the proportion of NC production equipment.

4) The sign '*' indicates $p<.10$ (two-tailed).

In the first place, relatively strong positive correlations can be found between sales size and technological variables in the large firms, although they are much weaker in the small and medium firms. In particular, correlations between sales size and technological capabilities (and, less importantly, R&D intensity) show opposite directions in the two groups. This seems to imply that while the large firms have depended on technological developments to expand their markets (and a growing market in turn has stimulated such technological developments), the small and medium firms have not followed this pattern but have largely relied on selling low-priced products based on, say, low labour and overhead costs. A significant correlation between sales size and new product developments in the large firms in contrast with their insignificant correlation in the small and medium firms seems to support this conjecture.

Secondly, as regards demand types, unit price has significant correlations with technological variables in the large firms but not in the small and medium firms, while

export ratio is important for both sizes, though to different degrees. In the large firms unit price appears to have a stronger relationship with technology imports than with indigenous technological developments. This applies, but less strongly, to the small and medium firms as well. On the other hand, export ratio is strongly positively correlated with indigenous technological effort rather than with technology imports in the large firms, while the opposite seems to be the case in small and medium firms. However, the significant positive correlations between export ratio and new product developments shown in both groups seem to suggest that, regardless of firm size, attaining technological competitiveness through new product developments etc. is crucial for export success. While large firms seem to be able to afford this with their own capacities, the small and medium firms don't, but have to depend on foreign technological inputs. In any case, these results about unit price and export ratio seem to confirm that a more sophisticated type of demand, expressed in a higher unit price or a higher export ratio, stimulates the search for higher levels of technologies. Since the large firms are characterised by such demand, they are likely to show higher rates of technological change.

Thirdly, the variables about demand prospects seem to fall behind the other variables in their importance for technological performance. They even show strong negative correlations with some technological variables, especially in the small and medium firms. This is probably because small and medium firms serve markets which favour low-priced products rather than technologically sophisticated but more expensive ones. This seems especially true in the case of domestic markets. On the other hand, in large firms demand prospects appear to be positively correlated with technology imports but negatively correlated with indigenous technological capabilities. This is either because those firms with higher indigenous technological capabilities have already largely saturated their markets or because in rapidly expanding markets foreign technologies can respond to more quickly than indigenous developments.

On the whole, we confirmed relatively strong positive correlations in the large firms,

and rather weak and complex correlations in the small and medium firms. Among the demand variables, sales size, unit price and export ratio seem to be more important than demand prospects in their influence on the technological performance of the firms.

Now let us turn to relationships between the degree of competition and technological performance, which we specified in our second hypothesis. We tried a same correlation analysis on the degrees of competition based on the firms' own assessment and the same technological variables we selected above. Table 9-10 below shows the results of this analysis.

Table 9-10. Correlation coefficients between degree of competition and technological performance (Spearman's rho)

Size group	Technological variables	Competition in domestic markets (price)	Competition in domestic markets (quality/performance)	Competition in export markets (price)	Competition in export markets (quality/performance)
Large firms	R&D intensity	.3086	-.2777	.4472	.7906
	Tech. Cap.[1]	.4247	.2604	-.5729	-.2814
	For. Eq.[2]	.6325	-.8944 *	-.6325	-.6325
	NC Eq[3]	.9487 *	-.4472	-.3162	-.1054
	Licenses	.6125 *	-.5208	-.1809	.1809
	New Products	-.1951	.1936	-.5379	-.3586
Small & Medium firms	R&D intensity	.1447	-.0569	-.2350	.3121
	Tech. Cap.	-.3305	.0733	-.3449	-.3143
	For. Eq.	-.4879 *	-.0069	-.0204	.2795
	NC Eq.	.2068	.6647 *	.3547	.3564
	Licenses	-.4607 *	-.2090	-.3950	-.1343
	New Products	.2406	.6400 *	-.0205	.3619

Notes 1)~4): the same as in Table 9-9.

To interpret the results in the Table it is crucial to bear in mind that demand types are different between the large and the small firms. If we take this into account then we can explain the above results, which are at first sight confusing and even contradictory. First, it appears that competition in domestic markets plays a contradictory role for the large firm: competition in terms of price is positively correlated with most of the technological variables (especially those relating to technology imports), whereas competition in terms of quality/performance seems to be the very opposite of this. We

would interpret these data in the following way: since price competitiveness is more important in the small and medium- sized firms, those large firms which are under intense competitive pressure concerning price try to establish their competitiveness around product quality/performance by introducing sophisticated foreign technologies, and in turn such investments in technology make them firms less price-competitive. (This interpretation is in fact consistent with our previous finding that unit price is positively correlated with technology imports). Consequently, these large firms which have achieved higher technological sophistication do not feel strong competitive pressure concerning quality/performance at least in domestic markets, as is shown in the Table. On the other hand, since low price is most important for the small and medium firms, those under a fierce price competition tend to avoid technological developments, especially ones by means of technology import as these are too expensive for them. But those small and medium firms under an intense quality/performance competition have to invest in technological changes. In this case, though, they appear to prefer in-house developments and buying NC equipment to technology imports.

Second, in export markets the contrast in the correlations of the large firms and small firms appears much weaker than it does in domestic markets. This seems to reflect the fact that the conditions of competition in export markets are similar between the large and the small firms while they are significantly different in domestic markets. The role of their differences in demand types, which is important in domestic markets, also appears insignificant here. According to the above Table, the firms under a stronger price competition in export markets tend to make less efforts on technological developments in `both' size groups. This is probably because, as we have shown, foreign customers for Korean products are still largely limited to those whose chief concern is low price rather than high quality. Since Taiwanese products are cheaper than Korean products in export markets, Korean firms, especially those under a fierce price competition, may feel that it is too risky to invest in technological developments which are likely to push up their product prices at least in the short-term as long as the type of foreign demand does not

change. On the other hand, in terms of quality/performance competition the correlations in the large firms are similar to those in the case of price competition, while slightly more positive correlations are found for the small and medium firms. But no significant degree or pattern of correlations is not found in either group. This is probably because the firms experience similar competitive pressure concerning quality/performance in export markets, regardless of their technological efforts. In any case, since degrees of competition in export markets are much the same for both large and small firms and, since, exports do not occupy a major part of sales in either group, competition in exports does not seem important in explaining their differences in technological performance.

To summarise our findings so far, in the first place, we confirmed that significant differences in size, type, growth and stability of demand exist between large and small firms. We also found differences in the degree of competition between them in domestic, but not in export, markets. Secondly, to see whether these differences different technological performances between large and small firms we examined the correlations between variables relating to market structure and technology. On the whole, the results seemed to confirm the importance of such market variables for explaining the technological performance by firms. But their importance appears to be different between large and small firms: and is more strongly positively correlated in the former than in the latter. The main reason for this, we believe, is differences in demand types: the large firms tend to serve the upper layer of the market, i.e. the demand with relatively high elasticity of product quality, while the small and medium firms serve the lower layer which is highly price-sensitive. This seems to be particularly the case in domestic markets. Therefore, while the large firms may increase their technological efforts in response to demand growth, etc., the small and medium firms will not necessarily because of the importance of low prices to them. So it seems that only after a firm grows beyond a certain size that the real importance of the market variables such as we examined here becomes clear. Among these variables, demand size, unit price,

export ratio and competition in domestic markets appear most useful for explaining different technological performances of large and small firms. Though demand prospects appeared less important than these, we cannot conclude that growth rate and stability of demand are thus unimportant, since demand prospects are only a partial aspect of the latter. On the other hand, competition in export markets does not seem important as a source of the different technological performance of the large and the small firms, because we could not find any significant difference between them regarding it.

Chapter 10
State Policy

As Fransman(1985) rightly points out, "in all countries the state plays a central role in shaping, stimulating and inhibiting various forms of technical change" (p.628), and thus "it is necessary to include the state in any list of sources of technical change" (p.599). To examine the role of the state is especially important in the case of Korea, where state intervention has been the most powerful driving force underlying its rapid economic and industrial growth, as is now well recognised in the literature (see, for instance, Jones and Sakong, 1980; Sen, 1983). In this regard, the machine tool industry is typical of the industries in which the Korean government has intervened in order to promote the rapid growth of strategic industrial sectors. And as we saw in Chapter 4, since the late 1970s, in particular, its involvement in machine tool sector has become more direct and specific. Not surprisingly, Jacobsson's(1984) study of the machine tool industry in Argentina, Taiwan and Korea noted that the Korean government had a greater degree of involvement than either the Argentinian or the Taiwanese. Besides the overall promotion of the industry, state intervention has also focused on technological development by influencing directly, or indirectly, the various forms of technological effort by the firms in the sector. Although in our survey results the sample firms appeared to give a low significance to government policy (see Table 5-7), all this means is that they do not normally recognise government policy as a direct motive of technological development. Government policy can, however, influence the technological behaviour of industrial firms through the use of various incentives, pressures and/or regulations. In particular, it can significantly transform the market environment in which firms operate and conduct technological change. For example, by providing finance for the purchase of domestically developed machine tools while prohibiting the import of similar products, as the Korean government has done, can be an effective measure to reduce

excessive foreign competition and boost local innovations. Therefore, we believe that government policy has been a major determinant of technological change in the Korean machine tool industry, whether the firms are conscious of it or not.

However, what we must focus on here is not whether state policy is an important determinant of technological change as such, but whether it is a source of the differences in the technological performance of large and small firms and, if so, to what extent. The role of the state in this regard can be considered in the following two, rather contradictory, ways: on the one hand, state intervention could facilitate the technological gap between large and small firms because it often tends to favour large firms, in order to exploit economies of scale by concentrating available resources on specific industries and firms; on the other hand, the state could play an important role in protecting small and medium firms and so lessen their technological gap with large firms by intervening in the market (e.g. regulations on monopoly) and promoting technological development by small and medium firms. Of course, these two modes of state intervention are not necessarily as contradictory as they first appear, because in practice there are many possibilities of complementarity between them and thus a state can pursue both types of policies. Even if state intervention does not favour large firms, the market will operate in favour of larger firms because of the latter's various economies of scale. For instance, banks tend to prefer financing large firms because the risks are lower than lending to small and medium firms. Therefore, small and medium firms need state intervention more in order to redress such inherent disadvantages in the market, and to improve their competitive positions relative to large firms. Thus even if a state does not particularly favour large firms in its policies, the simple lack of protection of small and medium firms may be thought of as a *passive* form of state intervention favouring large firms. Finally, when we assess the effects of state intervention on firms' technological performance, various aspects of government policy need to be considered.Both policies specifically designed for promoting technological development and policies designed for more general purposes can have profound effects on the technological efforts of firms.

Though we may not be able to decide their relative importance, any discussion of the effects of state policy on firms' technological performance should thus include such broader policies as well as more specific technology policies.

10-1. Hypotheses

It seems to have been generally agreed that government policies have been favourable to large firms at the expense of small and medium ones (e.g. see K.Lee, 1982; L.Jones, 1980; J.Kim, 1983). Most importantly, large firms are said to have had disproportionate access to subsidised credit under the patronage of the government, and this has been regarded as the main source of their (subsidised) high profits, and hence of their rapid growth. The conservative explanation of bias in government policy tends to suggest 'advantages of economies of scale' or 'international competitiveness (of large firms)', while the critiques tend to stress the stronger influence commanded by large firms over government officials and bankers (Jones, ibid.). In any case, it seems very difficult to deny that the Korean government, especially during the Park regime (1961~1979), has favoured large firms in terms of industrial policy. Though it is recognised that in the Chun regime(1980~1988) support for small and medium firms has been increased to some extent (KFSB, 1985), this does not mean that the bias in favour of large firms, or its lasting effect, has disappeared. For example, in spite of some new policies for promoting small and medium firms, preferential loans are still concentrated on large firms: during August 1985 to September 1986 more than 80 % of total trade loans (circ. $ 20 billion) were given to such firms (H.Son, 1987). And since the liberalisation (i.e. privatisation) of finance in 1982 many commercial and local banks have increasingly been dominated by jaebuls which already had virtual control of most major securities and insurance companies (ibid.). Consequently, economic concentration and monopolistic-oligopolistic market structure have been constantly accelerated under the Chun government. The support for small and medium firms is still thought to be insufficient and has been criticised as having only 'secondary' importance compared with the support for large firms. At best it seems to have been geared into the purpose of

serving a complementary role for capital accumulation of the latter over the economy (K. Lee, op.cit.).

Based on the above understandings about state policy in the Korean industrial development, we would suggest the following as our hypotheses in this chapter :

- Hypothesis 1: government industrial and technological policies regarding the machine tool industry have been biased in favour of large firms.

  (sub-hypothesis: under the Chun regime the support for small and medium firms has been increased, but this is still well short of the support for large firms in the industry.)

- Hypothesis 2: the above bias in government policies has had positive effects on technological development of large firms but negative effects on that of small and medium firms in the industry.

To see the validity of our hypotheses, we will first review major government policies, both general and technological, towards the machine tool industry and also policies for small and medium firms. Then we will consider the importance and effects of such policies on firms of different sizes by examining the responses of our sample firms. And lastly, we will speculate about the links between a bias in government policies and different technological performances of large and small firms.

10-2. Government policies for the machine tool industry

10-2-1. general policy

In Chapter 4, we briefly mentioned major policy changes and the history of state intervention concerning the machine tool industry. Here we will describe in more detail the major features and content of government policies which are either still relevant to the industry or which were applied to it until very recently.

The most direct and important intervention by the state in the industry began with the announcement of 'the Basic Development Plan for the Machine Tool Industry' in November 1977. According to an official at the Ministry of Trade and Industry (our

interview), it was from this Plan that the government started to be actively involved in promoting the machine tool sector with "sincere appreciation of its importance". Not surprisingly, the main purpose of the Plan was to prioritise support for the formation of a large production base. Even though the industry had existed for over twenty years by then, its production capacity was still small and thus the domestic demand for machine tools was largely met by imports. For example, in 1976 the domestic production of machine tools amounted to $ 20 million ($ 1 million for exports), while imports amounted to $ 77 million, and constituted 80.2% of the domestic market (B.Yoon, 1983). Though a few large firms were beginning to produce machine tools, the industry was largely dominated by small and medium firms (see Chapter 4). Therefore, the government's view was probably that the most urgent task for the industry was to enlarge and consolidate its production base as soon as possible. Ambitious goals were set for the production and the exports of machine tools: from $ 57 million of production and $ 6 million of exports in 1977, to $ 166 million of production and $ 66 million of exports in 1981 (the Ministry of Trade and Industry, 1977). Therefore, 41.8 % of the domestic demand (est. $ 122 million) in 1977 and 44.6 % of that (est. $224 million) in 1981 would be met by locally produced machine tools, according to this Plan.[1] To achieve these goals, the government designated specific firms to be promoted. These were classified into 'comprehensive machine tool producers' (large scale, several items per firm), 'specialised machine tool producers' (small or medium scale, at least 50% of production devoted to a single item), 'component producers' and 'raw material producers'. NC product items were allocated only to 'comprehensive producers'. Firms were selected on the basis of production and testing facilities, manpower composition, product performance and characteristics to be achieved, requirements of quality control and so on. Once selected, the firms were to be supported by the following various measures: (i) the priority procurement by the government and government-invested institutions; (ii) the priority procurement by

[1] The actual performance was considerably lower than these goals. In 1977 the production was $ 32 million and the exports $ 1 million, while in 1981 they were $ 89 million and $ 28.6 million respectively. The ratios of self-reliance were 22.8 % in 1977 and 40.2 % in 1981 (B. Yoon, 1983).

users of government funds for industrial promotion(e.g. government subsidies and loans, the National Investment Fund, etc.); (iii) loans in advance to producers when purchase contracts were made; (iv) the priority lending of long-term and low-interest loans for production facilities; (v) the recognition of those selected 'specialised machine tool producers', 'component producers' and 'raw material producers' as 'Small and Medium Size Specialised Machinery Producers' (see note7 in Chapter 4) which would receive special support from the government. In its turn, the government could demand a certain level of exports from the firms selected, and also force them to take product quality tests and regular evaluation and training in quality control by the Fine Instruments Centre (now incorporated into the Korea Institute of Machinery and Metals). Moreover, the firms were required to develop and produce their designated items with the specified performance and characteristics within a year and to produce at least one additional item within two years (especially, in the case of 'comprehensive producers'). These measures suggest that the government seems to have intended to combine financial and demand incentives with concomitant pressures concerning production facilities, exports, technological development and quality control.

In accordance with the Plan, firms were selected early in 1978. The number of firms involved were: 12 'comprehensive producers', 15 'specialised producers', 4 'component producers' and 11 'raw material producers' (MTI, 1978). A characteristic of this selection of firms is that while 'specialised producers' consisted of small and medium firms which had already over 10 years of experience in machine tool production, 'comprehensive producers' were large firms most of which had little experience in the industry but which had worked in other machinery sectors(e.g. automobiles, industrial machinery, etc.). Many of these large firms belonged to famous *jaebul*s such as Daewoo, Hyundai, Kia, Goldstar and so on. In fact, the government have urged and induced these firms to participate in the machine tool industry. The reason(s) why the government decided to promote (non-machine tool producing) large firms instead of the existing small and medium machine tool producers was not clear. But they may have

thought that it would be quicker and more efficient to use the financial and organisational capacities of the large firms to expand the production base and to facilitate the technological development of the industry. Another reason seems to have been related to the defence industry. Many of the large firms were already engaged in or had recently begun to manufacture defence products. In our interviews, many people pointed out that the production of machine tools had been necessary for such firms. They had needed the experience of producing machine tools as a basic technology for the defence industry, on the one hand, and they all had problems of excess capacity which could not be met by military demand alone, on the other. In any case, it seems certain that the Plan was primarily designed to urge and support the entry of these large firms into the machine tool industry. (Not surprisingly, a government official whom we interviewed described the period 1977-79 as an "inducement stage" in the history of government policy for the industry). However, because of their lack of experience in machine tool production and, perhaps, also because of the stringent requirements of product development in the Plan, these firms resorted to technology imports to develop their first models of conventional machine tools (see the numbers of licensing agreements during 1975-79 by large firms in Table 4-2 earlier). And the government may have supported, directly or indirectly, these technology imports by providing preferential loans, tax reduction and so on.[2]

As a result of the Plan, 1977~78 marked a critical turning-point for the industry when the initiative shifted from existing small and medium firms to the newly entered large ones. The government's role was decisive in this restructuring of the industry. The government intervened through effective policies which were not only firm- and product-specific but also, we would argue, 'firm size-specific'. Although at first sight the Plan looked 'neutral' in terms of size. But the product item(s) assigned for each firm show that all the items for 'specialised producers' were also covered by the items for

[2] In fact, in the Plan it was specified that if a selected firm imported foreign licences, it should report to the Minister of trade and Industry about the state of the assimilation of the imported technologies every 6 months (MTI, 1977).

'comprehensive producers'. Though there may, of course, have been differences in the aimed performance and other characteristics between the products, this does not exclude their possibility of competition in the market. This means that the government permitted the entry of large firms into markets which had hitherto been served by small and medium firms, and they, moreover, assigned new promising areas such as NC products exclusively to large firms. Thus, rather than facilitating the division of labour between large and small firms, the Plan in fact precipitated fierce competition between them in the conventional machine tool markets, aggravated by the overall excess capacity in such products (see Tables 9-1, 9-4 and 9-5). In addition, the real effectiveness of the specific measure to support small and medium firms,which was included in the Plan, is doubtful under the conditions of heavy support for large firms (without some protection of the area for small and medium firms). In the lists of 'component' and 'raw material' producers too, many firms belonging to large (including *jaebul*) companies were selected (MTI, 1978).

For firms selected as 'specialised producers', the losses caused by the entry of powerful large competitors may have surpassed the benefits from the limited support offered by the Plan. In fact, since the main focus of the Plan was on the expansion of production base of the industry, it is not surprising that the main beneficiaries would be large firms. Though we do not have data on the allocation of financial and other resources through Plan, the fact that the strongest financial support was given to such firms was pointed out in a report by the German Development Institute prepared then (GDI, 1978). Also, Jacobsson's study(op. cit.) suggested that a preferential loan amounted to $ 44 million was allocated to one firm and $ 5-10 million was given to another around 1977, though it is not clear whether these loans were provided under the Plan. The major part of such investment was directed into the Changwon Machinery Industrial Complex where most of the large firms were located.

In retrospect it does seem that the introduction of the Plan did contribute to a remarkable expansion in the production capacity of the industry. According to Yoon(

1983), total production capacity increased from $ 55 million in 1977 to $ 180 million in 1978, i.e. over a 200% increase within a year. As there has been no considerable change in the production capacity since then (ibid.), it would not be too much to say that the Plan largely formed the current structure of the industry. But Yoon clearly shows that the Plan also led to excess capacity in the industry : actual production was $ 86 million in 1978, i.e. only 47.8% of the capacity (it was 58.2 % in 1977), and remained at merely $ 89 million in 1981, i.e. 49.4% of the capacity.

During the period 1979~1984 (while the Plan still operated), the emphasis of government policy was on increasing the 'localisation', according to the official we interviewed. He described this period as a "fostering stage". Here the term 'localisation' implies both (i) the increasing substitution of locally made machines for foreign products which had been imported and (ii) the increase in the ratio of local content in such locally made machines. The government intervened in various ways to support securing domestic markets, localising components and getting access to export markets by local machine tool firms (especially, those selected by the Plan). The main measures used were import restrictions and financial assistance to customers of local machine tools. The government introduced the import licencing system in order to prohibit imports of foreign products that could compete directly with locally produced machine tools. According to Jacobsson (1984: 226), "the noteworthy aspect of this policy is that it is the Korea Machine Tool Manufacturers' Association (i.e. KOMMA) which has the power to decide which machine tools can be imported and if a product can be produced locally, an import licence is not given". Therefore, except for large-size and sophisticated products which could not be produced by domestic firms, most conventional machine tools and some low-performance NC items could now be protected in domestic markets. To support this measure, the government provided preferential loans to firms buying locally made machine tools. This means that the main focus of preferential loans shifted from expanding production capacity to increasing demand for the industry. However, this was not a separate measure for machine tools, but was managed within the broad policy of promoting the domestic machinery industry as a

whole (see S. Kim, 1983). The buyers' credit system was made up of 'the Procurement Fund for Locally-Produced Machinery' for domestic buyers and 'the Long-Term Export Credit Financing' for foreign buyers (Jacobsson, op. cit.). It was devised not only to stimulate domestic demand for locally made machines but also to encourage export markets. The preferential loans for such purposes were included in the National Investment Fund, Korea Development Bank Loans and Commercial Bank Loans (S. Kim, op. cit.). In all, the total amount of loans extended for increasing demand for domestic machinery was 806.6 billion won (about $ 1 billion) in 1981 and 775.6 billion won (about $ 0.9 billion) in 1982 (ibid., Table 10, p.19).

The protection of domestic markets by the import licencing system was certainly effective in securing a critical outlet for domestic machine tool producers. However, the measure helped the newly entered large firms more than for the small and medium firms who already had established customers in domestic markets. The buyers' credit system was a measure of more positive nature to boost demand for domestic machine tools and so seems to have provided a growing market for the industry. By 1984, therefore, Korea had achieved 63.5% self-sufficiency in conventional machine tools (and 28.7% in NC items) in contrast with only 19.8% in 1976 (and NC items were wholly dependent on imports then) (Yoon, 1983 and KOMMA, 1985, No.9). It is, however, questionable how much such customer loans contributed to increases in demand for products from the existing small and medium firms. Demand grew more slowly for products from these firms during this period (and in the case of lathes actually decreased, as shown in Figures 9-2 and 9-3 before), so such loans are likely to have made more impact on the large machine tool producers. In short, though the above two measures may not in themselves have contained a bias towards large producers, their effects were largely favourable to these firms. Consequently, their dominance in the industry became consolidated during this period.

In 1984, the support for specific firms by 'the Basic Plan' of 1977 was officially abrogated. The emphasis of government policy now shifted to 'internationalisation' and

'free market competition'. Of course, this does not mean that the government intervention in the industry has ended. Rather it implies that the government believes that the industry has now grown enough to do without the direct protection it needed in its infant stage. Government policy now takes more indirect forms and focuses on improving firms' efficiency and competitiveness rather than on providing direct subsidies. The government is seeking to achieve this through measures such as progressive import liberalisation, export stimulation, the development of key component technologies and of engineering capabilities in general (our interview). From the mid-1984 the government began announcing the items to be liberalised for import. So far they have been limited to conventional products (though all machine tools will be liberalised for import in the long run, the government seems to believe that NC items are still at the infant stage). Import liberalisation has two purposes for the industry, apart from the obvious desire to defuse foreign protectionism : first, to strengthen the competitiveness of domestic conventional machine tools and, second, to induce their producers to export. In a sense, this may be natural in the conditions where domestic demand for conventional machine tools is largely saturated but the export ratio of such products still remains meagre (12.2% in 1984 in contrast with 27.8% in the case of NC products. KOMMA, 1985, No.9). Nevertheless, the effect of import liberalisation may be destructive for small and medium producers most of which depend almost totally on domestic markets of conventional machine tools. It is not difficult to imagine that they will be more vulnerable to foreign competitors selling cheaper products. Therefore, wherever its intent is, import liberalisation can be regarded as a threat to domestic small and medium producers. Meanwhile, the development of key components (e.g. NC controller, ball-screw, servo motor, hydraulic system, etc.) and of engineering capabilities (especially, design capability, high-precision processing technology, heat treatment technology, etc.) is the main area where the government support will continue. At the moment the firms which are concentrating on developing component technologies with government support are mostly large firms like Tong-il, Daewoo and

Whacheon (KOMMA, ibid.). To some extent this may be inevitable, since these technologies are more concerned with NC products and only large firms possess the R&D manpower and enough facilities to develop some of them. But if the government wants to develop specialised components industries, more consideration needs to be given to small and medium firms in this area as well.

10-2-2. technology policy

Though the policies reviewed above have all influenced the rate and pattern of technological change in Korean machine tool firms, there are other government policies which focus specifically on technological development which have also had direct effects on the technological efforts of the firms. So it seems necessary to have a brief look at these particular policies.

There have been variety of policy measures to support the technological development of private firms in Korea (for major ones among them, see S.Kim, op. cit.: 26~40). To take some examples, there are R&D subsidies and loans, tax incentives for R&D and technology imports, technical assistance and information services, training of technical manpower and so on. These are general measures applied to all industries rather than specifically to the machinery or machine tool sector. Therefore, here we will only refer to those measures which have been especially important and relevant to the machine tool sector.

First, the government has provided financial incentives for technological development through special funds and bank loans to machine tool firms. Important sources of such incentives are the Machinery Industry Promotion Fund, the National Investment Fund, the Korea Development Bank loans, the Small and Medium Industry Bank loans, the Korea Long-Term Credit Bank loans and the Korea Technology Development Corporation. They are used for supporting R&D for new products, commercialisation of new technology, technology imports and manpower training, improvement of manufacturing processes, engineering projects and so on. Though we have no specific data on the machine tool sector, the total amounts of such loans are

shown in Table 10-1 below.

Table 10-1. Total amounts of loans extended for technological development

(unit : billion won)

Sources of loans	1981	1982	1983	1984(plan)
Machinery Industry Promotion Fund	5.5	4.9	4.4	6.1
Korea Development Bank	3.9	40.8	57.8	70.0
Small and Medium Industry Bank	10.0	11.2	30.0	40.0
Korea Long-Term Credit Bank	1.2	?	?	?
Korea Technology Development Bank	6.1	22.2	49.9	65.0
TOTAL	26.7	79.1	142.1	181.1

Source: KFSB, 1985: 117; S. Kim, 1983: 34.

Of the above loans, those by the Machinery Industry Promotion Fund and the Small and Medium Industry Bank are supplied exclusively to small and medium firms. Small and medium firms received less than 20 % in the case of the Korea Development Bank loans and about 30 % in the case of the Korea Technology Development Corporation loans(B.Cho, 1983). Therefore the total share of small and medium firms in the above loans is about 40%. This is a relatively favourable share in comparison with their share in total shipments, value-added and private domestic credit (see Table 8-4). So, at least as far as financial support for technological development(TD) is concerned, it would be difficult to say that small and medium firms have been discriminated against by government policy. However, this is not to say that they do not experience difficulties in getting even these loans. As we will shortly see, to be eligible for these loans firms must have been selected as 'Promising Small and Medium Enterprises'(see next) and to have met other similar requirements prescribed by the government and also meet the criteria demanded by banks. Moreover, small and medium firms often find that the limits and terms of such loans are too stringent and that the procedures to get loans are also too complicated (B.Cho, ibid.). Therefore, according to a study by Hwang(1984), in spite of the recent increase of loans to support TDs by small and medium firms, if loan procedures were easier and if qualifications to get loans less strigent then it is likely that the small firms' demand for TD loans would be much higher.

Secondly, major technological support to machine tool firms has been provided by the government through the involvement of government-sponsored research institutions. According to the legislation of the Industrial Products Quality Control Law in 1975, the Fine Instruments Centre (then affiliated to KIST) began compulsory quality tests for locally made machine tools, from engine lathe at first. Quality tests were followed by technical guidance and teaching by FIC. This policy has been a major impetus in generating recognition of the importance of precision amongst domestic machine tool producers and in the upgrading of their product quality (our interview). Firms began to learn precision processing technologies and calibration skills and became interested in quality control for the first time. Currently this quality inspection covers all the items of machine tools produced in Korea and is performed by the Industrial Technology Development Centre at the Korea Institute of Machinery and Metals (KIMM).

The other major role of research institutions is the R&D cooperation and technical guidance provided by them to machine tool firms. In this respect, the most important institutions seem to be the Korea Advanced Institute of Science and Technology (KAIST, formerly KIST), KIMM and the Small and Medium Industry Promotion Corporation (SMIPC). Since we will refer to SMIPC in the next section, here we will only mention about the former two. The involvement of KIST in the machine tool industry began in earnest in 1976 when they started joint R&D with Whacheon Co. on NC machine tools. By the next year they had succeeded in developing the first original model of an NC lathe in Korea.[3] Since then KIST has been involved in several joint projects developing NC models with domestic machine tool firms. Dr. Bong-Jin Lee played a significant role in this process. He led a NC research group (later incorporated into FIC) at KIST from 1968 and continued to perform a key role in several projects with private

[3] The machine body was developed by Whacheon, while KIST developed its NC part. Among the latter, information processing unit was an imported one (from FANUC) and only servo mechanism (spindle speed control, feed control and interface) was designed by KIST. There was a government financial support for this project. Though Whacheon failed to sell any unit of this model, they still use it for in-house uses (our interview).

firms until 1983 when FIC was absorbed into KIMM. He was involved in at least 6 major projects to develop NC lathes, NC milling's, machining centres and industrial robots during 1976~83 (our interview with him), which include all of those first NC developments 'with KIST' in our sample firms (see Table 5-14). Half of the projects were with large firms, the other half with medium-sized ones. Some of the projects received government financial support as a 'National Project' and the like (if a project is designated as a 'National Project', a considerable part -usually over 50 %- of its R&D costs can be covered by government direct subsidies). Dr. Lee now works closely with the Korea Machine Tool Manufacturers' Association (KOMMA). Since responsibility for NC research was absorbed into KIMM by the dissolution of FIC, KIMM has become the major research institute providing technical support for machine tool producers.[4] A good example of this is the establishment of the NC Centre within the institute in late 1982. The Centre has two main purposes: to perform R&D related to NC technology and to provide various technical services concerning the technology. So they perform research projects on NC machine tools, CAD/CAM, Robots and FMS on the one hand, and provide firms with services such as technical guidance by visits (consultancy and information offering), technical training programs (courses and practice on NC), seminars (by invited foreign experts or introduction of research results by KIMM) and general information services on the other. These services are largely provided free, but where field work by their research staff is needed the firm concerned must bear the expenses (our interview). During 1985-86 the Centre was involved in developing a CNC turning centre as a joint project with a medium-sized firm. In our judgement, the role of KIST and KIMM was crucial in helping Korean machine tool firms enter NC production by disseminating their advanced knowledge on NC technology to these firms through joint R&D and other ways. Meanwhile, a characteristic of the relationships of these institutions with private firms is that only those 'moderately large' or 'medium' sized firms tend to have made any significant links with them. Neither the largest firms like

[4] Also, its geographical location, i. e. Changwon, is advantageous to do so, for many of major machine tool firms are concentrated in the Changwon Machinery Industrial Complex.

Daewoo and Tong-il nor the smallest firms - for different reasons- seem to have made much use of such institutions. The largest firms already have sufficient R&D resources to execute their necessary projects, and thus seem to prefer in-house R&D or technology imports to joint R&D with the institutions. Small firms, while they are not yet ready for NC production, also and perhaps more importantly, lack the financial resources to do joint R&D and find the technical expertise of the institutions either too sophisticated and narrow or out of their field. Though technical services such as are provided by the NC Centre can be helpful for small as well as medium and large firms, in this case the location of KIMM at Changwon may be another obstacle : only large and a few medium machine tool firms are located in areas with easy access to KIMM.

Thirdly, besides the above institutions (KAIST, KIMM and SMIPC) which are involved in offering direct technological inputs to private firms, other government-controlled organisations like the Korea Institute for Economic and Technology (KIET) and the Korea Trade Promotion Corporation (KOTRA) were assigned a crucial role to collect and disseminate technological and market information for machine tool producers. Since we have already discussed them in Chapter 5 (5-2-2), we will omit further explanation here. One brief comment seems to be needed, however, about the role of industrial associations. It is notable in Korea that industrial associations like the Korean Society for the Advancement of Machinery Industry (KOSAMI) and the Korea Machine Tool Manufacturers' Association (KOMMA) inform firms of government industrial and technology policies and monitor their behaviour towards such policies. Needless to say, to be informed of up-to-date government policy is very important in a country like Korea which is characterised by a heavy government intervention in industries, not least because policy instructions need to be followed in order to get access to incentives promised by the government.[5] In turn, such industrial associations have

[5] For example, the Machinery Industry Promotion Fund, which has been a major source of fund for technological development of the machinery industry, is distributed to the firms selected by KOSAMI according to the criteria set by the government.

become the major vehicle for private firms to appeal to the government and thus influence its policy (our interview). Various formal and informal meeting, say, between KOMMA personnels and the government (the Ministry of Trade and Industry), with or without the participation of representatives of firms, and between KOMMA and its membership firms play this role of government-business communication.

Industrial associations provide not only policy information but also technical information. They do this through regular technology seminars, publication of industry journals and so on. Market information is collected and disseminated through trade exhibitions, etc. In many senses, therefore, it seems apt to describe them as an "effective knowledge-broker" (Amsden & Kim, 1986: 117), which mediates between markets, machine tool firms and the government. Though industrial associations seem to have been helpful for both large firms and small and medium firms, it is doubtful how much influence the latter actually have over such associations, given the dominance of the former in the industry. Even if small and medium firms constitute the majority of their membership companies, the board members are almost exclusively composed of presidents of large firms. Therefore, it is likely that important decision-making or major contacts with the government are made by the latter. This suggests a possible bias in the activities of these industrial associations and a difference in access to policy information between large and small firms. It may offer at least one reason why large firms can exert more influence over government policy than small and medium firms.

Lastly, another example of technology policies peculiar to the machinery industry is the scheme called 'First Korean Machine' (or 'Newly Developed Innovative Machine'). This was described in Chapter 5(5-3-4).

10-3. Government policies for small and medium firms

Intervention by the government in machine tool firms has been achieved not only through the policies which we have reviewed above but also through policies for small and medium firms. As the machine tool industry largely consists of small and medium firms, it has been recognised as an important industry in the policies devised for small

and medium firms. Therefore, we need to look at these policies in order to get a comprehensive picture of the government involvement in the machine tool sector and avoid the one-sided impression which might rise from the description we have made so far.

We have pointed out several times that since 1980 (i.e. under the Chun regime) support for small and medium firms has become relatively active, compared with the period during the previous Park regime. The government has devised many new policy measures and has reinforced existing ones to support the activities of small and medium firms in the national economy (for an excellent summary of these policies, see KFSB, 1985). Here, we will describe those which have been most important for or directly relevant to the machine tool industry.

First of all, financial support for small and medium firms has significantly increased since the early 1980s. The government increased the capital of the two banks which specialise in financing small and medium firms, i.e. the Small and Medium Industry Bank and the Citizens National Bank, by about three times and also expanded dramatically (more than six times) the size of the Small and Medium Industry Promotion Fund.[6] Also, as we already indicated (see Chapter 8), it raised the rate of obligatory loans to small and medium firms by commercial and local banks (35% and 55% respectively) and took similar measures on short-term financing, insurance and lease companies in order to support small and medium firms in access to the credit market. Moreover, to redress the problem of weakness in security of such firms, the existing Trust Guarantee Funds Co. has dealt exclusively with guarantees for small firms since 1983. To assist the purchase of local machines by small and medium customer firms, more than 80 % of the loans via the National Investment Fund for local machine buyers was set for such firms in 1984. Besides these, several new measures were devised to promote technological development (by both R&D and technology imports) in small and medium firms. The establishment of the Machinery Industry Promotion Fund

[6] This fund is managed by SMIPC. See below.

(Jan.1980), the Korea Technology Development Co. (May 1981) and the Korea Development Investment Co. (Dec. 1982) are major examples.[7] Also, from August 1983, 50 % of the loans granted by commercial banks for the support of technological development in small and medium firms came to be covered by the Bank of Korea (i.e. the central bank). Owing to these supportive measures, the share of small and medium firms in total bank loans has considerably increased (Table 8-4 and Table 10-1). And since the machine tool industry has been treated as a priority sector in most of the loans for small and medium firms (see below), it is likely that small and medium machine tool producers have had relatively favourable access to such loans, compared with firms in other sectors.

Secondly, the government has introduced firm-specific support for small and medium firms since 1983 by designating up to 5,000 firms as 'Promising Small and Medium Enterprises' by the end of 1987. This selection covers those small and medium firms which can rapidly improve their productivity with a little assistance and provides intensive support to them. Priority is given to firms which produce basic materials and components; which possess high technology; which can significantly increase exports or replace imported products, and so on. Firms are selected by banks, SMIPC and government-sponsored research institutions. Selected firms receive comprehensive financial, technological and marketing assistance from these and other organisations related to small and medium industries. For instance, they are given the first priority in loans such as those we mentioned above and enjoy special low interest-rates (often 2~3% lower than for other firms. See KOMMA, 1985b). To our knowledge, more than a half of our sample small and medium machine tool firms were designated as 'Promising Enterprises'. These firms are believed to have received more generous support than other small and medium firms.

Thirdly, the government has also reinforced institutional measures for the 'promotion' as well as the 'protection' of small and medium industries. It designated 'Original

[7] Among the three, MIPF and KDIC are exclusively for small and medium firms, while KTDC is not. But KTDC must supply at least 30 % of its funds to small and medium firms (H. Park, 1983)

Subsectors for Small and Medium Industry' to protect areas more appropriate for small and medium firms from penetration by large ones, and 'Priority Industrial Subsectors' to promote the industries with higher comparative advantage and strategic importance (for Korea) from December 1978. It has considerably increased the numbers of both recently : the total numbers became 205 in the former (in 1984) and 154 in the latter (in 1985). Small and medium firms belonging to these industries (especially 'Priority Subsectors') can receive various supports in terms of finance, tax, technological and managerial assistance and information services. The machine tool industry is a major 'Priority Subsector' with automotive, electrical and electronic component industries, and conventional-type lathes and milling machines (i.e. excluding NC or special-purpose types) are included in 'Original Subsectors'.

Lastly, some explanation needs to be given about the activities of SMIPC. It was established in January 1979 in accordance with the Small and Medium Industry Promotion Law and has implemented various programs to promote small and medium firms by operating the Small and Medium Industry Promotion Fund financed by the government (SMIPC, 1985). This provides low- interest preferential loans for the purchase of production facilities and operating capital, equipment leasing, management and technical extension services, training and information services, and assistance for R&D and technology imports through the 'Modernisation Program', 'Co-operative Program' and so on. Priority is given to firms engaged in 'Priority Subsectors' and which participate in programs provided by SMIPC. According to our interviews, most of our sample small and medium firms have experienced some help from SMIPC and their responses to it were generally positive. Some of them said that until their experience of SMIPC they had been sceptical about the use of government institutions.

As we have described above, it is clear that government support for small and medium firms has increased considerably during the 1980s. Nevertheless, it is doubtful if the bias in government policy towards large firms has really disappeared(or, rather, if the

present government support for small and medium firms is sufficient to 'correct' the adverse consequences- e.g. high industrial concentration- of past bias). For instance, though the share of small and medium firms in total bank loans has increased, their share in total private domestic credit is still lags far behind their contribution to total value-added, etc. (Table 8-4). This is because, as we indicated, large firms still dominate such major private credit as export loans, foreign currency loans, Korea Development Bank loans and so on. Moreover, since most of the loans for small and medium firms, especially low-interest preferential ones, are concentrated in some selected firms (e.g. 'Promising Enterprises'), the majority of small and medium firms are still excluded from such financial privileges. Even in the case of 'Promising Enterprises', firms tend to be selected on their stability rather than their potential for success. Therefore, 'small' firms which usually have weaker financial capabilities tend to be excluded (KFSB, op.cit.: 85). Also, in spite of the compulsory measure of 'Original Subsectors', large firms are still found in many such sectors (ibid.:142~143). In the machine tool industry, for instance, conventional lathes and milling machines are still dominated by large producers (see Table 9-1), even though they were designated as among 'Original Subsectors'. Only in the case of SMIPC, are our sample firms agreed about its usefulness, especially with regard to its technical guidance and extension, training and information services.

10-4. The effectiveness of government policies as evaluated by the sample firms

In Table10-2 next the evaluation of the effectiveness of some of government policies by our sample firms is presented. Firms were asked to evaluate the degree of assistance by the government in various aspects of their business activities suggested in the Table.

Table 10-2. Effectiveness of government policies
(5-point scale: 1 = very helpful ; 5 = very detrimental)

Policy assistance for :	Large firms		Small & Medium firms	
	mean	rank	mean	rank
1. sales in domestic markets	2.00	2	2.64	5
2. sales in export markets	2.14	3	2.57	4
3. obtaining domestic finance	1.88	1	2.23	1
4. obtaining foreign loans	2.00	2	2.33	3
5. controlling unfair competition	2.75	5	3.00	6
6. technological development	2.38	4	2.29	2

It appears that to both groups of firms the area where government assistance has been most helpful is in obtaining domestic finance(although their levels of satisfaction are different). Anyway, the fact that the small and medium firms also regarded assistance for domestic financing as the most effective policy seems to reflect the recent increases in financial support for them which we described above. For the large firms the next most effective policy has been obtaining foreign loans and sales in domestic markets, whereas for the small and medium firms it is assistance for technological development . This seems to confirm our previous analysis that large firms have been advantaged in access to foreign currency loans and domestic markets owing to government support, while small and medium firms (especially medium-sized ones) have been relatively favourably treated in technological policy. We must note that the biggest gap in the scores between the two groups is shown in the first item, sales in domestic markets. This seems to suggest that policy measures to promote domestic sales, e.g. import prohibitions, customer loans, etc., have been more helpful for large firms which had recently entered the industry, than to small and medium firms which had existing domestic customers. Large firms also expressed higher degrees of satisfaction with government assistance throughout all the areas covered above than the small and medium firms except with reference to technological development . On the whole, the degree of satisfaction is expressed in the following order: assistance for finance --> for sales --> for technology, in the large firms; for finance --> for technology --> for sales, in the small and medium firms.

To be more specific about technology policy, we also asked firms about the effectiveness of various policy measures in promoting the technological development(TD) of private firms and also about the future need for them. Firms were asked to select three most important policy measures, in terms of (i)those which have been most helpful in the past, and (ii)those which will be most helpful in the future. Ranks are given to the items later according to their aggregate weighted scores.

Table 10-3. Effectiveness and necessity of policy measures on TD.

TD policies	Effectiveness(ranks)		Necessity(ranks)	
	Large firms	Small firms	Large	Small
1. financial incentives for TD	4	4	1	2
2. tax incentives for TD	3	-	5	6
3. technical information services	6	6	4	5
4. education and supply of technical manpower	2	5	2	4
5. technical guidance and training	7	2	7	6
6. support for joint or contract R&D	-	5	5	7
7. consultancy and assistance on technology imports	6	5	-	-
8. government procurement	5	-	7	-
9. protection of R&D results (e.g. patents, '1st Korean machine, etc.)	6	5	7	7
10. protection of domestic markets for locally made machines (e.g. import control, localisationpolicy, etc.)	1	1	6	1
11. special assistance for small and medium firms	-	3	3	3
12. others	-	-	-	8

Both groups indicated 'protection of domestic markets for locally made machines' as the most effective measure to facilitate their technological development. This implies that the firms, regardless of their size, are motivated to develop new products, most of all, by guaranteed domestic demand which seems to reduce much of risks involved in their technological investment and to secure an outlet for such new products. Since we pointed out above that government policy to promote domestic sales seemed to have been more helpful for large than for small and medium firms, it may appear contradictory that the latter also chose such a policy as the most important one. It is not, wnen it is

recognised that they tend to be more oriented towards domestic markets than large firms (ref. Table 9-3) and that, as Rothwell & Zegveld point out, because of their lack of resources, they are "less able to accommodate the high risks involved in innovating than their larger counterparts" (op.cit.: 184). Therefore, for the small and medium firms to innovate, some certainty of saleability (like the protection policy above) is very crucial, especially in domestic markets. . Among the other, mostly supply-side, measures the large firms regard those related to 'technical manpower' and 'tax incentives' as having been effective, while the small and medium firms seem to regard 'technical guidance' (by research institutions) and, not surprisingly, 'special assistance for small and medium firms' as important. The effectiveness of 'financial incentives for TD' is similarly assessed by both groups. From this comparison, we can get some idea of the relative importance of these different measures for the two groups and also the possible bias involved in them. There seem to be few effective measures to redress the disadvantages of small and medium firms in their access to technical manpower (ref. the section 7-2 before), and tax incentives for TD (e.g. 'TD reserve fund' scheme) seem to be inadequate or insufficient for such firms. Only technical guidance, which indeed is often combined with special assistance for small and medium firms, has clearly been effective for them. As Hwang aptly points out, these are partly related to their pattern of technological developments: since small and medium firms tend to concentrate on improvements to existing products and technologies rather than on R&D on new products, restrictions on the boundary of 'R&D'(implying 'formal'), 'new technology', etc. contained in tax incentives may be too stringent for them, whereas technical guidance by institutions like SMIPC suits their particular needs (1984: 59-63).

Meanwhile, as regards the future need for the various measures, in both groups the importance of 'financial incentives for TD' is recognised as much greater than in the case of the policy's past effectiveness, though it appears more so in the large firms. This is probably because both groups now need an increasingly larger scale of R&D investment (ref. Table 5-9) as they seek to upgrade the technological sophistication of their products.

In contrast, the need for 'protection' measures has significantly decreased in the large firms, whereas it is still the most important one in the small and medium firms. This may suggest that the large firms have now established a firm position in domestic markets and feel some confidence in their competitiveness. But this does not imply that they no longer need protection. Rather, it seems to reflect the possibility that the effects of the current import liberalisation policy, which focuses on conventional machine tools, will be more threatening to small and medium firms than to large ones. For the reasons we suggested above, the small and medium firms seem to need the continuation of protection in domestic markets. Though we are not sure whether the consequence of the import liberalisation will turn out as they fear, we can appreciate their worries about it. If they do not improve price and quality competitiveness soon, many of them may have to disappear.

To conclude, the two size groups in our sample perceived the effects of government policy in different ways. Large firms saw a bias in their favour in most *general* policies, whereas *technology* policy was seen as relatively unbiased or even as favourable to small and medium firms. Differentiating between the various measures included in technology policy, however, reported that they are not uniformly favourable to either large or small firms. For instance, tax incentives for TD and the supply of technical manpower were perceived by large firms as advantageous to them, whilst technical guidance and training services seems to be more useful for small and medium firms.

10-5. Relationships between government policy and technological performance

Here we will discuss how government policy has affected technological performance of large and small firms differently. However, it seems almost impossible to measure quantitatively the effects of government policy on technological performance of private firms. This is because government policy, above all, is hardly a factor whose strength or impact can be measured in quantitative terms. Although we tried a quantitative

comparison of the effectiveness of some government policies in Table 10-2, it represents only 'subjective' assessments by our sample firms and so does not correctly express the actual degrees of government support provided for them. Given the absence of other satisfactory measures, it may nevertheless be of some help to examine the relationships between the indicators used in the Table and variables of technological performance. Table 10-4 lists the results of a correlation analysis on such relationships. We have used the same technological variables as in Tables 9-9 and 9-10 for the purpose of comparability.

Table 10-4. Correlation coefficients[1] between effectiveness of government policies and technological performance (Spearman's rho)

Size groups	Technological variables	Effectiveness of government policies(in Table 10-2)[2]					
		'policy1'	'policy2'	'policy3'	'policy4'	'policy5'	'policy6'
Large firms	R&D intensity	.0000	.6325	.4472	n.a.	.8660 *	.2887
	Tech. Cap.	.7970*	.3179	.4800	.2236	-.0638	.5874
	For. Eq.	.6325	-.5000	-.6325	n.a.	-.7746	.0000
	NC Eq.	.9487*	-.5000	-.3162	n.a.	-.2582	.4472
	Licenses	.4144	-.0905	-.1739	.2236	.1913	.0264
	New Products	.3150	.4582	.5086	.4472	-.1260	.8607 *
Small & Medium firms	R&D intensity	.1784	-.4152	-.5845*	-.2160	.5010*	-.1917
	Tech. Cap.	-.5957*	-.4088	-.0241	.1852	-.1493	-.3856
	For. Eq.	-.0925	-.0208	.1244	.1234	.3978	.3753
	NC Eq.	-.2309	.3329	.4233	.0000	-.1035	.2852
	Licenses	-.0930	.0523	-.3051	-.6573	-.2500	.5221 *
	New Products	.0000	-.1454	.2374	.4767	.1920	-.1388

Notes:1) We reversed '+' '-' signs of correlation coefficients for the convenience of interpretation.

2) We abbreviated each category of policy listed in Table10-2 as 'policy 1' ~ 'policy 6' in the same order as in Table 10- 2.

3) The sign '*' indicates p<.10 (two-tailed).

A broad impression from the Table is that there is no simple positive relationship between firms' evaluation of policy effectiveness and their technological performance. This is not surprising, for we are dealing with *subjective* assessments of policy effectiveness rather than actual amounts of government support. Nevertheless, more positive correlations are found in the large firm group, especially in the case of 'policy 1' ('assistance for domestic sales') and 'policy 6' ('assistance for TD'). Since 'policy 1' is

the area where the large firms seem to have benefited especially from government support in comparison with the small and medium firms (see Table 10-2), the results seem to show a positive influence of government policy on the technological efforts by large firms. On the other hand, the fact that few significant positive correlations are found in the small and medium firms seems to testify to their overall lack of satisfaction with government support. The positive correlation between 'policy 6' (assistance for TD) and 'Licences' seems to indicate that only those small and medium firms receiving government support for technological development can attempt more 'formal' technological transfer, because of the latter's large expenses and other difficulties for small firms. Meanwhile, the significant positive correlation between 'policy 5' (i. e. controlling unfair competition) and 'R&D intensity' in both size groups implies that government policy for promoting fair market competition stimulates R&D efforts by firms regardless of their size. Although the effectiveness of this policy was ranked lowest by both groups of our sample firms (see Table 10- 2), its potential effect on firms' R&D efforts has been shown to be clearly positive in our data. If applied more decisively, it could be expected to encourage firms' efforts on technological change, especially small and medium firms. This seems to point to a direction of for future government policy.

In short, though we lack data to clearly confirm the relationship between government support and technological change, we can conclude from the evidence suggested above, at least tentatively, that policies in favour of large firms seem to have been helpful for the technological performance of these firms. In particular, government support for them in terms of sales in domestic markets seems to have been particularly effective. However, it must also be said that there seems to be no simple, direct causal relationship between government policy and a firms' technological performance. As we pointed out at the beginning of this chapter, firms tend not to perceive government policy as a major motive or determinant of their technological efforts. Yet

government policy clearly has greatly influenced factors which have functioned as more direct motives, or constraints, of firms' technological activities in the Korean machine tool industry. In this respect, the fundamental role of government policy may be in acting on their underlying environment (which in turn determines their technological performance) rather than in directly determining firms' technological performance. The bias in state intervention which we have reviewed in this chapter must thus be seen not as a direct cause of the different technological performances of large and small firms but as a more structural variable which contributes to technological performance through its influence on, say, factor and product markets which were examined in earlier chapters.

Chapter 11
Firms' Internal Organisation

Finally, we will examine the role of firm's internal organisation as a source of the different technological performance of large and small firms. We have so far reviewed the relative importance of size effects, labour market factors, capital market factors, product market structure and state policy. We found that each of these sources contribute, in a different degree, to the different rates and patterns of technological change in large and small firms in the Korean machine tool industry. With the exception of size effects such sources are mainly related to the environment in which the firms operate and undertake technological change. However, the technological performance of a firm depends not only on its environment but also, and sometimes more significantly, on its own internal organisation. The conventional view (i.e. the neoclassical approach) of a firm tends to see it "simply as a profit seeking 'chooser' of inputs and technology operating within a framework of widely available technological knowledge, and known factor prices." (Nelson, 1981: 1036). But a new approach, which has emerged relatively recently, sees the firm as a 'social system', "... which influences how managerial decisions are carried out, and how alternatives are perceived and evaluated."(ibid.: 1036). Accordingly, a firm's productivity depends as much on its internal organisation as on its environment(e.g. factor prices). And since the organisation of a firm can be to a significant degree independent of its environment as Fransman(1986) pointed out [1], two firms producing

[1] To quote the relevant part of his paper,

> "By conceptualizing the firm as a 'social organism' account is taken of the obvious, but frequently ignored, fact that transformation of inputs into outputs involves the interaction between people. This social intercourse is structured by the organization of the firm which will determine factors such as the fuctions that are assigned to departments and individuals, and the way in which decisions are made within the firm. *The organization of the firm is to a significant degree independent of the firm's environment.* Accordingly, there is no reason why two firms producing similar products in the same industry should be similarly organized. Furthermore, *there is no reason why such firms should respond in the same way to the same environmental*

similar products in the same environment but which are differently organised can show different productivity, including the ability to improve products and processes. Therefore, to understand inter-firm(and inter-country) differences in productivity and technological performance we must consider the internal organisation of firms as a major explanatory factor.

In fact, in the literature on innovation studies, most of which can be classified as the 'social system' view in Nelson's dichotomy, many variables related to firms' internal organisation have been identified as important factors for successful innovation. Among them, the most frequently and typically indicated ones are good internal communication, good internal co-operation and co-ordination, quality of management and decision-making style (see Rothwell, 1977). More importantly in these studies, some attempts have been made to identify the relative 'organisational' advantages and disadvantages of large and small firms in innovation with regard to these and other aspects (e.g. Rothwell & Zegveld, 1981: Chap.10). It is not hard to imagine that large and small firms do have different organisational structures and characteristics, and hence that their different technological performance may stem at least partly from such differences in their internal organisation. Of course, there may also be variation in internal organisation among firms within the same size group, hence different technological performance among them. However, differences between large and small firms are believed to be more pronounced, because the growth of a firm usually involves (and is accompanied by) significant changes in organisational structure as well as in production techniques. Moreover, depending on various external and internal conditions, the quality of social relations within a firm can be significantly different between large and small firms. Here lies the need to compare organisational characteristics between them and look into their effects on the two's different technological performance.

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conditions."(Fransman, 1986:25; italics are my emphasis).

11-1. Hypotheses

There are many aspects of a firm's internal organisation which have been emphasised by innovation studies and organisation theorists in relation to a firm's performance in productivity and technological innovation. We will focus on the following four aspects as these have been most frequently discussed by various writers and are likely to be different between large and small firms: quality and style of management, degree of bureaucratisation, internal communication and co-operation, and labour relations.

Firstly, the role of management in facilitating or barring technological innovation must be considered, for many of a firm's decisions on technological change depend on its management after all. The importance of management to innovation has been pointed out by Carter and Williams(1957), Rothwell(1977) and Pavitt(1980). For successful innovations, management must possess high quality and ability (preferably with technological training), and have the capacity to attract talented people and formulate an effective training and innovation policy. Top management should be open-minded and progressive; indeed, unless top management has the will to innovate, there is little that other members of the firm can do to generate and expedite an effective innovation policy. In this regard, it is likely that large firms will have superior management personnel and expertise. This is because the growing or large firm tends to attract managerial talent of a high order and specialised management functions permit more effective performance in individual departments of the firm (Staley & Morse, 1965: 99). However, according to Rothwell & Zegveld (1981), though they also recognise the lack of management expertise as a weakness of small firms, they point out the latter can enjoy an advantage over large firms in terms of dynamic, entrepreneurial management which reacts swiftly to take advantage of new opportunities and undertakes high risk innovations. So we will hypothesize these two different possible relationships between firm size and the character of management below.

Secondly, the degree of bureaucratisation of an organisation has been thought to be strongly associated with its innovativeness. Here the term 'bureaucratisation' means

organisational structure in terms of formalisation, hierarchy and decision-making style. Many authors have contended that there are some organisational structures which are conducive to innovation and others which are not. Burns and Stalker(1961) distinguish between 'organic structure' and 'mechanistic structure': the former has fewer formal rules, less hierarchy and a decentralised decision-making pattern, while the latter has the opposites. Organic structures are advantageous for innovation, because it is more effective in collecting and processing information on external changes and hence more flexible in a dynamic environment. In contrast, mechanistic structures which are highly bureaucratised tend to bring about rigidities in organisation and stifle active participation and innovation by their employees. Authors like Argyris(1962) especially stress the importance of decision-making styles and procedures. His key concern is whether an organisation is more effective under participatory modes of decision-making or in a hierarchical regime in which decisions are made at the top, with little participation from below. Most studies seem to suggest that the former (i.e. decentralised, participatory decision-making) is more conducive to innovation (e.g. Marrow, et. al., 1967; Kim & Lee, 1982). In general, degree of bureaucratisation tends to be proportional to firm size.[2] So in this respect large firms can be said to have disadvantages relative to small and medium firms. However, as regards decision-making style at least, we cannot easily say which firms have a more centralised or decentralised style of decision-making. For example, small firms are often headed by all-powerful autocrats who refuse to listen to advice from their subordinates, rather than by democratic, consultative managers (Rothwell & Zegveld, op. cit.). Therefore, empirical investigations are required to decide this.

Thirdly, good and efficient internal communication is recognised by most studies as a necessary condition for successful innovation (see Rothwell, 1977). Though internal communication is connected with organisational structure, we need to look at it

[2] But there can be some difference between a developed and a developing country in this regard. According to Kim & Utterback (1983), young (and smaller) firms tend to show more mechanistic organisational structure in a developing country, because of different environments from those in a developed country.

separately in that 'informal' (i.e. individuals') communication channels are as much, if not more, important as 'formal' ones in the retrieval and dissemination of useful information. Since innovation is not simply a matter of R&D but a corporate wide task which should involve inputs from the production and marketing departments throughout the course of the project, good internal communication and co-operation between different functions are especially required. Otherwise, the final product, while working satisfactorily from the technical point of view, may be extremely difficult to manufacture or might fail to meet user requirements. According to Rothwell & Zegveld (op. cit.), small firms often enjoy an advantage over large firms because of the ease with which they can organise internal communication. There is less need to establish sophisticated formal communication networks in small firms, where communication is most often of an informal reactive kind, which occurs rapidly thus offering a fast response to internal problem- solving and in reorganising to adapt to change in the external environment.

Fourthly, recently the effects of labour relations on technological change have attracted increasing attention in many studies. In the literature, there are two different, and possibly conflicting, views on the role of labour relations on the technological performance of firms. First of all there is a body of literature which emphasises that good labour relations contribute to improvements in productivity and technological performance. Authors like Doeringer and Piore(1971) and Freeman and Medoff(1979) have focused on the role of trade unions in shaping 'internal labour markets' (discussed in Chapter 7), and thereby affecting the level of productivity. According to their view, trade unions have positive effects on productivity because they reduce labour turnover and promote employees' long service, which facilitates firm-specific traing and learning and thus contributes to the accumulation of technological capabilities. Also, since trade unions provide a channel for employees to accommodate their discontent and grievances with management and participate in decision-making within firms, they stimulate workers' morale and motivation (see Park and Chang, 1983, for further

explanations and related references). Probably Japan is the most frequently cited example of the importance of good labour relations to productivity. Dore(1973) has produced one of the most interesting studies on this subject. According to Fransman(1986: 200~201) though, good labour relations are not important to all types of technological change but mainly to incremental forms of it.[3] While radical innovations are likely to come from formal R&D efforts, incremental improvements often result from the more obscure activities of other personnel such as production engineers and workers[4] (see, for instance, our Table 5-4 earlier). In this regard, the role of work organisations like quality circles seems to be important.

There is, however, another body of studies which sees industrial conflict as a source of technological change. This line of research has its origins in Marx's views of the history of innovation (Marx, 1955 & 1976) and has been stimulated, more recently, by the debate on the labour process among Marxist political economists (e.g. Braverman, 1974). As Marx saw invention as a capitalist's weapon against revolts by workers (Marx, ibid.), so labour process theorists see technological change as a means to weaken workers' resistance by strengthening managerial control. Bruland (1982) and Lazonick (1979 and 1981) are good examples of this approach. In any case, it seems plausible that industrial conflict may stimulate automation and radical innovations, though firms may not necessarily make (nor succeed in) such attempts. But industrial conflict is unlikely to contribute to incremental innovations, for the reasons we mentioned above. As regards the relationship between firm size and labour relations, a common view seems to be that small firms have advantages over large ones in that the former allow more 'personal' relations between management and workers (e.g. Staley and Morse, 1965: 100 ; Rothwell

[3] To quote the relevant paragraphs,

> "The importance of factors such as these is underlined when it is realized, as noted above in the case of the machine tool industry, that the cumulative impact of incremental improvements in processes and products tends to be greater than that of more radical change. *Such incremental improvements depend to a large extent on the social relations existing within the firm.*"(ibid.; italics are my own).

[4] Freeman (1974) also points out the contribution of non-specialists and non-professionals to minor, incremental innovations.

& Zegveld, 1981; 177). This view was supported by Jones and Prais(1978) in their study of the British motor industry. However, this may not be necessarily so when small firms are under autocratic management and are not unionised. Probably high labour turnover and low work morale (and thus low productivity) will prevail under these conditions.

Based on the above theoretical considerations, we propose the following hypotheses which we will examine in this chapter :

- Hypothesis 1: (i) quality of management is superior in large firms, but (ii) small and medium firms have more a dynamic, innovation-oriented style of management than the former.
- Hypothesis 2: large firms have more bureaucratic organisational structures, i.e. they are (i) more formalised in work organisation and (ii) more centralised in decision-making.
- Hypothesis 3: small and medium firms are superior to large firms in internal communication and cooperation.
- Hypothesis 4: small and medium firms have better labour relations.

All the hypotheses except the first imply that the internal organisation of small and medium firms is advantageous to that of large firms for technological innovation. If this is true, it means that internal organisation is in fact the only source from which small and medium firms can enjoy significant advantages over large firms in achieving innovation. We have argued so far that they are largely disadvantaged in other sources related to the environment of firms(e.g. market, state policy...etc.). Considering the results of our analysis on the technological performance of the two groups (see Chapter 5), the importance of internal organisation, even if it is proved to be better in small firms, does not seem to surpass that of the other sources. Only in minor, incremental forms of technological change where our sample small firms show a rather good performance, can we find the positive effects of their better internal organisation. So we would suggest the following as our hypothesis on the relationship between firms' internal organisation and technological performance:

- Hypothesis 5: characteristics in the internal organisation of small and medium firms are advantageous for, especially, incremental forms of technological change.

11-2. Quality and style of management

Assuming that top managers often greatly influence the quality and style of the whole management, we will first review the personal backgrounds of the chief executives of our sample firms.

As we indicated before, there is a significant difference in forms of ownership between our sample large and small firms: while all the large firms are joint-stock companies, only a half of the small and medium firms are such and the other half are individual (or family-owned) businesses. Accordingly, it is not surprising that the chief executives in the two groups have substantially different status and backgrounds. For instance, among the 9 large firms only 2 of them are managed by their founders (or rather relatives of the founders of the groups they belong to), while 6 of the rest have employed professional managers as their chief executives. In contrast, 10 of the 14 small and medium firms are still managed by their founders and one by the second generation of its founder. Only one has an employed manager as its chief executive. The others are managed by the subsequent purchasers or others. Table 11-1 below summarises some of

Table 11-1. Personal backgrounds and characteristics of the chief executives

Characteristics of the chief executives	Large firms	Small & Medium Firms
1. age (years)		
(i) average	55.6	50.3
(ii) range (min.~max.)	48~65	34~67
2. education (% of university graduates)	88.9	64.3
3. technical expertise		
(i) those with Bachelor's degree in science or engineering (%)	22.2	35.7
(ii) those who worked as technicians or craftsmen	0.0	28.6
4. length of service (years)		
(i) in the company	10.0	13.7
(ii) as the chief executive	7.8	13.4
(iii) engaged in machine tool business	5.4	15.6

the important aspects of the personal characteristics of the managers in our sample.

In terms of age, there is no significant difference between the chief executives of the two groups. But age range is wider in the small and medium firms. This is because some of the small firms were established relatively recently by young entrepreneurs, who have university backgrounds in engineering or management and seek to exploit their talents in the machine tool business. However, in general, the average educational level of chief executives is higher in the large firms: 8 out of 9 are university graduates, compared to about two-thirds in the small and medium firms. The other one-third in the latter are typical, traditional types of small entrepreneurs in Korea. They have little education and have established their businesses over a long time by their own hands. So these top managers in our sample are typically, old and have diverse educational levels of from primary to high schools. But the proportion of university graduates among the small firms's chief executives is not low, which seems to imply an improving educational level among top managers of small and medium firms and challenges the traditional assumptions about their low educational levels. Moreover, if we look at the subjects of the chief executives' university education (see 3 (i) in the Table), we can see that the proportion of those with degree in science or engineering is certainly higher in the small and medium firms (i.e. actually over a half of those with university degrees in the latter studied engineering, compared to about one-fourth in the large firms). Most of the chief executives with university education in the large firms studied social sciences (especially, business management). On the other hand, chief executives who were originally technicians or workers are not found in the large firms, whereas they constitute 28.6 % of the top managers of the small and medium firms. Therefore, in total, the proportion of those who acquired technical expertise from either education or manufacturing experience is much greater in the latter (64.3 %) than in the former (22.2%). In fact, many of the chief executives of the small and medium firms had worked in other companies as engineers or workers and had later started their own business with small capital and on the basis of their accumulated knowledge and skills of machine tools (our

interview). In particular, some of the oldest small firms were established by those who had worked as ordinary workers in the factories managed by Japanese employers during the pre-independence period. After Korea's independence, they were able to purchase their own factories or other plants on the disposal of confiscated 'enemy'(i.e. Japanese) property.

The last item in the Table, length of service, shows that chief executives do not differ very much in their total length of service in their companies, but that they do show significant differences in the period of time for which they have been chief executives and an even greater difference in that for which they have been engaged in the machine tool business. From the Table, we can see that while the top managers of the small and medium firms served as 'chief executives' from the beginning (because most of them are themselves the founders of the firms), those of the large firms became chief executives by internal promotion. It is interesting too, to see that large firms' chief executives have spent more time as chief executives than they have been in the machine tool business because many of their organisations have only entered the business recently. The reverse applies in small firms because here some chief executives have experience of working in other machine tool producing firms. In any case, the big gap in the length of experience in machine tool business between the chief executives of the two groups is likely to make their depth of knowledge about machine tool production very different. In this respect, at least, the top managers of the small firms seem to be clearly superior to their counterparts in the large firms.[5] Therefore, we can expect that this is one of the few strengths which the small and medium firms have over the large firms in the Korean machine tool industry.

In conclusion, considering their educational backgrounds and experience, there seems to be a difference in the relative strength of expertise between the chief executives of the two groups: while the chief executives of the large firms may be superior in

[5] Not surprisingly, top managers are in fact often the best technological experts in the small and medium firms, as we already mentioned as regards Table 5-4 in the last chapter.

'managerial' expertise, those of the small and medium firms appear clearly superior in 'technological' expertise. Since the former had no education or experience in machine tool production before they took up their present posts, their familiarity with technological matters concerning machine tools is likely to lag far behind the latter. But their education as managers and experience within large firms, where not only modern techniques of management can be taught and implemented but also a variety of managerial assets (e.g. acquaintance with influential personnels in banks, government, etc.) from size advantages can be acquired, seem to make them superior in managerial expertise. Therefore, contrary to our rather simplistic notion of 'quality of management', there are at least two more or less independent aspects of management abilities. And we have found that the top managers of the two size groups have different strengths in each of these aspects. This, however, does not necessarily mean that we can decide which group is superior in terms of its overall management quality. If we consider that the quality of management of a firm depends not only on the abilities of its top manager but also on those of its management staff as a whole, then the overall assessment of management quality is likely to appear better in the large firms, which have a clear advantage over the small and medium firms of possessing competent middle-managers. Though we do not have the relevant data, it seems certain that the large firms enjoy this advantage because of their advantages in recruiting and their higher specialisation among managerial functions. The managerial strength often comes from these middle-managers, so the weakness in the technological expertise of their chief executives can be overcome by having middle managerial staff with technological training and experience. We can find some evidence to support this judgement in Table 11-2 below, which shows the subject assessments of some aspects of managerial abilities in each sample firms by one of its own middle-managers. Therefore, we have no reason to reject our first hypothesis on the quality of management.

Table 11-2. Subjective assessment of management quality on some selected aspects (5-point scale: 1 = very inferior ; 5 = very superior)*.

Aspects of management abilities	Large firms	Small & Medium firms
1. accounting and general management abilities	3.8	3.2
2. ability to recruit qualified technical manpower	3.4	3.1
3. intimacy with research institutes or technological experts	3.9	3.5

Note(*): The respondent was asked to assess managerial abilities of his own firm, by comparing with those of other firms in the industry.

Turning now to the style of management, is there any significant difference in managerial policy and attitude towards technological innovation and training? To know this, we also questioned middle-managers of our sample firms about their top managers' (i) product market strategy, (ii) interest in developing new products, (iii) preferred method of developing new products, and (iv) interest in training of employees. The results are summarised in Table 11-3 below. We found no significant difference between the two groups in any of the four aspects mentioned above. As regards product market strategy, most top managers in both groups adopt the third (i.e. 'a dual strategy') or the second (i. e. 'initiating new products') strategies. So top managers of our sample firms, regardless of their size, seem to follow similar strategies focusing on new product development. This result is consistent with the answers to our second question, according to which top managers in both groups are similarly positive in their extent of their interest in new product development.

Also, in their interest in education and training of employees, they have similar, though less positive, scores. Only in our third question, i.e. top manager's preferred method of new product development, do the two groups show a moderate degree of difference. As is seen in the Table, while more than half of the top managers of the small and medium firms preferred copying and imitation, top managers of the large

firms tended to prefer technology import (and original innovation by in-house R&D) as much as imitation. Nevertheless, there seems to be no *fundamental* difference in top managers' preferred method of new product development between the two groups. Therefore, despite the fact that the top managers of the small firms tended to have technological backgrounds, we could find no evidence to support the hypothesis that they are more innovation-oriented than those of the large firms.

Table 11-3. Top managers' orientation towards innovation and training

Top managers' orientation in terms of :	Large firms	Small & Medium firms
1. product market strategy (%)		
(i) defending the existing market	0.0	0.0
(ii) initiating new products	44.4	28.6
(iii) a combined strategy of (i) and (ii)	55.5	57.1
(iv) no clear or consistent strategy	0.0	14.3
2. interest in the develoment of new products (5-point scale : 1=no interest; 5=great interest)	4.7	4.4
3. preferred method to develop new products (%)		
(i) importing foreign technology	33.3	21.4
(ii) disassembling and/or imitating foreign products (i.e. 'reverse-engineering)	33.3	57.1
(iii) original innovation by in-house R&D	11.1	0.0
(iv) subcontracting to or joint-R&D with	0.0	0.0
(v) other	22.2	21.4
4. interest in education and training of employees (5-point scale : the same as '2.' above)	4.0	3.9

Note(*): To quote the phrases to describe each item of strategy,

(i) = a strategy which tries to defend the firm's existing market share by maintaining the competitiveness and strengthening the marketing of the existing products rather than developing new products.

(ii) = a strategy which continually searches for market opportunities and initiates market change by introducing new products almost always ahead of other competitors.

(iii) = a dual strategy which tries to defend the market share in the firm's existing products while watching other competitors closely for new products and rapidly adopting those which appear to be the most promising.

(iv) = without any consistent strategy, the firm seldom makes adjustment of any sort until forced to do so by environmental pressures."

This typology of market strategy largely follows that suggested by Miles and Snow (1978).

11-3. Degree of bureaucratisation

we examined the degree of bureaucratisation in our sample firms in terms of the following : degree of formalisation in work organisation and degree of participation in decision-making. These two aspects seem to be essential to see whether a firm has an 'organic' or 'mechanistic' structure of organisation in the Burns and Stalker's sense (op. cit.). First, the degree of formalisation was investigated by asking representatives of the workers of our sample firms to indicate (i) how distinct job divisions were and (ii) how strictly work rules were applied and observed, within their own firms. Secondly, the style of decision-making was investigated by asking the middle-managers to indicate who participates in making various managerial and work decisions such as recruitment, remuneration and so on. The results are summarised in Table 11-4 below.

Table 11-4. Degree of formalisation and style of decision-making in our sample firms

Organisational characteristics	Large firms	Small firms	Significance (two-tailed)
1. degree of formalisation			
(i) distinctness of job divisions	2.1	3.0	*P<.05
(ii) observance of work rules	2.0	2.4	
2. style of decision-making			
(i) employees' remuneration	2.6	2.6	
(ii) hiring or recruiting personnel	2.4	3.0	*P<.10
(iii) dismissal of personnel	2.1	2.6	*P<.10
(iv) positioning personnel and allocating work	2.8	3.1	
(v) emplyees' promotion	2.2	2.2	
(vi) new product development	2.8	2.9	
(vii) deveopment or introduction of new production techniques	3.1	3.3	

Notes: 1) The respondent was asked to indicate how much he agree or disagree with the following statements by selecting one number on a 5- point scale (1 = strongly agree ; 5=strongly disagree):
"(i) In our company, there is little room for mutual interference or overlap in tasks because of distinct job divisions.
(ii) Our workers perform their jobs according to the existing work rules rather than at their supervisor's discretion."
2) The respondent was asked to indicate degree of participation in decision-making by selecting one number among the following: 1=chief executive only; 2=1+other executives; 3=2+middle-managers; 4=3+ordinary employees; 5=all.

From the Table, it appears that the large firms have certainly more formalised work organisation than the small and medium firms. They not only seem to have well-defined job divisions among their employees but also depend on more formalised work practices than the latter. The large firms show a higher degree of centralisation in their style of decision-making than the small and medium firms, though the gap between the two is not as distinct as in the degree of formalisation. The biggest gap is found in decisions on employment (i.e. hiring or sacking employees), where the large firms have a clearly more centralised pattern of decision-making than the small and medium firms.[6] With regard to decisions on technological change, both groups show a considerably decentralised pattern of decision- making (especially, on decisions about new production processes) more than in any other decisions. Therefore, both groups seem to allow relatively wider participation in decision-making on technological change in order to collect useful ideas and information from their employees as much as possible. In this sense, both groups seem to agree, at least implicitly, that a participatory mode of decision-making is more conducive to innovation. However, given that other important decisions are made in an authoritarian way it remains to be seen how effective such a moderate extent of participation in a restricted area is.

To conclude, our hypothesis on degree of bureaucratisation is modestly confirmed in our data. Therefore, it can be said that the large firms have a rather 'mechanistic' organisational structure whereas the small and medium firms show a less bureaucratised, 'organic' structure.

11-4. Internal communication and co-operation

It has often been assumed that bureaucratic organisational structure is an impediment

[6] This seems to be connected with the different sources (and methods) of employment in the two groups, on which we discussed in the section on 'labour market factors' (see Chapter 7). For instance, if employees are recruited mainly by 'personal connection' like in the small and medium firms, many middle-managers can participate in the process of such recruitment by introducing new employees through their own personal connections.

to effective internal communication and co-operation among employees (for instance, Kim & Lee, 1982: Chap.7). This is because the bureaucratisation of an organisation, characterised by increasing formalisation, rigid hierarchy and centralised decision-making, tends to stress the observation of formal rules and procedures and thus to discourage the formation of flexible and informal communication networks among employees which are both based on, and stimulate, their voluntary participation in organisational processes. Therefore, for this reason and the ease of communication owing to small size, small and medium firms are alleged to have advantages over large firms in internal communication and co-operation.

In our samples, we focused on the three aspects of the quality of internal communication and co-operation within firms : communication between different departments ; the extent of informal communication channels ; and the extent of a co-operative spirit amongst employees. Representatives of workers of our sample firms were asked to answer these questions. Table 11-5 shows the results.

Table 11-5. Quality of internal communication and co-operation

Aspects of internal communication	Large firms	Small firms	Significance (two-tailed)
1. communication between different departments	1.9	2.6	
2. opportunities of informal communication	2.0	2.8	
3. co-operative spirit	1.7	2.4	*P<.05

Note: A 5-point scale which is the same as in Note1) of Table11-4 was used. The actual phrases of the questions are following:

"1. There are smooth contacts and communication between the different departments in our company.

2. Fellow employees have frequent informal chances to meet and discuss.

3. There is a very co-operative spirit among the employees of our company."

Contrary to our hypothesis and the conventional view about the advanage of small firms in internal communication, the Table above suggests the opposite results. Though the scores of the small and medium firms are not disappointing at the absolute level (i. e.

at least they are better than the middle (=3) on the scale), they appear clearly behind those of the large firms. How do we interpret these results ? We can first doubt the reliability of the answers. Since our respondents were representatives of workers(usually foremen) in the production departments of our sample firms, they may not know much about the situation in other departments and so cannot represent the real conditions in their companies. Of course, this may be partly true. However, there are some reasons to believe the reliability of the above results. For instance, if internal communication and co-operation among employees is greatly influenced by the personnel and incentive policies of the firm, then the relatively better position of the large firms in this respect, which we confirmed in the section on 'the internal labour market' earlier, is consistent with our above results. Moreover, as we saw in Table 5-4, the fact that the contribution of non-R&D department, e.g. sales, production, etc., to idea generation for technological projects seems to be greater in the large firms could be an example of their better internal communication between different departments. But this does not mean that in the large firms there are no difficulties in internal communication stemming from their large size and higher degree of bureaucratisation. On the contrary, in our interviews respondents in a few of the large firms admitted the problems of delays in communication between, especially, sales and R&D departments. And this seems more so in the largest firms belonging to *jaebuls*, where the sales function is often not only geographically distanced but also organisationally separated from (i.e. lacking direct coordination with) the R&D or production functions. An R&D engineer from one of the largest firms criticised the lack of organisational flexibility in his own firm, which, he thought, deterred the prompt commercialisation of new products, a fatal drawback in areas characterised by rapid technological changes. Nevertheless, we also found that large firms had devised (or were trying to devise) various measures to counter this and to promote speedy and active communication (both formal and informal) between, and within, their different departments. An example of these efforts is Total Quality Control(TQC) activities. As we will see next, all the large firms in our samples had

introduced one or other form of TQC system different from their existing organisational processes. (It is 'total', because it involves virtually all of the organisational units within a firm). One of their aims in introducing TQC was to remove various problems associated with the growth of the organisation, e.g. weakening of control and co-ordination function, growing friction between different departments and hierarchies and so on. By applying techniques of QC and scientific management and by promoting communication at various organisational levels, the firms try to achieve high efficiency and cooperation among employees through TQC. Therefore, horizontal rather than vertical communication, small group rather than large group activities, and informal (i.e. voluntary) rather than formal (i.e. compulsory) meetings are emphasised. Quality circle members meet usually once a week after regular working hours. Many firms link the performance in QC activities to incentives for employees (e.g. bonuses, special promotion, overseas training opportunities, etc.). Though the effectiveness of TQC is different in the large firms, as we shall see later the response from their workers is fairly positive and certainly better than in the small and medium firms. These firms seek to promote formal and informal communication and morale and cooperation among employees through, e.g. group training, employee suggestion schemes, company newspapers and journals, trade union activities and so on.

Therefore, internal communication and co-operation within firms does not seem to depend wholly on their size or degree of bureaucratisation. Conscious and active efforts by firms to expedite communication and promote cooperation among their employees seem to play a great role. Probably for these reasons, our hypothesis on internal communication and co-operation does not prove to be valid in our samples.

11-5. Labour relations

Lastly, let us see how the large and the small firms in the Korean machine tool industry differ in terms of labour relations. First of all, we will examine a general indicator which shows the extent to which workers in each group have channels to express their demands and how effective such channels are. We interviewed the representatives of

workers (i.e. foremen and/or union officials) to acquire this information.

Table 11-6. Existence of labour-related organisations andworkers' response to them

Aspects of labour organisation	Large firms	Small & Medium firms
1. No. of firms having the following organisations :		
(i) trade union	6 (66.7%)	2 (14.3%)
(ii) joint industrial council	8 (88.9%)	8 (57.1%)
(iii) quality control circles	9 (100.0%)	11 (78.6%)
2. workers' response as regards (5-point scale : 1=very positve ; 2= negative) :		
(i) trade union	2.0	1.5
(ii) joint industrial council	2.3	2.0
(iii) quality control circles	1.4	2.0

As can be expected, in all three types of the major labour-related organisations large firms are more organised than small and medium firms. The gap is most pronounced in the case of trade unions. Though most of the small and medium firms at least have QC circles, three of them have none of the three organisations. In these firms, therefore, the workers seem to have virtually no legitimate channel to express their collective demands to the management. To compare the character of the three organisations in the Korean context, trade unions can be said to be most voluntary in the sense that they are usually formed by the workers' initiative.[7] The other two are largely initiated and led by the management, and therefore seem to be fundamentally limited as a means for workers to take part in, and influence, their companies' decision-making. In Korea, however, even trade unions are often distrusted by workers, for under the very authoritarian labour legislation of the government (see J. Lim, 1985) many trade unions have been virtually controlled by the management, through the appointment of 'pro-management' union officials, etc. Nevertheless, according to our interviews, firms

[7] It is not uncommon in Korean companies that when faced with the possibility of the formation of independent unions by workers, management intervenes and takes the initiative to form 'pro-management' unions, instead.

with trade unions tend to have relatively more active labour-management negotiation functions (such as 'joint industrial council') than those without unions. Thus, even within the limited power under the prevailing unfavourable conditions the trade unions in our sample firms seem to play a certain role in protecting their workers' rights.

The responses of workers to the activities of the above organisations appear largely positive in both groups. But in the large firms the response to QC circles is most positive, whilst in the small and medium firms trade unions receive the most positive response. This is probably because each organisation has different levels of success and gives different real benefits to workers in each group. From this point of view, it is interesting that QC circles appear to be more important than trade unions in the large firms. We suspect that this reflects the weak position of trade unions as the effective spokesman of workers' interests in these firms. On the other hand, if a trade union exists in a small or medium-sized firm, it seems to have a greater significance to its workers than it has in a large firm. This is understandable because small and medium firms are typically non-union (which means that their workers have typically weak bargaining power). However, we doubt if a trade union in a small firm can exert stronger influence in protecting its workers than a union in a large firm.

Let us see then how workers feel about their jobs and management, and how much influence they have over them(see Table 11-7).

According to the results shown in the Table, there is no difference between the two groups in the degree of their workers' satisfaction with wages and working conditions. There are clear differences however, in their degree of satisfaction with working environment and with management abilities. These results are largely consistent with the findings of our earlier analyses on the variables concerned. On the whole, therefore, degree of job satisfaction is higher in the large firms. Their workers are most satisfied with the abilities of their managers, but least satisfied with wage levels. This contrasts with the small and medium firms whose workers show the lowest degree of satisfaction with their working environment.

Table 11-7. Job satisfaction, workers' influence and job climate

Aspects of workers' job conditions	Large firms	Small firms	Significance (two-tailed)
1. Degree of workers' satisfaction with (5-point scale : 1=very satisfied ; 5=very dissatisfied) :			
(i) wage levels	2.8	2.8	
(ii) working conditions (working time, work rules, etc.)	2.6	2.6	
(iii) working environment (safety, health)	2.2	3.1	*P<.05
(iv) management abilities	2.1	2.6	*P<.10
(v) management system	2.4	2.8	
2. Degree of workers' influence over (5-point scale : 1=very great ; 5=no influence) :			
(i) decision on wage levels	2.4	2.7	
(ii) decision on working conditions	2.1	2.6	
(iii) improvement on working environment	2.2	2.6	
(iv) changes of management personnel	3.9	3.7	
(v) improvement of management system	3.1	3.2	
3. Job climate in tems of [1](5-point scale : 1= strongly agree ; 5=strongly disagree) :			
(i) communication between managers and workers	1.7	2.5	*P<.05
(ii) employees' morale and motivation	2.2	2.6	
(iii) employees' loyalty to the company	2.1	2.6	
(iv) anxiety about losing jobs	3.9	3.5	
(v) consideration of leaving jobs	3.8	3.6	

Note 1): The respondents were asked to select the appropriate number on the 5-point scale about the following statements:

"(i) There are frequent contacts and smooth communication between managers and workers in our company.

(ii) Our employees have high morale motivation

(iii) Every employee perceives the objectives of the company as those of his own.

(iv) Many employees are afraid of losing their present jobs.

(v) Many employees are considering leaving the company."

The degree of workers' influence also seems to be greater in the large than in the small firms, though the gap is not statistically significant. Workers in the large firms have relatively great influence over their working conditions or working environment, but very little over the decisions related to management staff or the managerial system itself. This is almost similar, though less significant, in the small and medium firms. Thus, the pattern (but not degree) of workers' influence over decision-making in their companies

can be said to be similar between the two groups.

Not surprisingly, we see from the Table, job climate is also better in the large firms. Since they offer more channels of communication between workers and managers and allow more workers' influence, however limited, over their working conditions, they may well enjoy relatively better communication between labour and management. Similarly, since workers in the large firms are more satisfied with their jobs, it's not strange that they show higher morale, motivation, and loyalty to their companies. In the last two items of the Table, we also find that in the large firms workers feel that they have higher job security and better employment stability than in the small and medium firms. This is not surprising in that the former have greater power in the market and offer better employment conditions to their workers than the latter.

Labour relations in a firm can affect its technological performance not only through general factors such as job satisfaction and work climate but also , more specifically, through its workers' attitudes towards technological change. It is likely that the more positive the attitude which workers have towards such change then the better the firm's technological performance will be. We included this as an aspect of labour relations in our survey. The following questions were asked to, again, the representatives of workers: as a result of new product developments or the introduction of new production processes in the last five years, (i) have there been reductions in the number of production workers ? ; (ii) have there been considerable changes in the methods or conditions of work for production workers ? ; (iii) (in case 'yes' to either (i) or (ii)), the response of the workers to such changes at the time; and (iv) the present attitude of the workers towards technological changes. Table11-8 below shows the results.

No firm reported a reduction in the number of workers as a result of technological changes. But most of the firms in both size groups had experienced changes in the methods or conditions of work in the production departments. In the interviews, many

Table 11- 8. Workers' attitude towards technological change

Questions for workers and tech. change	Large firms	Small & Medium firms
1. a reduction in production workers due to technological changes	none	none
2. changes in methods and/or conditions of work (no. of firms which answered "yes")	7 (77.8%)	9 (64.3%)
3. workers' past response to technological changes 1)	4.0	3.4
4. workers' present attitude towards technological changes 1)	4.4	4.0

Note 1): For these questions, a 5-point scale was used: 1= very resistant; 2= somewhat reluctant; 3 = no interest; 4= relatively positive; 5 = very positive.

respondents pointed out that such changes had come when their companies had introduced automated facilities or had entered into the production of NC machine tools. Surplus workers were not laid off but usually retrained and relocated. Also, a continuous increase in output had allowed their companies to do without layoffs in spite of the introduction of automated facilities. How about workers' response to these technological changes? The Table above suggests two interesting points: first, the workers in the large firms have more positive attitudes towards such changes, both in the past and the present, and secondly, workers in both groups have more positive attitudes now than before. This second finding is particularly interesting in that it contrasts with the case of many developed countries where the impact of new technology has caused the fear of a large scale unemployment and other adverse consequences among workers (Benson & Lloyd, 1983). Probably this is because Korean workers have not experienced (or recognised) any negative consequences of new technology on their jobs yet.[8] For example, as referred to above, they have not experienced layoffs due to technological changes. According to the answers of our respondents, workers have become more

[8] In our interview with an official in the Federation of Korean Trade Union, he admitted that most unions did not yet recognise the potential problems that might be caused by new technology. But he pointed out that they could become increasingly an important issue because of the rapid pace of technological change.

positive towards technological change because they think it will bring about not only 'improvements in product quality' and hence 'superior competitiveness of their companies' but also 'opportunities for them to learn new skills' and 'more efficient and easier performance of their work'. This positive attitude may last as long as output increases in their companies continue and they do not need to face layoff. But it is doubtful whether such attitude will persist once the impact of technological change threatens jobs, as in developed countries.

The evidence we have seen so far suggest that, contrary to the conventional view and to our hypothesis, the quality of labour relations is not better in the small and medium firms. Judging from the above limited evidence only, the opposite may even be true. We must be cautious in our interpretation however. Firstly, our data does not necessarily represent the views of the all or even a majority of the workers in our sample firms, and, secondly, we feel we need to know more about the objective conditions (including histories) of labour relations within the companies in order to understand the real situation there. Unfortunately, we could not get access to such data in our survey. Most of the sample firms (especially the small and medium ones) were not willing to discuss labour relations frankly or in detail, or to permit outsiders to interview their workers in a free atmosphere. So it is possible that, answers to questions on a sensitive area like labour relations have presented a more positive picture than the real one. It seems certain at least that the small and medium firms in our sample do not have better relations between management and workers than the large firms. After all, as we discussed earlier, they have higher labour turnover, which is convincing evidence of poor labour relations.

One apparently conflicting fact is that labour disputes are more frequent in the large firms. For five years until the time of our survey in 1985, the firms which experienced labour disputes included three out of the nine large firms and only one out of the fourteen small and medium ones. In Korea, however, a labour dispute often reflects not so much the firm's bad labour relations as its workers' relatively strong organised power. Not surprisingly, the three large firms where labour disputes occurred were all unionised,

although the one small firm was not. Firms without trade unions rarely experience disputes, even if their employment conditions are often worse than those of firms with unions. Therefore, we strongly suspect that the main reason for the fewer disputes in non-union firms lies, not in their workers' compliance and job satisfaction, but in their managers' suppression and in the workers' weak bargaining position (especially, their weak position in the labour market in the case of the small and medium firms). In fact, even the disputes in the three large firms can be said to be exceptional, because in Korea most companies, with the support of the government, have effectively suppressed strikes and any action by workers. The timing of the disputes -all three happened in Spring 1985- also tells of their exceptional character. Under the harsh working conditions characterised by the longest average working hours in the world and the lowest wage levels among the NICs (see ILO, 1986), workers' discontent has naturally grown rapidly throughout all industries. However, because of the strict government control over trade unions and workers in general, the actual numbers of labour disputes has been maintained at a low level. But once the government's grip over workers is loosened, labour disputes tend to explode simultaneously in many different firms, like in 1979 when the former Park regime collapsed or in 1985 when the results of the general election brought about some political freedom. The above three cases were products of the latter. Also in Summer 1987, just after the successful nation-wide demonstrations for democratisation in June, large scale strikes occurred in well over three thousand companies throughout the country. Four of the large firms in our sample, including all the three mentioned above, were involved in these strikes. Though we do not know how many of our sample small and medium firms also experienced strikes then, it seems certain that labour disputes occur more often in the large firms in the Korean machine tool industry. The most common reason for these disputes is, not surprisingly, discontent with wage levels. However, underlying this, the resentment of workers with 'pro-management' unions and their desire to replace them with independent unions is often found among the more fundamental motives (J.C.Kim, 1987). In this respect, it can be

said that the role of trade unions, and labour relations in general, has faced a turning point in Korean industrial history. It is expected that more and stronger unions will increasingly be formed in the machine tool industry. It remains to be seen whether more labour disputes will occur than in the past in the small and medium machine tool firms too.

To conclude, we did not find any evidence to prove that labour relations are better in the small and medium firms. So we can safely reject our hypothesis on this. However, we did not find a firm evidence to suggest that the large firms are better in this regard, either. The frequency of labour disputes contradicts the evidences on job satisfaction and work climate. But we suggested that, under the conditions of strict labour control in Korea, the numbers of labour disputes may reflect, not the quality of labour relations of the firms concerned, but just the relative strength of their organised workers. In general, the quality of labour relations is not likely to be much different between the two groups because workers in both have been subjected to a repressive style of management and labour policy.

11-6. Relationships between firms' internal organisation and technological performance

Here we like to see how the variables of firms' internal organisation we've mentioned so far affect technological performance, in our sample firms. To do this, we are relying on the same method of statistical correlation analysis which we used in the earlier sections. Again, for purposes of simplicity, we selected a limited number of variables which are thought to represent well each of the four aspects of internal organisation suggested above. In particular, those variables in which the large and the small firms showed relatively big differences were selected, because our aim is to explore the sources of their differences in technological performance.

First, we suggest in Table 11-9 below the results of the correlation analysis

(Spearman's rho) between the variables concerning top management, degree of bureaucratisation and internal communication, and those representing technological performance. For the latter, we used the same variables in Table 9-9 earlier.

Table 11-9. Correlation coefficients between selected organisational variables and technological performance (Spearman's rho)

Size groups	Technological variables	1.Top management			2.Bureaucratisation 1)			3.Inter. Commun. 1)
		age	years in MT 2)	interest 3) in NPD	job division 4)	decision personnel 5)	decision technology 6)	communication between 7)
Large firms	R&D intensity	.5000	.5000	.1309	.3354	.0000	.0870	.2070
	Tech. Cap.	-.4104	-.1316	.3452	-.0696	.7308 *	.7039 *	.2009
	For. Eq.	-1.0000 *	-1.0000 *	-.3536	-.7379	-.5643	-.5643	-.2887
	NC Eq.	-1.0000 *	-1.0000 *	-.3536	-.7379	.0513	.0513	.2887
	Licenses	-.5643	-.5526	.0000	-.5865	-.3056	-.1502	.1557
	New Products	.7000	.5643	-.1369	.0788	.7906 *	.6214 *	.0697
Small & Medium Firms	R&D intensity	-.1816	-.2259	.0608	-.0713	-.3780	-.0504	-.1963
	Tech. Cap.	-.4952 *	-.2058	-.4702	.2365	-.1717	-.1879	-.1501
	For. Eq.	.5253 *	.3289	.0543	.4004	.2267	-.2905	.4434
	NC Eq.	.0343	.1310	.1143	.1916	-.4439	-.5536 *	-.0197
	Licenses	.1436	-.3441	-.1737	-.1388	-.4411	-.1573	.2384
	New Products	-.1680	-.1374	.1445	.4454	-.5146 *	-.7283 *	.3214

Notes:1) For these variables, we reversed '+''-' signs of their correlation coefficients for the convenience of interpretation.

2) 'years in MT' = length of service in machine tool business (i.e. 4 (iii) in Table 11-1).

3) 'interest in NPD' = interest in new product development (i.e. 2. in Table 11-3).

4) 'job division' = distinctness of job divisions (1 (i) in Table 11-4).

5) 'decision personnel' = decision-making in hiring personnel and in terminating the employment of personnel (i.e. a combined votable of 2 (ii) and (iii)in Table 11-4)

6) 'decision technology'= decision-making in new product development and in new production processes (i.e. a combined variable of 2 (vi) and (vii) in Table 11-4).

7) 'communication between' = communication between different departments (1. in Table 11-5)

8) The sign '*' indicates P<.10 (two-tailed).

As regards characteristics of top management, we found that the variables of 'age' and 'experience in machine tool business' show almost similar patterns of correlation coefficients in both size groups. Perhaps this is because the two variables are closely connected with each other in both. But the content of such correlations is different between the large and the small firms. In the former, older and more experienced(in machine tool

business) top managers are negatively correlated with technology imports, but modestly positively correlated with R&D intensity and new product development. Therefore, large firms which have older and more experienced top managers tend to invest heavily in in-house R&D rather than importing foreign technologies. But they do not seem to have necessarily higher indigenous technological capabilities. On the other hand, in the small and medium firms older (and, less importantly, more experienced) top managers seem to be positively correlated with the import of foreign equipment, and negatively correlated with technological capabilities and R&D efforts. This is contrary to our expectation in that the age and experience of top managers do not lead to higher technological capabilities. It is interesting to find that younger top managers seem to be more active in R&D efforts and to have higher technological capabilities in the small and medium firms.This is probably because they have received a university education in engineering and thus have a more dynamic, innovation-oriented style of management, while older managers tend to prefer stability in their business and avoid the risks involved with innovation. The last variable concerning top management, i.e. 'interest in new product development', is rather surprisingly of little importance in both size groups. But this is perhaps because most of our sample firms are similar on this variable, rather than because it is not important for technological innovation *per se*.

Among the variables concerning degree of bureaucratisation, 'distinctness of job divisions' seems to be least significant for technological performance. It is negatively correlated in the large firms, but positively correlated in the small and medium firms. On the other hand, the two variables representing 'style of decision-making' are relatively important in both size groups, and show, not surprisingly, a coherent pattern of correlations. In the large firms, the more centralised their style of decision-making is, then the higher their technological capabilities and the more successful new product developments are (and the lower their dependence on technology imports is). But in the small and medium firms, it shows a quite different result: here centralised decision-making is negatively correlated with almost all the technological variables, and especially with new product developments and the introduction of NC equipment. So we

can see that the effect of style of decision-making on technological performance is not uniform, as is suggested in many existing studies, but can be different according to firm size . It seems likely that a participatory mode of decision-making is helpful for technological change in the small and medium firms. In contrast, in the large firms it is not necessarily so and those with a centralised decision-making structure can show a higher performance in technological change. However, it is not yet clear whether their high technological performance is due, at least partly, to their centralised decision-making or whether the relationship is just accidental. What we can say is that a participatory mode of decision- making is not a necessary condition for higher technological performance in the Korean large machine tool firms. In the last variable, 'internal communication between different departments', we did not find any significant correlation coefficient. This looks strange when we consider that most of the innovation studies have emphasised the critical role of internal communication for successful innovation. But we cannot reject its importance only with the above simple evidence. More detailed data and in-depth analyses will be needed to test further the relationship between internal communication and technological performance.

Let us next see the results of the same correlation analysis between the variables on labour relations and those of technological performance (see Table11-10). First, it is rather surprising to find that workers's job satisfaction is largely negatively correlated with technological variables in the large firms. In particular, higher job satisfaction appears to be connected with lower R&D intensity and a lower level of NC equipment in these firms. We are not sure if this implies that workers' higher job satisfaction reduces the need to invest in R&D and introduce automated equipment like NC machines. More evidence is needed here too. By contrast, workers' job satisfaction is positively correlated with R&D intensity and technological capabilities in the small and medium firms. Therefore, though the large firms show a higher degree of workers' job satisfaction (see Table11-7), it is not likely that this is a source of their higher technological

performance. Secondly, workers' influence over their jobs has no significant correlation with technological performance in the large firms, while it shows some significant correlations with new product developments and the introduction of foreign equipment

Table 11-10. Correlation coefficients[1] between labour relations and technological performance (Spearman's rho)

Size groups	Technological variables	Satisfaction environment [2]	Satisfaction management [3]	Influence work. cond. [4]	Influence environ. [5]	Communication mgr.-wkr. [6]	Attitude technology [7]
Large firms	R&D intensity	-.7650*	-.5555	-.1195	.2469	.6831*	.2887
	Tech. Cap.	-.1594	.0939	.0943	-.2819	.0368	.6235*
	For. Eq.	-.1054	-.3689	.3162	-.2635	-.2887	.0000
	NC Eq.	-.5270	-.7906*	.3162	.1581	.2887	.8944*
	Licenses	-.5315	-.4471	.2381	-.0752	.4281	.4562
	New Products	-.2899	.1064	-.2316	.1118	.0456	.2817
Small & Medium firms	R&D intensity	.4763*	.0502	-.2962	.1239	.0206	.2286
	Tech. Cap.	.0375	.4586*	-.2128	-.2128	-.2492	.4143
	For. Eq.	-.2426	.3084	.6102*	.1074	.4430	-.1899
	NC Eq.	-.0175	-.1875	.3657	.3168	-.1475	.2026
	Licenses	-.0908	.4280	.1859	.1800	.0891	.0470
	New Products	.2688	.2596	.5692*	.6837*	.2991	.7217*

Notes: 1) Among the variables in the Table, for the first five variables (i.e. 'satisfaction environment'--'communication mgr. - wkr.') we reversed '+''-' signs of their correlation coefficients for the convenience of interpretation.

2) 'satisfaction environment' = workers' satisfaction with working environment (i.e. 1 (iii) in Table11-7)

3) 'satisfaction management'= workers' satisfaction with management abilities (i.e. 1 (iv) in Table11-7)

4) 'influence work. cond.'=workers' influence over decision on working conditions (i.e. 2 (ii) in Table11-7)

5) 'influence environment' =workers' influence over improvement of working environment (i. e. 2 (iii) in Table11-7)

6) 'communication mgr. - wkr.' = communication between managers and workers (i.e. 3 (i) in Table 11-7)

7) 'attitude technology' = workers' present attitude towards technological changes (i. e. (iv) in Table 11-8)

8) The sign '*' indicates P<.10 (two-tailed)

in the small and medium firms. Since such workers' influence is relatively stronger in the large firms (Table 11-7), it is unlikely to be a source of the latter's higher technological performance. Thirdly, communication between managers and workers shows a significant positive correlation only with R&D intensity in the large firms, but appears to have little importance for other technological variables in both size groups. Lastly, workers' attitudes towards technological change seems to be more important than any

other variables in the Table. Their attitudes are largely positively correlated with technological variables, in particular with technological capabilities and the introduction of NC equipment in the large firms and with new product developments in the small and medium firms. We are not sure whether workers' positive attitudes have led to higher performance in such aspects or whether, conversely, higher technological performance has led to their positive attitudes. In any case, it seems certain that workers' positive attitudes towards technological change facilitate the technological performance of their firms.

How about the effects of labour disputes on technological change in the Korean machine tool firms? Have the more frequent disputes in the large firms stimulated automation or radical innovations by them, as was suggested in some of the labour process studies? At the moment we have little data to either prove or disprove this point. It is true that large firms which experienced labour disputes are also the leaders in the introduction of NC machines and other automated facilities as well as in radical product innovations in the Korean machine tool industry. However, it is highly unlikely that their labour disputes have motivated these latter technological changes. As we already indicated, disputes have occurred only very recently (i.e. 1985 and 1987) and were exceptional in the sense that sudden political events made them possible. Above all, firms hardly seem to need radical technological changes in order to cope with a workforce like Korean workers receiving such low wages and enduring long working hours. Instead, the primary motive of technological change has come from increasing competition in domestic and export markets (our interview, and also see Table 5-7). Growing demand for NC products was especially important in this regard. Nevertheless, it is possible that the current increase in labour disputes will stimulate automation and product innovations of a high technological sophistication in the near future. Not surprisingly, it is reported that interest in factory automation(FA) has rapidly increased among Korean companies since the nation-wide labour disputes of August 1987 (*Dong-A Ilbo*, 16 Oct. 1987). So it remains to be seen whether labour disputes will become

an important motive for technological change in the Korean machine tool industry.

To summarise, our statistical analysis fails to prove the existence of strong correlations between variables on firms' internal organisation and those of technological performance. Among the former, age and experience of top managers, style of decision-making and workers' attitude towards technological change appear relatively important. Even in these variables, their effects on technological performance are often contradictory between the two size groups. For instance, while older and experienced top managers and centralised decision-making are positively correlated with new product developments (especially by in-house R&D) in the large firms, younger and less experienced (but more educated) top managers and a decentralised decision-making style are associated with higher performance in new product developments and indigenous technological capabilities in the small and medium firms. Therefore, we suspect that it may be dangerous to generalise about the role of firms' internal organisation in technological innovation without considering the contextual difference of firm size. Moreover, as we already found, many of the alleged organisational advantages of small and medium firms (i.e. our hypotheses 1~4) did not apply to our samples. So if there are any organisational characteristics in our sample small and medium firms which have been helpful for their incremental technological changes (i.e. our hypothesis 5), they are found only in the superior technological expertise of their top managers and their relatively decentralised style of decision-making. In addition, the fact that their top managers' most preferred method of new product development is an informal form of R&D like copying or imitation of foreign products (Table 11-3), is also important in this regard. It must have contributed to the accumulation of know-how by the firms for doing incremental technological changes. However, the importance of these few positive aspects is reduced by the less favourable position of the small and medium firms on other important aspects like management skills, internal communication and labour relations. On the whole, we think that the Korean small and medium machine tool firms have not fully actualised the many advantages in internal organisation which have usually been associated with small size.

PART IV

Synthesis and Conclusions

Chapter 12

Synthesis:Building a Causal Model of Firm Size Differences in Technological Performance in the Korean Machine Tool Industry

In the previous chapters, we have tried to assess the relative technological performances of large and small firms in the Korean machine tool industry (Chapter 5), and have analysed various extra-and intra-firm factors which might be important for explaining differences in performance (Chapters 6 to 11). From these analyses, we have found that the conditions and environments which influence firms' technological acquisition are significantly different between large and small firms in many aspects and also that their differences in technological performance do not seem to stem from a single important source but from various sources which represent different aspects of firms' environment. It is also likely, however, these sources are not independent but interact with one another in a complex way. Accordingly, any attempt to explain the causal mechanisms of the different technological performances of large and small firms must consider the complexity of relationships between the various sources and explore how they contribute to the different technological performances. This is the task of this chapter.

We will not attempt this examination through another lengthy empirical analysis. That is beyond the scope of this study. Also, we do not think that it is possible to determine quantitatively the relative importance of individual sources or their combined effects on differences in technological performance. Instead, what we will try to do here is mainly to compile the results of our empirical analyses in the foregoing chapters, to identify some significant interconnections between various independent factors from them, and then to establish a plausible model of the causal mechanisms concerning the different technological performances of large and small firms in the Korean

machine tool industry. So the first section will be a summary of our findings in the previous chapters; the second will introduce two contrasting explanations of the growth gap between large and small firms in the Korean economy and assess them in terms of their relative validity for the explanation of our own subject. And in the final section, based on these findings and assessments , we will try to suggest a model to explain why large and small firms in the Korean machine tool industry show different rates and patterns of technological change.

12-1. The relative positions of large and small firms in the Korean machine tool industry: a summary

As we have seen so far, the conditions under which small and medium firms in the Korean machine tool industry carry out technological change are considerably different from those of their large counterparts.

First of all, firm size itself seems to impose some `direct' constraints on the capacities of firms to acquire and develop technologies. It was found that the absolute size of R&D often limits the development of new technology products like NC machines by small and medium firms, even if the relative intensity of R&D investment by small firms is rather higher than that by large firms. Moreover, there are economies of scale involved in doing R&D and in utilizing its results. Because of their diversified product lines, large firms can not only pool their various know-how and R&D resources and organise them more efficiently, but also exploit R&D results for a larger volume of production and for different purposes (i.e. products). Size also benefits large firms as regards external communication and marketing: their vast domestic and overseas marketing networks, for instance, allow them easy access to information on markets (both domestic and foreign), technology and government policy measures, which is crucial for successful technological innovation; such networks are also a major advantage in establishing product brands and providing quick after-sales services, thereby facilitating the marketing of their new products.

Secondly, as far as the labour market is concerned, it seems true that large firms have better access to a superior labour force in terms of education, skills and experience. Employment stability is also generally higher in large firms. However, in contrast to the conventional dual labour market hypotheses, jobs within large firms are not characterised by higher wage rates and shorter working hours. Our analysis revealed that the apparently higher wage levels in large firms stem mainly from their longer working hours (especially, longer `overtime'). Nevertheless, large firms have many attractions other than wages and working hours: they provide better employment conditions in terms of job security, opportunities for training and advancement, welfare facilities and fringe benefits, work environments, etc. We confirmed many of these in our comparison of the internal labour markets in large and small firms. It was probably the large firms' stronger financial and market power which made possible their better employment conditions. And such power also basically determines the capacity to recruit employees of high quality, but also of high wage levels, like engineers and technicians.

On the other hand, different employment patterns seem to be partly a product of different market strategies. The competitiveness of small and medium firms is based on product prices, so their main emphasis may have been placed on low wages rather than on product quality and technological innovations. In consequence, they have kept their labour costs as low as possible and have recruited only a minimum number of technically qualified employees. In contrast, large firms, focusing on products of higher quality and price, have had more need to recruit (and train) technological manpower of the best calibre and to upgrade the skills of production workers. These different employment strategies are clearly reflected in the marked differences in the source and method of recruitment of technological manpower between the two size groups: while large firms tend to recruit new graduates largely by `public notice' (i.e. free competition), small and medium firms depend on `personal connections' or just on the internal promotion of their existing employees (Table 5-3 and 7-6 before). There are a fewer differences between the two size groups in the case of the recruitment of production workers.

So large and small firms not only select qualitatively different manpower via different sources of recruitment, but also manage them with different systems of training, promotion and incentives. As a result, their labour forces tend to have and to acquire different levels and types of technological capabilities. But, in turn, the different technological levels and requirements of large and small firms also tend to reinforce such differential access to the labour market and to make their job characteristics more divergent from each other. Consequently, there is a strong tendency towards labour market segmentation between large and small firms, and it is might be called a `dual labour market' in the Korean machine tool sector.

Thirdly, one of the major disadvantages of small and medium firms resides in the capital market. We have shown that they are disadvantaged in virtually all of the aspects which we reviewed with regard to the capital market; the diversity of financial sources, access to credit, and internal financing capability. The consequent financial difficulties of small and medium firms seem to have severely restricted their capacity to invest in technological development and have also influenced their pattern(s) of technological change.

It was also noted though that such financial disadvantages of small and medium firms were not merely the result of the working of the capital market itself. The government has had virtual control over all the major banks in Korea, and has used them as the most powerful means to pursue the aims of its industrial policy. Our examination of the role of the government in the allocation of credit to firms of different sizes revealed that, though the situation has improved for small and medium firms since the early 1980s, access to some important policy loans (e.g. export loans, foreign currency loans, etc.) is still dominated by large firms. Also, benefits from the recent policy changes tend to be confined to medium- sized firms rather than to have spread into the majority of smaller firms.

There seems to be a close relationship between a firm's financial capability and its scale and form of technological development. Since large firms are clearly superior in both internal and external financing, they tend to concentrate on formal and relatively major

types of technological change in comparison with small and medium firms. External finance is crucial for small and medium firms for relatively big technological projects which are beyond their own internal financing capability. Therefore, only medium-sized firms with access to bank credit can initiate such projects, while most small firms without such access have to be content with informal and minor innovations funded by their own limited funds.

Fourthly, in the product market too, large and small firms face different environments in several respects. Generally speaking, Korean machine tool firms still depend largely on domestic rather then export markets, and specialisation between large and small firms remains at low level. But it can be said that large firms are relatively more export- oriented and produce more expensive and technology-intensive items (e.g. CNC products) in comparison with small and medium firms. Since the entry of large firms into the industry in the mid-1970s, sales by large firms have grown faster and more steadily than those by small and medium firms. Consequently, the level of demand, its growth rate, stability and prospects are all superior in large firms. However, this faster and steadier growth in demand has been achieved in part simply by sacrificing the existing small and medium firms rather than by creating and extending new demand. Though many small firms have survived either by keeping their product prices low or by specialising in items with small markets, the existence of large firms seems to be both an ever-present threat and a barrier to entry to certain product markets.

As regards degrees of competition, large firms tend to feel stronger pressure of competition than small and medium firms in domestic markets. This is probably because they not only compete in conventional items with small and medium firms whose products are more price-competitive, but also compete among themselves in high technology products where technological change is very dynamic. But there is little difference between them in export markets, where both of them recognised similarly high (i.e. higher than in domestic markets) degrees of competition. Since the large firms are more dependent on exports, they seem to be under a stronger degree of `overall' competitive

pressure than small and medium firms.

In our analysis on the relationships between market variables and technological performance, we found positive correlations between demand size and technological innovation, between unit price and technology imports, and between export ratio and new product developments. However, these correlations are likely to represent reciprocal relationships rather than causal ones. Though degrees of competition also showed some significant correlations with technological variables, the relationship is quite complex and often contradictory between large and small firms. All we can say is that there is no uniform correlation between degrees of competition and firms' technological efforts.

Fifthly, the state has heavily involved in shaping the structure of the Korean machine tool industry, but access to the benefits of state policy have been uneven to firms of different sizes. The most significant government intervention in the industry started with the Basic Development Plan in 1977, which had precipitated the entry of several large conglomerate firms into the industry. These new entrants received very generous financial, tax and other privileges, and become the greatest beneficiaries of the Plan. In consequence, the years 1977-1978 became defacto the turning-point of the industry, in that not only did the scale of production dramatically increased but also the initiative of the industry decisively shifted from the existing small and medium firms to the newly entered large firms. Although the main focus of government intervention in the industry has continuously changed, according to the evolution of the industry, its emphasis on the leading large firms seems to have largely continued.

Government policies specifically focused on technological development have had some direct influence on the motivation and capacities of firms for technological change. The government has stimulated and assisted the technological efforts of machine tool firms in various ways such as financial and tax incentives, assistance by public R&D institutes, information services through various government-related sources, protection and promotion of locally developed machines and so on. In these measures,

government policy has favoured neither large nor small and medium-sized firms. And through its specific policies for small and medium firms, the government has increased its support for small and medium machine tool firms since the early 1980s. So the initial bias in government policy, which favoured large firms, has been more or less redressed. But it is doubtful whether the bias has really disappeared and whether the present support for small and medium firms is sufficient to correct the adverse consequences of the earlier bias. Also, present policies towards small and medium firms tend to benefit only relatively small numbers of medium-sized firms, while most small firms are still excluded.

Lastly, large and small firms seem to have considerable differences in their internal social organisation. In theory, many characteristics of the internal organisation of small and medium firms are alleged to be more conducive to technological innovation. However, in our analysis we found no firm evidence to support this. It is true that small and medium firms have top management with better technological education and experience and that they also have less bureaucratic organisational structures. But it is doubtful whether their top managers are more innovation-oriented or have more interest in technical training of employees than their counterparts in large firms. Moreover, the quality of their internal communication and co- operation, and of their labour relations, both of which are thought to be important for successful innovation, did not turn out to be better than those of large firms. Thus we think small and medium firms in the Korean machine tool industry have failed to promote and exploit many advantages in internal organisation which are often associated with small firm size. Also, the literature which argues these advantages need to be more critically examined in the future.

Having specified the major findings from the previous chapters, we are now in a better position to think about the different technological performances of large and small firms in the Korean machine tool industry. It seems clear that the various sources of their different technological performances are not independent from each other, but have certain causal or reciprocal relationships among themselves. We have touched

upon some of them already. For instance, access to the labour market (including employment stability) tends to differ between large and small firms mainly because they have different financial and market power. This different financial and market power of large and small firms, in turn, is not just a natural result of the operation of the law of economies of scale but, to a considerable extent, a consequence of heavy intervention by the state. To inquire into all of these relationships would require an enormous amount of data and complex analyses which go beyond the original intent of this study. But it seems possible to point out some of the key causal linkages involved.

In our view, there are at least two main forces at work which run through, and predominate over, the causal processes which bring about differences in technological performance between large and small firms. They are `firm size' and `state intervention'. Although other sources also exert their influences on the processes to some extent and seem to have their own dynamics of change, they can be said to be preceded by and also largely conditioned by, those two dominant factors. For example, a firm's access to the labour market or the capital market tends to be, first of all, significantly constrained by its size. But the state can also intervene in such markets with a bias which significantly alters the firm's access to them. If these accounts are correct, then a question naturally arises: which one has played a more important role in the case of the Korean machine tool industry ? Very different policy implications follow depending on the answer to this question. If size itself has been the main determinant, then the different technological performances of large and small firms have mostly been inevitable, and in a sense even desirable because they are just a consequence of economies of scale. However, if a bias in state intervention has been more important, then the present technological gap between large and small firms is largely an artificial one, and the technological performance of small and medium firms has been unduly suppressed by such policy bias. This issue can be located within a broader problem of the growth gap between large and small firms in the Korean economy at large and its consequent rapid industrial concentration, which has aroused vehement debate for a considerable period of time in Korea not only among

policy-makers and the business community but also among various academic circles. According to different interests and political positions, two broadly contrasting explanations have proposed: one stresses economies of scale, the other policy bias. We will briefly discuss each of these explanations and attempt a critical assessment of their relative validity in the light of our case study findings. This will be used as the cornerstone of our final model to explain different technological performances of large and small firms in the industry.

12-2. Firm size versus state policy

12-2-1. two explanations

Since the early 1960s Korea's rapid economic growth has been accompanied by an equally rapid concentration of economic power.[1] In particular, a small number of large business groups (i.e. *jaebuls*) have grown faster than any other part of the national economy and have thus occupied an increasingly dominant role in it.[2] Different explanations have been suggested with regard to the cause(s) of this rapid economic concentration. Jones(1980) describes two typical, and contradictory, versions of them:

(1) The conservative version: (the economic concentration is largely) " a natural result of the economic process itself. Korea has modernized rapidly. Economic

1 A comparison of changes in the shares of small and medium firms between Korea and Japan may be a good example to illustrate this point. The following Table shows such a comparison in manufacturing sector.

(unit : %)

Country	Year	Establishments	Employees	Shipments	Value-added
Korea	1963	98.5	62.4	56.0	49.8
	1983	97.4	54.3	34.7	37.5
Japan	1963	99.4	69.4	50.3	53.3
	1980	99.5	73.4	52.1	56.9

Souce : KFSB,1985,p.20.

2 For example, the share of shipments by 30 largest *jaebuls* in the manufacturing sector increased from 34.1 % in 1977 to 40.7 % in 1982 (Son, 1987: 431).

modernity means taking advantage of economies of scale in technology, organization and marketing. Rapid growth means rapid structural change from small primitive production and marketing units to large modern units. It also requires placing resources in the hand of those entrepreneurs who have proven themselves most capable of survival in the international arena. The rapid rise in business concentration is thus merely one inescapable facet of Korea's transformation from a primitive economic structure to one which is modern and internationally competitive. If Korea is to continue to grow then this process must not be attentuated by the facile egalitarian notions which have contributed to stagnation and continued poverty in many LDCs. It is of course essential that efficient small and medium entrepreneurs be given the opportunity to grow, but this is already insured by existing policies and institutions." (pp.1~2) ;

(2) The radical version: (the economic concentration is largely) "the result of a circular political-economy process. Economic size means economic power and influence on the government's resource allocation decisions. This in turn means greater size, greater power, and still greater influence. Most importantly, large groups have disproportionate access to large volumes of subsidized credit, allowing them to generate subsidized profits. These are then plowed back and, with the multiplier effect of a high debt/equity ratio, form the basis for still more credit, growth and profits. One result is economic inefficiency, as resources are diverted from more productive uses. In addition, there are detrimental social and political effects as income distribution is adversely affected and as economic power begets political power." (ibid.).

As is suggested above, while the conservative version derives the cause of the rapid economic concentration in Korea from the comparative advantage of economies of scale by large organisations, the radical version attributes it to the greater political influence of large organisations on government decisions on the allocation of resources (especially, credit). How do these two explanations relate to our own subject, and how can we assess their relative validity in the light of our findings ? Of course, the two explanations cannot be directly applied to our case, not least because economic concentration is, needless to say, not identical to unequal technological performance among firms and may thus stem from significantly different causes. But, without confounding these two

different problems with each other, it may nevertheless be possible to identify two parallel contrasting explanations similar to the ones above. This is not only because a firm's growth is not a phenomenon totally separated from its technological performance, but also because the different environments of large and small firms in the Korean economy will be common in both cases. Therefore, we can assume that, among the two main forces which seem to determine the technological performances of large and small firms, advantages (or disadvantages) inherent to firm size would be emphasised by the conservative position, while bias in state policy in favour of large firms would be more stressed by the radical one. Which one is closer to our evidence?

Let us trace back some of our earlier findings to answer the above question. First, we have already ascertained that firm size and state policy both `directly' influence firms' technological performances. While firm size seems to have exerted such influences through, for instance, absolute R&D size, economies of scale in R&D, and organsiational advantages in external communication and marketing, state influence is through technological policies concerning direct technical assistance to private firms, and, in particular, those services provided by various government- controlled R&D and training institutions. We found that in these specific policies bias against small and medium firms has been relatively weak. So, limiting our judgement to direct influences only, firm size seems to have been more important than state policy for bringing about the different technological performances of large and small firms. However, direct influences are likely to be less important overall than indirect influences. These are exerted through their effects on third factors like the labour market, the capital market, product market structure and firms' internal organisation. Therefore, a more comprehensive assessment of the relative significance of firm size and state policy needs to rely on a comparison of their effects on third factors. Both of firm size and state policy can heavily influence such factors.

So how are we to decide which one of the two has been more influential in this context ? Again, there seems to be no way to decide this by relying on quantitative methods, because it is not plausible to measure the extent of influences by firm size and

state policy at the firm level. Accordingly, any judgement in response to the above question will inevitably be of a speculative nature. We suggest the following approach as a practical way of handling this: since the extent of bias in state policy seems to be uneven among different areas (e.g. manpower policy, finance policy and so on), it may be better to distinguish between those areas where state intervention has been heavily biased and those where it has not. Where policy bias has been weak, differences between large and small firms must be sought from factors other than state policy, possibly, firm size. In this way, we can at least confirm whether or not `policy bias' deserves as comparable a position of causal significance as `firm size'. Moreover, in doing this, we can illuminate the interrelationships between state policy and various other third factors.

12-2-2. connections between policy bias and third factors

Let us start with the labour market. Although we mentioned little about state intervention in the labour market, this was not because the state has not played an important role in this area. The state is actually deeply involved in labour markets through its education and labour policies. Two kinds of state involvement can be identified: on the one hand, the government has actively fostered the education and training of technological experts and a skilled labour force to meet the growing demand from private firms for qualified manpower in the process of industrialisation[3]; on the other hand, it has controlled wage levels, to keep labour costs low in industry, by regularly suggesting guidelines on wage increases to firms and by harshly suppressing union activities by workers. Such state intervention in the labour market has played

[3] In particular, since the launch of the Heavy and Chemical Industry Promotion Plan in 1973 (see Chapter 4), the Korean government has drastically expanded the capacity of college and post-graduate programmes with special emphases on mechanical, chemical, electrical and electronics engineering. Also, qualified personnel were recruited from expatriate Koreans abroad who were employed in university, industry and research institutes in developed countries. See Park (1987) for technological manpower policy.

a significant role in upgrading the technological capabilities of private firms and also influencing their motivation for technological change through control of wage levels. However, there doesn't seem to be any particular bias against small and medium firms in this respect. Of course, we can point out that government's manpower policy tends to have been focused on fostering technological and skilled manpower of the fields required mainly by large firms and that its application of labour law is relatively stricter to large than to small and medium firms. Nevertheless, these are not likely to stem from any intentional bias regarding firm size, and also have little direct impact on the different labour market conditions of large and small firms. Therefore, we think the latter have not resulted from any explicit bias in state intervention in labour markets. However, we do not think they are thus purely a result of differences in firm size. A firm's labour market conditions tend to depend on its financial and market power and its internal social organisation rather than the other way round. So if policy bias is evident and plays a significant role in these latter aspects, we cannot say that the different labour market conditions of large and small firms are simply due to size difference . Thus we are now turning to such other aspects.

Let us consider the aspects of financial and product markets together. These are, in fact, the areas where state intervention has been most prominent in Korea. The machine tool industry in particular has received heavy protection and promotion by the Korean government as a strategic industry (see Chapters 4 and 10). Accordingly, the industry is characterised by a heavy state intervention in the financial and product markets corresponding to the industry. But as saw in Chapter 8, the industry is also characterised by a relatively strong bias in the way the state intervention has intervened in such markets. For instance, the focus of government policy when it first intervened in the industry in earnest (i.e. circ. 1977) was on inducing large conglomerate firms to enter it by providing them with large-scale preferential credit, tax privileges and other incentives. This was possible because all the major banks were virtually under the government's control. The intervention was very product-and firm-specific, thereby

enabling newly entered large firms to dominate in new and promising product markets while limiting the existing small and medium firms to their conventional product lines. Large firms penetrated into these latter markets however, because protection measures for small and medium industries were then minimal. Consequently, large firms' dominance in the industry could be easily consolidated by heavy government support like above. Only since the early 1980s have some serious efforts been made to redress such bias in policy and promote small and medium firms. The earlier strong bias in government policy on the industry is now much corrected. However, support for large firms may now be less important given their dominant position. In fact, their present advantageous conditions in product markets, e.g. large demand size, bigger market share, dominance in NC markets, etc., can largely be seen as the results of past policy support. Moreover, as we pointed out in Chapter 8, they still enjoy the dominant share of some major policy loans such as export loans, foreign currency loans, the Korea Development Bank loans, etc. It looks as if it is only in those financial and market supports `directly connected with technological development' that small and medium firms are more or less favourably treated. So, though it may be weaker than before, the bias in credit allocation by the government seems to have far from disappeared.

The last aspect we have to think about is firms' internal organisation. Is there state intervention here as well? And if there is, is it also biased towards large firms? It is clear that the state has exerted influence on several aspects of firms' internal organisation. Above all, by tightening control on union activity it considerably strengthened the power of management vis-a-vis that of employees and has thus affected the decision-making style and work climate within firms. It has also been directly involved in resolving labour disputes on behalf of management, mainly by using police force. The state also has stimulated management's innovative-orientation through industrial and technology policy, and has encouraged and assisted firms in introducing QC circles into their work organisation. In all of these measures we found little bias either for or against any particular size group of firms. Though their effects may be uneven among firms, those measures are applied to all firms without discrimination. Therefore, the differences in

internal organisation between large and small firms do not seem to stem from state policy. In our view, many of these differences originate in size differences and differences in the origins and age of companies. But they may in part to also be influenced by different conditions in product and factor markets, which tend, as we mentioned above, to be more susceptible to biased state policy.

To sum up, we have established that bias in state policy is significant in financial and product markets, less significant or non- existent in labour markets and firms' internal organisation. Financial and product markets occupy a causal position of greater importance compared with labour markets or firms' internal organisation. Therefore, bias in state intervention in financial and product markets seems to have had a far-reaching impact on the broader environment for technological change in large and small firms. So, although there seems to have been no direct bias in state intervention concerned with labour markets and firms' internal organisation, the different conditions of large and small firms in these aspects cannot be said to be free from the impact of policy bias in its overall context. This implies that if there is a significant change in policy bias concerned with financial and product markets, the different labour market and organisational conditions of large and small firms will also change to a considerable degree.

What the above discussion confirms for us is that the role of state policy seems to be more significant than would be admitted by those who attribute the superior technological performance of large firms purely (or predominantly) to size advantages. Does this mean that our analysis can be seen to validate the radical version rather than the conservative version of the two contrasting explanations we mentioned earlier? Not necessarily so. This is not because we still do not know which one, firm size and policy bias, has been more important although we certainly do not have a clear answer yet. Ultimately, such an answer must be sought in the particular relationship between firm size and policy bias in the specific country concerned. In fact, the fundamental difference between the conservative and the radical explanations is not that they each stress one of

its two determinants, but rather that they hinge on the contrasting perceptions of government-business relationships. The conservative version posits no direct connection between firm size and policy-making, while the radical version takes the position that firm size (and its implied economic power) greatly influences the nature of state policy. This means that conservative commentators would argue that even if there is any policy bias then it stems from the rational consideration of resource allocation by policy-makers (e.g. "for the benefit of the economy as a whole in the long- term", etc.), while radical commentators tend to ascribe such bias to political connections between policy-makers and large firms(especially, *jaebuls*). Therefore, although it is true that the conservative commentators usually belittle the importance of bias in state policy, the mere existence of policy bias is not sufficient to disprove their argument and support the radical explanation. The ultimate judgement depends on whether the political connections the latter suggest exist and whether they are the source of policy bias in favour of large firms. According to the answer to this question, our explanation of the different technological performances of large and small firms will also end up with very different concluding models. So, finally, we will briefly discuss this issue.

12-2-3. the issue of government-business relationships in Korea

Among those Korean people who are critical of the relationship between the government and large conglomerates in Korea, the notion `jungkyung yoochak' (political-economic adhesion) has been much in vogue for describing the reciprocal, and allegedly corrupt, character of such relationships. The following statements are good examples which summarise the ideas contained in the notion:

> "(large conglomerates) accumulated capital mainly through such "non-rational" processes as speculation, price-fixing, tax evasion, and taking advantage of cumulative inflation. More crucial to this process, however, was that they played on political connections to gain economic favors in exchange for political contributions." (K. Kim, 1976: quoted in Jones & Skong, 1980: 269);

"Many opponents of the Government claim that the conglomerates receive political favours, engage in monopolistic practices and oppress their workers. The companies complain that they are forced to pay "voluntary contributions" to the Government which amount to half their total tax. This system causes serious distortions in company earning, where profits are doctored to minimise tax liability. Managers say that if a company chief refuses to go along with a government proposal, he is likely to receive a thorough audit from the tax inspector." (*Financial Times*, 3 December 1987).

Despite the 10 year time-interval between these two observations, the main features described by them remain unchanged. The conglomerates are seen to receive special economic privileges as a reward for their political contributions. And because of this intimate political nexus and their access to powerful government officials, they are seen to be able to exercise disproportionate influence over policy-making and its implementation in a way which is most favourable to them. In this system of `jungkyung yoochak', policy bias is thus inevitable. How much is this true?

Jones & Sakong (1980) offer an important contribution to the study of the relationship between government and business in Korea. Though they did not specially focus on the problem of firm size, their study provides many insights into related topics, e.g. the influence of business on government decision-making, the sources of business concentration and so on (see ibid., chapters 3 and 8 in particular). As far as the degree of influence on government policy is concerned, it seems true that large firms are, in general, more influential than small and medium firms as their survey results show (see Table 10 in p. 74, ibid.). To test the validity of this finding in the machine tool industry, we used the same question in our survey: "To what extent can you (or your company) influence government policies affecting your business?" Responses are summarised in Table12-1 next.

As is shown in the Table, large firms believe that they have more influence than small and medium ones. This is consistent with Jones & Sakong's results, where the

two groups also show a statistically significant, though not big, difference. So we can conclude that unequal influence on government policy according to firm size exists also in the machine tool industry.

Table 12-1. Degrees of business influence on government by firm size

	All firms	Large firms	Small firms
a. % distribution to response scaling :			
" 1= can get anything	**0.0**	0.0	0.0
2= can frequently affect	**9.1**	12.5	7.1
3= can sometimes affect	**40.9**	62.5	28.6
4= seldom affect	**31.8**	25.0	35.7
5= affect not at all "	**18.2**	0.0	28.6
	(100.0)	(100.0)	(100.0)
b. mean scores	**3.52**	3.13	3.86
c. significance of difference (Mann-Whitney test, two-tailed)		*P<.10	

Where does the greater influence of large firms on government policy come from? Is it mainly due to their superior political connections, especially through political contributions, as the exponents of `jungkyung yoochak' argue? This is a difficult question to answer, because of the inherent difficulty of empirical investigation into such a matter. But there are some positive, though not solid, grounds to affirm, at least partly, the role of political connections. As Jones & Sakong (ibid.) acknowledge, extensive interaction between government and business in the process of policy-making is facilitated by the network of close personal ties of bureaucrats and businessmen rooted in school, region, or family, and also by the interchange of personnel between the two sectors (especially, the recruitment of ex-civil servants into companies). Furthermore, it is hard to deny the existence of the covert practice of political contributions as is described by the earlier quotation from the *Financial Times*. Intermittent economic and political scandals may have exposed only the tip of the iceberg.[4] In addition, there are also other important sources of influence possessed by large firms, though these cannot be necessarily called `political' connections in the

[4] For illustrative cases, see the case of Yul San Group as an example in the 1970s (L. Jones, 1980: 79-99) and several similar scandals in the 1980s summarised in the magazine *Shin-dong-a* (January 1988).

above sense. For instance, the dominant positions in most of the influential business associations are virtually monopolized by representatives of large firms. Among them, the Federation of Korean Industries (FKI), the Chamber of Commerce and the Korean Traders Association (KTA) are especially powerful. Also, there are a plethora of industry-specific associations which represent particular industries, like KOMMA and KOSAMI in relation to the machine tool industry. We already pointed out in Chapter 10 that in these latter organisations large firms play a dominant role. The Korea Federation of Small Business is the only industrial association which specifically promotes the interests of small and medium firms. Though the dominance of large firms in these business associations does not necessarily mean that they represent only (or mainly) the interests of large firms, it is likely that they become a vehicle to transmit their particular needs and to provide opportunities to form rapport with government officials, (which in turn can be a future source of their influence). More importantly, such business associations do not operate in isolation from personal and political connections such as those mentioned above, but in fact utilize all these connections and are shaped by them. Here lies the reason why the role of the business associations cannot be thought to be purely economic. In short, therefore, it seems likely that the influence of large firms on government policy stems to a considerable extent from their intermingled political and economic power, if not from strictly political connections.

The evidence suggested above *appears* to justify, by and large, the theses of `jungkyung yoochak'. However, the above features obscure one fundamental characteristic of the political economy of Korea, without which much understanding of the cause(s) of policy bias will be superficial and misunderstood. As Jones & Sakong (ibid.) point out, while Korea is similar to Japan in that rapid economic growth is led by a strong partnership and close ties between government and business, one decisive difference is that in Korea the dominant partner is unequivocally the government, whereas in Japan the reverse may be closer to the truth. The reason for this difference seems to come, according to Jones & Sakong (ibid.), from differences in political structure.

While, in Japan, ascension to the higher political and government positions requires success in electoral politics, which in turn depends heavily on the funding and support of business, the Korean regime (both Park's and Chun's) has its original, and ultimate, power base in the military. Therefore, the government is not dependent upon the political support of business, although it relies on the latter for economic success, which is desperately needed to get the legitimacy for the regime. And since credit allocation through banks is under the virtual complete control of the government, the subordinate position of business is inevitable, given the latter's high debt/equity ratio.[5] The following description by Jones & Sakong summarise the situation: "In Korea, the business community could dismiss Park (i.e. the former government: our addition) only by shutting down operations and ruining themselves in the process. Conversely, the Korean government can ensure the failure of any businessman, should it care to do so,"(ibid.: 68). To express this in a more theoretical vein, the `state autonomy', a concept on around which much of the current debate about theories of the state has been developing[6], seems to be great in Korea. Thus, when we consider government-business relationships in Korea, we must first recognise government dominance over the business community and thereby avoid the danger of overestimating business influence on government policy. In fact, this asymmetrical relationship between the state and the private sector also seemed to be reflected in Table 10-1, in which only limited overall influence on government policy is reported by our sample firms (see the % distribution figures according to the extent of influence: "frequently", 9 % ; "sometimes," 41 % ; "seldom", 32 % ; and "not at all", 18 %).

So, to explain policy bias by using the notion of `jungkyung yoochak' becomes quite

[5] The average debt/equity ratio of Korea's 50 major business groups was 462 % in 1984, whereas it is normally about 100 % in advanced countries (see Management Efficiency Research Institute, 1985).

[6] There are various positions on the existence and extent of state autonomy among Marxist and non-Marxist theories of the state. For main lines of arguments among these different theoretical strands, see M. Carnoy(1984), T. Skocpol's article in Evans,Rueschemeyer and Skocpol(1985), and R. Miliband(1984).

shaky. Even if the influence of large firms is proved greater than that of small and medium firms, and a considerable part of the former's influence actually comes from their political connections, this cannot be proof that they are thus responsible for policy bias. If the main direction of influence runs from the government to business rather than the other way round, and the predominant interest of the government in the private sector lies in its economic performance (i.e. rather than its political support), then there is no logical reason to deny that policy bias has come from purely economic considerations to maximize performance. Although it is certain that there is widespread practice of political contributions, especially at the election times, this has also taken "the form of an unavoidable political tax levied by a powerful incumbent, rather than a discretionary contribution that imposes obligations on the recipient." (Jones & Sakong, ibid.: 68). This, however, does not mean that political contributions lead to no influence on policy-making, but that it is better to regard them as `thanks' for policy support rather than `encouragement' to make particular policies. Our earlier quotation from the *Financial Times* seems to confirm this. If it is the case, then policy bias must be explained by factors other than political contributions and favouritism. In our view, it is more accurate to see it as a result of the government's strategic decisions based on its autonomous power rather than as reflection of the greater political influence of large firms.

There was actually an objective background to the emergence of policy bias in the process of Korean industrialisation. From its beginning in the early 1960s the former Park regime was committed to economic growth, regarding it as the key to both national political survival and to Park's own political survival. The first priority of government policy in the early stage of industrialisation was the maximisation of growth rate, as was expressed in the well-known tenet of `growth first, distributions afterwards'. Given the condition of poor resource endowments (except labour force), the logical conclusion of this policy was to concentrate resources into selective industries regarded as maximising export and growth, and thus to prioritise large rather than small firms on the grounds of international competitiveness and economies of scale (K. Lee, 1987). This basic orientation of government policy largely continued as the strategy

of economic development until the 4th. 5-year Economic Plan (1977-81). It is only during the 1980s, i.e. under the Chun regime, that some serious measures to support small and medium firms have been taken, as we pointed out in chapter 8. In fact, this recent change in policy emphasis is also a good example of the autonomous character of government decisions on economic matters. If the superior political influence of large firms had determined policy bias in favour of them, such a change would not have occurred, since the economic role and power of large firms (especially, *jaebuls*) has grown steadily throughout the 1970s and 1980s. This suggests that the strong autonomy of the Korean state could not only create policy bias, but also allow it to be redressed. Such state autonomy has one clear limit; in both cases, the government must prove that its policy promotes economic growth. Otherwise, the legitimacy of the policy, and of the government itself, will rapidly come into question. Thus the state autonomy seems to operate in both ways: on the one hand, it enables the government to freely devise policy measures regarded as the most effective to promote growth and on the other pressures it to prove the validity of such measures by ensuring the economic success of the private sector. In this sense, state autonomy in Korea is not unrestrained but is fundamentally bound to serve economic growth, not only in policy-making but also in policy implementation. Therefore, although it is true that lobbying is important for firms to get access to privileged support from the government, the latter's decisions do not necessarily depend on political contributions or other informal influences by firms rather than their real competence. Resource allocation by the discretion of the government may be discrepant with the principle of free market competition, but it is not arbitrary: it involves a kind of competition in which firms are selected on their own merits by government's judgement. So government judgement can be said to have replaced the role of selection by the market. However, our point here is not to argue that government decisions are necessarily rational. We simply want to show that policy bias can be (and has been) a result of the government's autonomous judgement, on the best ways to promote economic growth rather than a result of political influence from

outside. In its process of decision-making, the government has actually made many mistakes: for instance, one result of its overemphasis on growth rates and economies of scale had been overcapacities in some sectors and too high industrial concentration. The possibilities of such mistakes in its judgement and decision-making are of course increased by the existence of imbalances in political access by different economic groups, e.g. large and small firms. In this case, political connections may be partly responsible for policy bias. Nevertheless, they cannot be thought of as its ultimate cause, in that they could not change the dominant position of the state and its strong commitment to economic growth. If these latter conditions continue, policy bias is likely to stem mainly from the government's own prejudice rather than from political favouritism. To explain policy bias of the Korean government, therefore, differentiating the role and extent of state autonomy from sectional economic interests seems to be essential.

In conclusion, we have a rather mixed answer to our original question. First, we have rejected the `conservative' argument that attributes the different technological performances of large and small firms purely to the operation of economies of scale. We suggested several examples to show that state policy has been biased in favour of large firms in major areas of its intervention and argued that such bias has been crucial to generating the gap in technological performance between large and small firms. This has not, however, lead us to agree with the radical explanation which links policy bias to the greater political influence of large firms. Though we recognise large firms have superior political connections and lobbying power to small and medium firms, they have actually had little influence on state policy as the Korean state has successfully maintained a strong state autonomy. For this reason, we regard policy bias as stemming mainly from the government's own decisions, e.g. their emphasis on economies of scale (i.e. "the bigger, the better"), etc., rather than from particular political connections. Nevertheless, this does not deny the importance of intimate contacts and connections with policy- makers for business success in

Korea. Far from it. Those contacts/connections are indispensable to get access to various kinds of policy support for private business. But all this indicates is simply the subordinate position of business vis-a-vis the government, not that policy- making itself is vulnerable to such outside influences. In addition, influence alone can not secure access to policy support: firms must show they are viable, and prove it by achieving good economic performance (e.g. exports) to receive continuous support. This may be one of the main reasons why large firms are sometimes seen to make high technological efforts even when there do not seem to be strong competitive pressure to do so.

Since the dependence of business on the government is so high, there are always dangers such as the abuse of discretionary power by certain state officials and/or the excessive protection and promotion of some private business. In this regard, it is a matter of debate whether the bias in state intervention found in the machine tool industry was necessary and rational in terms of the economy's as well as the industry's dynamic and long-term development. This issue will be pursued further in the next chapter when we discuss the policy implications of our study.

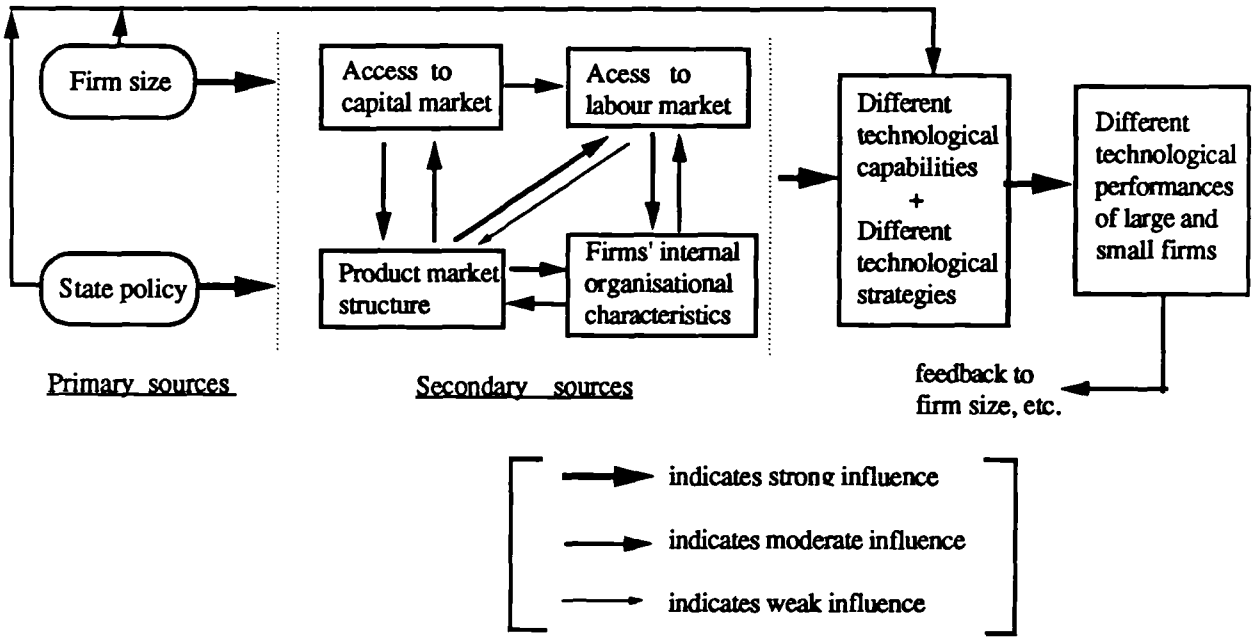
To sum up, our conclusion is that, of the two key possible reasons for the different technological performances of large and small firms in the Korean machine tool industry, policy bias seems to be as important as economies of scale, and it is not attributable to different political influence based on firm size, but is, rather, derived from state autonomy. Therefore, size and policy bias should be treated as relatively independent when we explain the causal relationships among various sources of the different technological performances of large and small firms.

12-3. A final explanatory model

Through the above discussion we are now able to suggest some outlines of the causal relationships which lead to the different technological performances of large and

small firms in the Korean machine tool industry. We summarise such outlines in a diagrammatic form in Figure 12-1 below.

Figure 12-1. A model on the sources of firm size differences in technological performance in the Korean machine tool industry



We have already described most of the relationships indicated, so we will only mention the points which constitute the main features of the model. First, it seems reasonable to distinguish between `primary' and `secondary' sources according to causal order and significance among the various sources we have hitherto reviewed. Firm size and state policy (or, rather, bias in it) are primary causes, because, between them, they seem to determine the whole process which brings about the different technological performances of large and small firms. Both of them have significant influences on other, `secondary', sources which are more immediately responsible for such different technological performances. But these latter sources are, of course, not wholly determined by firms size and state policy, but respond to other idiosyncratic influences, too, thereby having their own dynamics. Secondly, the two primary causes thus have two kinds of influences on firms' technological performances: `direct' ones involving either

pure size constraints on R&D or access to government technological services; and `indirect' ones which are exerted through `secondary' sources. Though it's difficult to determine statistically, we consider that the importance of the latter exceeds that of the former. This is because large and small firms show especially significant differences in their factor and product market conditions. Meanwhile, as far as the relationship between firm size and state policy is concerned, we found that they were relatively independent of each other, in the sense that the direction of policy was not determined by the influence of firm size. (Conversely, we can of course suppose that policy bias favouring large firms would result in a further gap in firm size. But it is absurd to assume a direct link in such a direction, because state policy does not directly determine size of private firms). However, thirdly, in their influences on `secondary' sources, and hence on technological performances, it is hardly possible to distinguish the effects of firm size from those of state policy. We can only suggest that policy bias was particularly prominent with regard to capital and product markets. Since these latter aspects are in positions of higher causal importance among `secondary' sources, the overall significance of policy bias is not likely to fall behind that of firm size itself. In any case, in the situation where policy is biased in favour of large firms, there can be few pure economies of scale which are clearly separable from policy effects. Therefore, an approach which emphasises either of these two factors is not relevant. We must recognise and focus on the interconnected influences of both on the different environment of technological development of large and small firms. Lastly, all these interconnected and mixed influences stemming from the primary and secondary sources make the `capabilities' of large and small firms to acquire, generate and use technologies different. Because of these influences and because of their different technological capabilities, they tend to take up different `strategies' of innovation and technological change. Large firms tend to rely on formal technology imports and relatively major (i.e. expensive) innovations, while small and medium firms rely on minor and informal innovations through copying, adaptation and so on. In consequence, they show

different performances in terms of patterns as well as rates of technological change. And, finally, these different technological performances affect, of course, their productivity and hence competitiveness in the market, with the latter's accompanying consequences for changes in firm size.

Though only very sketchy, the above model seems to describe concisely the causal mechanisms concerned with all the major sources of the different technological performances of large and small firms in the Korean machine tool industry. If the model is correct, it seems to suggest some interesting theoretical and practical implications on the subject of firm size and technological development in a developing country. We will discuss these and other implications to be drawn from our study in the next, concluding chapter.

Chapter 13
Conclusions

13-1. Theoretical implications

The original purpose of this study was to improve the present conceptualisation of technological change in the Third World by introducing the hitherto neglected dimension of firm size. We expected that this would also enrich the literature on firm size and innovation with findings on the peculiarities of the Third World expeience. Through this case study on the Korean machine tool industry, we have so far focused on identifying the different technological efforts and performances of large and small firms and on explaining the sources of such differences. In doing this, we intended to enhance, in particular, our understanding of the determinants of inter-firm differences in technological performance in a developing country. The theoretical implications which emerge from this analysis can be summarised under three headings: firm size and technological performance; size advantages and disadvantages in technological change; and the connection between firm size and state policy. We will briefly comment on each of them.

1. firm size and technological performance

To understand appropriately the processes and performances of technological development by firms of different sizes, it was essential to differentiate between the diverse forms of technological change typically conducted by firms in Korea. Our typology of technological change ((i) introduction of capital equipment embodying new technology; (ii) import and absorption of foreign know-how; (iii) imitation, adaptation and improvement of foreign products; (iv) new invention and innovation) enabled us to confirm clearly the fact that large and small firms show differences not only in the rate and pattern of technological change but also in their paths of technological development.

Overall, the rate of technological change appeared relatively superior in large firms, but the gap was quite uneven among the different types of the change: it was greatest in the import and absorption of foreign know-how and least in imitative product developments. This specific feature of the gap is closely connected with the different modes of entry and different patterns of technology acquisition followed by large and small firms in the industry. Unlike the experience of the machine tool industry in developed countries(see Sciberras and Payne, 1985), large and small firms were characterised by sharp contrasts of scale and technological base from the beginning. Small and medium firms were established by craftsmen or, more recently, by engineers who developed their first machine tool models mainly by copying and modifying foreign designs. In contrast, most of large firms had no expertise in machine tool production when they, as subsidiaries of conglomerates, entered the industry, induced by government intervention, during the mid-1970s. They thus relied on the import of foreign capital goods and technologies to establish their production base within a short period of time. In terms of the 'modes of technology transfer' classified by Fransman(1985: 577), it can be said that large firms depended mainly on 'formal'(i.e. market-mediated) transfers whereas small and medium firms largely resorted to 'informal'(i.e. non-market-mediated) ones. Due to characteristics inherent to each category, the indigenous content of the technology transferred seems to have been higher in the latter. Therefore, indigenous, though incremental, design capability crucial for imitation has been accumulated from early on by small and medium firms.

However, after the initial period of heavy dependence on technology imports (i.e. 1975~79), large firms have also increasingly turned their main efforts to in-house R&D for technology acquisition, thereby continuously building up their indigenous capability. On the other hand, since around 1983 some medium-sized firms have begun to try more 'formal' modes of technology transfer (e.g. licensing agreements, joint ventures) to get access to more sophisticated foreign technologies. These changing trends in the modes of technology acquisition also attest to the fact that there are *heterogeneous* paths

of technological development distinguishable between large and small firms in Korea.

What all the above findings signify is that it is meaningful to consider the dimension of firm size in a theorisation of technological change in the Third World. As the case of the Korean machine tool industry shows, large and small firms in developing countries are often characterised by sharp contrasts in both their initial conditions and their subsequent experience of development and technological progress. So far scant attention has been paid to the significance of these, especially to the specificity of small and medium firms, in the existing literature, including the studies from the neo-Schumpeterian approach.

On the other hand, our study also suggets interesting implications as regards the changing relative roles of large and small firms in technological innovation in the different stages of Third World industrialisation. In the early stage of the development of the Korean machine tool industry, small and medium firms had played the leading role and pioneered many areas of conventional machine tool production and associated technologies. In the later(and present) stages, however, large firms have become more and more dominant, in both output and technological developments. In particular, large firms have almost dominated the development and production of NC machine tools.

This trend resembles, at least in its appearance, the typical pattern of industrial evolution in a developed country described by authors like Utterback and Abernathy(1975) and Rothwell(1984). However, the underlying mechanisms are significantly different between this and the Korean case. In the first place, the early small entrepreneurs in the Korean machine tool industry did not base themselves on innovations of radical new products but, instead, on copying and learning existing foreign designs which were considered as already mature technologies in industrialised countries. Moreover, second, the shift of the leading role from small and medium-sized to large firms during the 1970s was not a natural result of evolution via the operation of *economies of scale*, but largely a product of *state policy*.

Nevertheless, it seems undeniable that the 'stage' factor(i.e. the transition from the earlier to the later stages of industrialisation) has had some effect on the changing

leadership in the industry. As an industry(or a country) progresses into higher planes of development, it increasingly needs 'deeper' levels of technical knowledge. To acquire such knowledge, therefore, the type of learning must also change: from relatively costless learning which is based on 'doing', to more and more costly learning, including R&D(Bell, 1984). Large firms can afford such costly learning better than small firms. This kind of mechanism appears to have operated in the Korean machine tool industry as well. It was shown clearly in the case of the development NC products by large firms. On the whole, it seems true that size has become more important in the industry, because of the increasing emphasis on R&D, international competition and so on. So the present higher technological performance shown by large firms has to be explained, at least partly, by this. However, it by no means implies that small and medium firms have no role to play in this later stage of the industry. It is still, by and large, a skill-intensive industry characterised by diverse customer demand and small batch production. So the relative role of small and medium firms in this stage depends greatly on how they can exploit these sectoral advantages and how they can eliminate their disadvantage in R&D(see 'Policy implications').

2. size advantages/disadvantages in technological change

Technological change, as a form of creation and/or application of new knowledge, is both costly and risky. Since the capacity to afford such costs and risks is unevenly distributed among different firms, it is not strange at all that the technological performances of firms appear uneven. In this regard, firm size is among the most significant aspects on which firms' capacities for technological change rely. Apart from the availability of resources, it is often responsible for various other organisational and environmental characteristics which are connected with firms' motives and competences for technological change.

In the literature, the size-related advantages and disadvantages in technological innovation are well-known through the seminal works by Rothwell & Zegveld(1981 and 1982). Bearing in mind that such works are based on the economic conditions and the type

of innovations typical of advanced countries, we have empirically examined the significance of these and other major factors in the particular context of, and for the typical forms of technological change in, the Korean machine tool industry. We categorised a variety of those factors into size *per se*, labour market factors, capital market factors, product market structure, state policy and firms' internal organisation.

In general, the case study confirmed- with some interesting exceptions- the existence and operation of many size-related advantages and characteristics such as suggested in Rothwell & Zegveld's studies(ibid.) and in other literature. For instance, it was found that large firms not only enjoyed advantages of larger R&D, better access to qualified manpower and financial resources, and a large and more steadily growing demand for their products, but that they also seemed to feel more pressure to seek technological change due to their specific market types and competitive environment. Meanwhile, small and medium firms were found to be not fully exploiting their potential advantages of small size (especially, those associated with internal organisation); instead, they seemed to draw their main advantages from low labour and overhead costs and accumulated experience of imitative developments.

However, one of the most important findings in our study -and this is the main deviation from the experience of advanced countries on which authors like Rothwell & Zegveld based their model- is the fact that most of the advantages of large firms were not really due to pure `size' itself but were considerably from the effects of state policy. In Korea, especially in the machine tool industry, state intervention has been very heavy and pervasive, and tends to have been biased towards the promotion of large firms, most notably with regard to credit and product markets. This means that state intervention may have actually exacerbated, rather than reduced, the gap between large and small firms in their capacities to afford the costs and risks associated with technological change.

Therefore, in developing countries where the degree of state intervention in industry is usually high (Sagasti, 1980: 36), it is wrong to regard the similarities with characteristics found in advanced countries as reflecting pure `size' advantages. Unless

state intervention is neutral (or minor), the effects of firm size and of state policy will be so intermingled that we cannot easily distinguish one from the other. For this reason, when explaining the technological performances of different sized firms in developing countries, one of the primary tasks we must focus on is to identify the extent and direction of state intervention and its impact on other major factors which influence firm's technological performance.

3. the connection between firm size and state policy

Finally, since state policy was found to have favoured the growth and technological performance of large firms in the Korean machine tool industry, we examined a deeper issue of political economy, and considered whether economic power was also translated into political influence on government decision-making(and implementation). This issue is directly connected with the current theoretical debate on `state autonomy' in social science (see footnote 6 in Chapter 12).

In the case of Korea though, it was confirmed that although large firms did have relatively greater political influence and closer contacts with policy-makers than their small counterparts, the strong autonomy maintained by the Korean state seemed to have kept large firms from influencing the direction of government policy in their favour. The business community, regardless of firm size, has been subordinated to the government, rather than the other way round. We ascribed this conspicuous asymmetrical relationship between government and business in Korea mainly to its peculiar political structure and state control over credit allocation. In so far as our judgement on the state's independence from the influence of the business class is correct, policy bias towards the promotion of large firms must have stemmed from government's own prejudice in favour of them. It was pointed out that the strong commitment of the Park regime to economic growth(itself largely a product of its craving for legitimacy and national defence) had led it, especially since the heavy and chemical industry promotion policy, to overemphasise the importance of 'scale', thereby giving disproportionate support to large firms(*jaebuls*, in particular), without carefully

considering sectoral differences. The machine tool industry was not an exception, even though its scale economies are not generally regarded as big (or, at least, are much smaller than other heavy industries). So, whether it is rational or not, policy bias can stem from autonomous state decisions, rather than from differnt political influence linked to firm size.

Meanwhile, it is suggested by some authors (for instance, Hamilton, 1987) that strong state autonomy such as found in Korea is *a necessary condition* for successful accumulation.[1] According to them, the effectiveness of state intervention, and hence the efficient growth of the economy, depends a great deal on state autonomy. In the light of the Korean machine tool industry's case, although one could criticise the excessive bias towards large firms and its negative consequences, it seems undeniable that the existence of state intervention has contributed to the industry's rapid overall growth and technological progress. In addition, due to its autonomy the state was able to correct some of the earlier policy bias(and its associated adverse consequences) during the 1980s. Thus it is only if a state abstains from abusing its own discretionary power and avoids misjudgement, that its strong autonomy can be instrumental for economic growth.

However, state autonomy is not static and permanent. Ironically, as an inevitable political consequence of the economic growth which it promoted, the state is likely to lose much of its autonomy sooner or later. Such a pressure can come from either the increasing power of the business class or the rising civil demands for freedom and democracy, or both. In this regard, it is interesting to see if the current political transition in Korea, especially the change from an authoritarian quasi-military rule to a

[1]To quote Hamilton (ibid.: 1243),

> "This defines a further political condition necessary for sustained accumulation: economic policy needs to be aimed at economic growth through private accumulation rather than at simply protecting private capital. That is, it is necessary to have a state that is capable of taking harder decisions which are contrary to the interests of section of the business class. ...These carry with them a further implied political condition, namely that the state is both sufficiently strong and sufficiently independent from particular class interests to implement policies that will promote accumulation at the expense of other interests."

more electoral politics, will result in a serious weakening of state autonomy. And if so, in which direction it will weaken is also an important question: will it mainly increase the political power of large business groups because of the increasing importance of their political contributions, as was envisaged by Jones & Sakong (1980: xxxiv), or, instead, will it strengthen the influence of the middle-strata (including small and medium firms) and the working class ? Futhermore, if the latter is the case, then what implications does such a political change have for the conditions of small and medium firms in terms of their entrepreneurship, innovativeness, and internal social relations ? In this respect, the Korean case provides an interesting theoretical subject to reflect upon political change(e.g. democratisation) and its long-term effects on the pattern of economic and technological development.

13-2. Policy implications

Throughout our analysis we have also tried to find and reveal weaknesses as well as strengths in the experience of technological development by Korean machine tool firms. They not only help us consider useful directions for the further development of the industry, but also provide some interesting references which other, less industrialised, developing countries can utilise for their industrial and technological policy. Some of these policy implications are suggested below as regards (i) the role of the state; (ii) the task of small and medium firms; and (iii) the relationship between large and small firms.

1. the role of the state

As already stated, the state's role was crucial in determining the technological performance of Korean machine tool firms and in shaping the structure of the industry. However, its bias towards large firms has been accompanied by many contradictory effects and consequences, from which other developing countries can get useful policy implications for the development of their machine tool industry. On the one hand, it

certainly contributed to the rapid expansion of the industry's production base with the diversification of its product items, enhanced the industry's overall level of technological sophistication, and, in particular, facilitated the entry to such high technology areas as CNC machine tools. But, on the other hand, by inducing and promoting firms from large business groups in other sectors, a relationship of confrontation and competition rather than of complementarity was established between the new (large) entrants and the existing small and medium machine tool firms. This not only led to a sort of technological and economic dualism in the sector but also aggravated the degree of economic concentration within the country. The heavy allocation of credit to large firms, without carefully considering sectoral characteristics, resulted in excess capacity of these firms, and hence raised a problem in *allocative efficiency* of investible resources. Also, the privileged support for large firms depending on foreign technologies tended to facilitate technological dependence (at least in the short term) at the expense of the indigenous technological capabilities accumulated in small and medium firms, thereby unduly suppressing the latter's potential for growth based on their technological dynamism. The performance by small and medium firms thus seems to have been sub-optimal than without policy bias towards large firms, and there have been few 'new technology-based', 'innovative' small firms.

A contrasting example is suggested by the Taiwanese case. There, state intervention in the machine industry was not as great as in Korea (Jacobsson, 1984) and largely played a *supportive* role by promoting existing small and medium firms, without discrimination, to develop based on indigenous efforts of technological learning by imitation.[2] A special policy intended to induce selective large(and 'modern') firms into the industry, i.e. such as the Korean policy, was absent in Taiwan. Nevertheless, its

[2] To quote Amsden(1985: 279),

> "Almost all machine tool companies in Taiwan whether large or small acquired their initial know-how through copying, or reverse engineering. The only exception is the one machine tool firm which is part of a large conglomerate (Tatung) and which has relied on foreign licences to short-circuit the learning process."

See also Fransman(1986b).

machine tool industry has been remarkably successful in exports and technological progress, surpassing its Korean counterpart as regards indigenous technological capability(Amsden, 1977 and 1985; Jacobsson, ibid.). Many small and medium firms are active even in NC machine tool production.[3] In the light of this Taiwanese experience, it is doubtful whether the policy bias of the Korean state was really necessary and appropriate in the machine tool industry, where, unlike other heavy industries, the comparative advantage of large scale is not great. In particular, as the Taiwanese example seems to suggest, small and medium firms can play a leading role in the industry at the development stage such as is found now in most Third World countries. The comparison of experiences between Korea and Taiwan suggests that what is important is not so much the degree of state intervention as the form or focus of it. In short, state intervention should be taken under careful consideration of sectoral differences(especially, in terms of economies of scale and stage of maturity).

Then what kind of policy is needed for the Korean machine tool industry ? Now seems the time for the state to seriously reconsider and redefine its role in the sector. To suggest some very broad lines for its future policy direction, the state, first of all, must end its bias towards large firms in all of its major spheres of intervention and let them strengthen their self-reliance through exploiting economies of scale. Instead, it now must take more interest in the promotion of small and medium firms in the sector. Support by state intervention is needed by small and medium firms much more than large firms. Such a policy should not serve merely to protect inefficient small firms but rather, should focus on the effective support of technological innovation and export activities by them. To do this, the state must first have a clear recognition that small and medium firms can greatly contribute to technological innovation and diffusion,[4]

3 According to *Financial Times*(3 July 1987: a special report on the machine tool industry), there are about 80 producers of NC machine tools in Taiwan. The majority of them are small and medium-sized.

4 For the views that small and medium firms can play a positive role particularly in the present rapid

though their lack of resources make it difficult for them to accommodate the high technical, financial and market risks involved in innovation. Thus the state must understand that its assistance is necessary and, more importantly, can be very effective, in reducing such risks and overcoming the disadvantages of small scale.

In this regard, the existing policies in Korea, although improved during the 1980s, cannot be seen to have been sufficient and pertinent. According to our study, the difficulty of finance is still far too great a problem in most small and medium firms to try significant R&D projects and employ qualified technical manpower. Access to new equipment (e.g. NC machines) and technological information is also seriously hindered by financial difficulties. Many firms, even when succeeded in R&D, tend to face greater problems in commercialising its results for lack of engineering fund and working capital. So what the state needs to do is, above all, to reduce these difficulties by significantly expanding its financial support (including tax privileges) for small and medium firms. This must include not only those specific loans for technological purposes, as the Korean state has done so far, but also financial assistance in general. Firms can afford R&D when, after all, their overall financial conditions enable them to do so. Besides finance, it is important to reorient the main function of technical services for industry by government- sponsored research institutes into assisting small and medium firms. Since large firms now possess their own R&D capacities, the transfer of technology from these institutes will be of greatest help for small and medium firms: it will save the latter's costs for R&D and technical manpower and enable them to gain access to up-to-date technologies and useful information of various nature.[5]

Together with support for technological development, the state must also stimulate

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technological change and world-wide economic restructuring, see Rothwell & Zegveld (1981 and 1982), Rothwell(1984) and Perez(1985).

[5] In this respect, also, the Taiwanese case is instructive. According to Fransman(1986b: 196-197), since Taiwanese machine tool firms are smaller than their Japanese and Korean competitors, the state provision of technology inputs through the bodies like the Mechanical Industrial Research Laboratories (MIRL) has been crucial for the firms to acquire NC technologies.

and assist export activities by small and medium firms. Most of them currently depend on domestic markets too much and thus desperately need overseas outlets for further sales growth. Export increases will stimulate technological efforts by small and medium firms to improve efficiency and product quality, and such efforts will in turn facilitate further export success.

However, the most important change is a political change. Such a major shift in state policy seems to necessiate a significant transformation in the existing economic decision-making structure, which has hitherto been dominated by a small group of political, bureaucratic and industrial elites. Small and medium firms have largely been alienated by the main policy-making bodies. But policy changes such as we have suggested above cannot be successful without the participation of the small and medium firms themselves in the decision-making process and the adequate reflection of their opinions in the consequent policies and in their implementation. So it is necessary to broaden and deepen contacts between the government and small and medium firms at various levels, for these contacts have lagged far behind those between the government and large firms. But doing this is, of course, not merely a matter of political will, but one to be determined by a struggle between large and small firms for realising their own sectional interests.

2. the task of small and medium firms

Although it is true that small and medium firms have suffered from factors largely beyond their reach, viz. handicaps of size and of bias in state policy, we also noted many problems for which they themselves were mainly, or partly, responsible. For instance, many of them tended to be content with safe domestic markets under government protection for cheap, traditional products, and lacked active efforts to seek new opportunities and a willingness to accept the risks involved. Related to this, they tend to rely too heavily on low wages and cheap facilities and equipment. Managers usually showed little interest in training employees. The qualities of labour relations and

internal communication, often proposed as typical advantages of small firm size, were poorer than their large counterparts. Not surprisingly, their employees, especially production workers, were characterised by low degrees of job satisfaction and high rates of turnover. Since the machine tool industry is very skill-intensive, high labour turnover seems to be especially detrimental to the accumulation of firm-specific skills within these firms.

To tackle these problems in the context of the changing international and domestic market conditions (see below), small and medium firms need first to re-examine their overall competitive strategies. It is not sufficient any more to produce cheap and simple products based on low wages. They have reached the stage of transition, which Bell(1984) termed 'qualitative discontinuities'. They must try more technologically complex models(e.g. CNC products) and boldly enter into export markets by tapping their technological capability and innovations. To do this, the following efforts seem to be needed: (i) firms must select strategic models in which they will be specialised - in particular, it is extremely important to identify the innovative, specialist products in which their comparative advantage over large firms lies; (ii) to acquire the technologies needed, while increasing their own R&D efforts they need to actively utilise public research institutes and technical assistance bodies to get access to R&D inputs, and/or form research associations for joint technological projects to save R&D costs; (iii) their conscious efforts to develop the advantages of small scale organisation should be increased - for instance, improvements in working conditions and industrial relations to lower labour turnover, changes of management style into more democratic ones, more positive attitudes toward innovation and the training of employees, more risk- taking entrepreneurship and so on; (iv) firms must begin to introduce NC equipment and take advantage of its merits for small batch production: in this regard, the current misconception of some firms about it should be corrected(i.e. they still regard NC machines as made for mass production and thus not suitable to them). In fact, NC machine tools have reduced the optimum scale of production and thus can be more advantageous to small and medium firms (Sabel, 1982: 65-70; Watanabe, 1987). But since they still find it either too expensive

or too unfamiliar to productively use and repair, government assistance for its purchase (or lease) and user-training may be very helpful to stimulate the adoption of NC equipment among small and medium firms.

3. the relationship between large and small firms

Finally, some suggestions on the desirable relationship between large and small firms in the Korean machine tool industry seem to be necessary. As we pointed out, because of their contrasting starting-points large and small firms have been marked by a stark dual structure in which any serious links or interdependence between them are lacking. However, this situation has to change in order to adapt to the new internal and external economic environment Korea now faces: for instance the decline of low wage advantages; the increasing protectionism (including over technology) by advanced countries; the import liberalisation of domestic markets; the increasing demands and strength of the working class; the impact of the microelectronic revolution, etc. In these new conditions, Korean machine tool firms, regardless of their size, now have to upgrade their productivity and product quality. Technological development becomes more and more important for their survival and growth.

It is here that large and small firms can co-operate with each other for their mutual benefit. It is desirable for them to increase the division of labour between them either in the form of subcontracting or of specialisation. As regards subcontracting, Korea is too underdeveloped compared with, say, Japan.[6] Through developing subcontracting relationships, large firms can save their production costs and improve their flexibility to respond to changing market demand, while small firms can receive technical assistance from the former and get access to their overseas marketing networks. On the other hand,

[6] For instance, the ratio of subcontracting (i.e. the number of subcontractors/ the total number of small & medium firms) in the general machinery sector in Japan is 84.1 % (1981) while it is only 23.4 % in Korea (1983), according to SMIPC (1984: 45). See Jaewon Kim(1983) for a detailed analysis of subcontracting in the Korean machinery industry. For technical transfer between large and small firms through subcontracting in the Japanese machine tool industry, see Watanabe(1983).

specialisation is also mutually beneficial not only for attaining scale economies in production by both groups but also for exploiting their relative strengths in technological innovation (for example, product vs. process innovations).

For the industry as a whole, too, to promote the complementary roles of small and large firms in innovation is desirable, because "Technological change is best promoted in a system where the complementarity of small and large firms lies in the fact that the former are particularly adept as initiators of radical innovations while only the latter have sufficient resources for successful large-scale development "(Rothwell & Zegveld, 1981: 178). The concept of *dynamic complementarities* between small and large firms, suggested by Rothwell (1984), is worth appreciating in this regard. The state can play a significant role in facilitating such dynamic complementarities in developing as well as in developed countries. So governments in Third World countries should pay more attetion to the maximisation of complementarities between large and small firms in their design of industrial and technology policy.

Appendix: Questionnaires used in the field survey

I. General Information (respondent: head office)

1. a) When was the company established? _____ year

   b) If the plant was not established by the present owner, when was it acquired?

   _____ year

   c) When did the company start to produce machine tools?

   _____ year

2. Please indicate the type of ownership of your company.

   (1) joint stock co. _____ (2) other corporations _____

   (3) individuals _____

3. What was your company's performance during the last three years in the following aspects?

   (unit: million won)

Items \ year	1982	1983	1984
Capital			
Value of shipments			
Tangible fixed assets (Value of machinery & equip.)			
Value added			
Net profits			

4. a) Has your company had any expansion projects?

   (1) yes _____ (2) no _____

b) If so, when were they? In consequence, how has the production capacity of your major products grown? (100 = acquisition, establishment, or initial production under expansion program).

production capacity / date		Names of major products 1	2	3	4	5
Acquisition-Establishment	year					
1st expansion	year					
2nd expansion	year					
3rd expansion	year					
4th expansion	year					
5th expansion	year					

5. What were the gross output and the domestic-export sales for each of your major products during the last three years?

(unit: units, million won)

year	items	names of products	1	2	3	4	5
'82	Gross Output	Units					
		Value					
	Shipments	Domestic					
		Export					
'83	Gross Output	Units					
		Value					
	Shipments	Domestic					
		Export					
'84	Gross Output	Units					
		Value					
	Shipments	Domestic					
		Export					

6. Please indicate the composition of sales in 1984 by types of markets.

(unit: %)

types of markets \ types of products			machine tools	other products	total
Export	Direct export				
	Indirect export				
Domestic Sales	By order	Subcontract to large firms			
		Government procurement			
		Other kinds of order			
	For market				
Total					100

7. What is the composition of manufacturing cost during the last three years?

(unit: %)

items \ year	1982	1983	1984
materials cost			
labour cost			
other cost			
total cost	100	100	100

8. Please indicate the numbers of your own production machines by the following classifications.

a) total number of production machines _____

b) by produced year : (1) before '69 _____

(2) '70 - '74 year _____

(3) '75 - '79 year _____

(4) after '80 _____

c) by countries of origin: (1) Korea _____

(2) Japan _____

(3) U.S.A. _____

(4) Other countries _____

d) N.C. machines _____

II. Management & Strategy (respondent: managing director)

1. Please indicate the number which represents your company's production process among the following.

_____ (1) manual type on the whole

_____ (2) largely mechanical type but not continuous process

_____ (3) semiautomatic type

_____ (4) completely automatic type

2. The following are questions about the degree of competition with respect to your major products.

a) In domestic market,	no competition		moderate		very intense
(1) cost competition	1	2	3	4	5
(2) quality/performance competition	1	2	3	4	5

b) In export market,	no competition		moderate		very intense
(1) cost competition	1	2	3	4	5
(2) quality/performance competition	1	2	3	4	5

3. What aspect do you think your customers prefer for your major products?

only price	mainly price	middle	mainly quality	only quality
1	2	3	4	5

4. How do you expect the market prospects for your major products to be in the near future?

	drastic decrease	a little decrease	little change	10% increase	10-30% increase	30-50% increase	more than 50% increase
a) Domestic market	1	2	3	4	5	6	7
b) Export market	1	2	3	4	5	6	7

5. If your company is engaged in production to order or subcontract,

a) how is the price of a product determined?

totally by ordering firms	mainly by ordering firms	consensus between the two	mainly by our firm	totally by our firm
1	2	3	4	5

b) how frequent is technical assistance from ordering firms?

never	1-2 times in a year	every 2-3 months	every month	several times a month
1	2	3	4	5

6. Has your company received a loan from a domestic financial institution in the recent past?

a) (1) Yes _____ (2) No _____

b) If yes : how easy was it for your company to receive the loan?

very difficult		moderate		very easy
1	2	3	4	5

7. Has your company ever used a domestic or foreign institution to collect market information?

a) (1) Yes _____ (2) No _____

b) If yes :

(1) what's the name(s) of the institution(s)?

_____

(2) how easy was it for your company to use the institution(s)?

very diffidult		moderate		very easy
1	2	3	4	5

c) If no : how does your company collect market information?

8. Has your company ever used an institution (research institute, university, public institute, etc.) or an industrial association to collect technological information and knowledge?

a) (1) Yes _____ (2) No _____

b) If yes :

(1) what's the name(s) of the institution(s)?

_____

(2) how easy was it for your company to use the institution(s)?

very difficult		moderate		very easy
1	2	3	4	5

c) If no : how does your company collect technological information and knowledge?

9. Which of the following do you think is most similar to the product market strategy which your chief executive has taken so far?

_____ (1) a strategy which tries to defend the firm's existing market share by maintaining the competitiveness and strengthening the marketing of the existing products instead of developing new products.

_____ (2) a strategy which continually searches for market opportunities and initiates market change by introducing new products almost always ahead of other competitors.

_____ (3) a dual strategy which tries to defend the market share in the firm's existing products while watching other competitors closely for new products and rapidly adopting those which appear to be the most promising.

_____ (4) without any consistent strategy, the firm seldom makes adjustment of any sort until forced to do so by environmental pressures.

10. How much do you think your chief executive has been interested in the development of new products?

no interest		moderate		great interest
1	2	3	4	5

11. Which of the following do you think your chief executive most prefers as a method to develop new products?

_____ (1) to import foreign technology

_____ (2) to disassemble and imitate foreign products (i.e. by reverse - engineering)

_____ (3) to commit it to domestic research institutes or do joint research with them

_____ (4) to develop a qualitatively different product from a foreign one by purely internal efforts

_____ (5) other (specify) _____

12. How much do you think your chief executive has been interested in training and career development of workers?

no interest		moderate		great interest
1	2	3	4	5

13. Listed below are several types of management and work decisions. For each of these, please indicate the decision style in your company by selecting an appropriate number among the following :

1 = almost exclusively decided by the chief executive
2 = opinions of levels down to the executives are reflected
3 = opinions of levels down to the middle managers are reflected
4 = opinions of levels down to the ordinary employees are reflected
5 = opinions of all levels are reflected

a) Determining employees' remuneration _____

b) Hiring or recruiting personnel _____

c) Terminating the employment of personnel _____

d) Positioning personnel and allocation of work _____

e) Determining employees' promotion _____

f) Development of new products or improvement of product quality _____

g) Development or introduction of new production techniques or improvement of production process _____

14. The questions below inquire about your evaluation of the company's capabilities in various aspects compared with those of the other firms in the same industry. Please indicate your evaluation by selecting an appropriate number.

	very inferior		inter-mediate		very superior
a) Quality of production facilities and equipment	1	2	3	4	5
b) Quality of workers' skill	1	2	3	4	5
c) Employees' morale and motivation	1	2	3	4	5
d) Capability to recruit technical manpower	1	2	3	4	5
e) Relationship with research institutes or experts	1	2	3	4	5
f) Financing capability	1	2	3	4	5
g) Capability to procure materials	1	2	3	4	5
h) Marketing capability	1	2	3	4	5
i) Accounting and general management capabilities	1	2	3	4	5

III. Top Manager (respondent: chief executive)

1. Are you?

_____ (1) the founder (first generation)

_____ (2) second generation of the founder

_____ (3) third generation of the founder

_____ (4) the subsequent purchaser

_____ (5) unrelated manager

_____ (6) others (specify) _____

2. If the plant was not established by the present owner, from whom was it acquired?

_____ (1) Japanese, directly

_____ (2) Japanese, via government

_____ (3) Korean, going concern

_____ (4) Korean, failing or bankrupt

_____ (5) Other (specify) _____

3. What is your age? _____ years

4. What was the main occupation of your father? Please specify his position and the period of service in the occupation.

a) main occupation _____

b) position _____

c) period of service _____

5. The following are questions about your formal education.

a) At what stage did you finish your academic education? _____

b) If you graduated from a college or a university, what is its name?

_____

c) What was your major field? _____

d) Under what system was most of your pre-college education?

_____ (1) traditional Confucian

_____ (2) Japanese colonial school

_____ (3) modern Korean school after Independence

_____ (4) foreign (specify) _____

6. The following are questions about your career.

a) How long have you been with this company?

_____ years _____ months

b) How long have you held your current rank?

_____ years _____ months

c) Excluding the company you now work for, how many years have you spent in each of the following lines of work?

	year	months
(1) government		
(2) military : officer		
(3) military : enlisted		
(4) financial institution		
(5) trading company (export-import)		
(6) domestic trading company		
(7) private Korean-owned industry		
(8) private foreign-owned industry		
(9) government-owned enterprise		

(10) professional _____ year _____ months

(11) other (specify) _____

d) How long have you engaged in machine tools (or related) business?

_____ years _____ months

7. In your business, a number of problems had to be solved. In solving these problems, you may have had help from others. Please indicate all significant participants (if you had 2 or more, please rank).

	Domestic											Foreign				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	self	employee(s)	friends and relatives	other individuals	commercial and special banks	other financial institutes	other private companies	government proper	government agency	military	other (specify)	private companies	government	banks or financial institutes	military	other (specify)
a) perception of business opportunity and market identification																
b) obtaining financing																
c) choice of production process and plant design																
d) plant construction																
e) getting technicians and training																
f) government support and permits																
g) recruiting personnel, setting up organization structure and managing people																

1. a) Please fill in the form below which inquires about your employees at the end of the last year.

(unit: persons)

items \ types of employees	Working Proprietors	Administrators		Production workers						Total
		managers	ordinary administrators	engineers	technicians	qualified craftsmen	unqualified craftsmen	apprentices	manual workers, etc.	
Total										
By the length of services: less than 1 year										
By the length of services: 1 - 3 years										
By the length of services: 3 - 5 years										
By the length of services: 5 -10 years										
By the length of services: more than 10 years										
By the length of occupational career: less than 3 years										
By the length of occupational career: more than 3 years										
Annual total pay										
new employees in '84										
retired employees in '84										

b) How many the temporary employees were in your firm in 1984?

_____ persons

2. On the average, how many hours per week are worked in your company by :

a) ordinary employees : (a) production workers _____ hrs.

(b) administrators _____ hrs.

b) high-ranking staff _____ hrs.

c) the chief executive _____ hrs.

3. Please fill in the form below which inquires about your company's employment style.

		accession source		accession route					hiring criteria	
		① external	② internal	① public notice	② employment agency	③ school's recommendation	④ personal connection	⑤ scout from other company	educational level	other qualifications
Production workers	technicians	%	%	%	%	%	%	%		
	ordinary workers	%	%	%	%	%	%	%		
administrators	managers	%	%	%	%	%	%	%		
	ordinary administrators	%	%	%	%	%	%	%		

4. a) What is the proportion of the employees who had work experience in other firms among the total?

_____%

b) In this case, what about the types of their former companies? Please fill in the table below.

(unit: %)

types of employees \ former companies	1 Other big firms in the same industry	2 Other small firms in the same industry	3 Big firms in other industry	4 Small firms in other industry	5 Other (Specify)	Total
Production workers: technicians						100
Production workers: ordinary workers						100
administrators: managers						100
administrators: ordinary administrators						100

5. Is your chief executive's personnel policy closer to the policy of company A or B or somewhere in the middle? Please indicate an appropriate number for each type of workers.

In company A : employees are hired on a merit basis and fired whenever they perform below expectations.

In company B : employees are hired for life, become part of a business family, and are seldom released.

	the same as A	similar to A	the middle	similar to B	the same as B
a) managers, technicians	1	2	3	4	5
b) ordinary workers	1	2	3	4	5
c) ordinary administrators	1	2	3	4	5

6. Is the supervision style in your company closer to the style of company A or B or somewhere in the middle? Please indicate an appropriate number for each type of workers.

In company A : since supervisors direct and control work in detail, there is little descretion on the part of the persons concerned.

In company B : since supervisors perform only some basic supervisory function, the persons concerned can enjoy relative autonomy in their own work.

		the same as A	similar to A	the middle	similar to B	the same as B
a)	managers, technicians	1	2	3	4	5
b)	ordinary workers	1	2	3	4	5
c)	ordinary administrators	1	2	3	4	5

7. Please indicate how much you agree or disagree with each of the following statements by selecting an appropriate number.

strongly agree	agree	half & half	disagree	strongly disagree
1	2	3	4	5

a) In our company, there is little room for mutual intervention because of distinct job divisions. _____

b) In our company, additional jobs and mutual intervention are not unusual because of ambiguous job divisions. _____

c) Our workers perform their jobs according to the existing work criteria rather than to their supervisor's direction and command. _____

d) Our workers perform their jobs mainly according to their supervisor's discretion and arbitrary direction. _____

8. With respect to the promotion system in your company, please fill in the form below.

	job ladder (i.e. promotion ladder)	promotion criteria (please indicate 1,2,3... by the order of importance)
Production workers	* please describe.	(1) job record ( ) (2) supervisor's recommendation ( ) (3) formal education and acquisition of qualifications ( ) (4) skill levels ( ) (5) seniority ( ) (6) other _____ ( )
administrators		(1) job record ( ) (2) supervisor's recommendation ( ) (3) formal education and acquisition of qualifications ( ) (4) skill levels ( ) (5) seniority ( ) (6) other _____ ( )

9. a) For each of the training and career development facilities listed below, please indicate whether this facility is available by the employees in your company by selecting an appropriate number from below.

0 = not available to all employees
1 = available only to technicians and engineers
2 = available only to ordinary workers
3 = available to all production workers
4 = available only to administrators
5 = available to all employees

(1) Internal vocational training _____

(2) Formal courses (minimum 2 weeks) _____

(3) Training visits _____

b) Are the results of such training and career development programs as above reflected in the personnel transposition or the promotion of the employees concerned?

(1) Yes _____ (2) No _____

10. Are there such incentives as the following in your company?

a) wage increase or a special allowance : (1) Yes _____ (2) No _____

b) special promotion : (1) Yes _____ (2) NO _____

c) special reward or commendation : (1) Yes _____ (2) No _____

d) welfare systems for employees
(Please list _____)

V. LABOUR RELATIONS

(Respondent: Representative of Trade Union)

1. a) Do the following organisations exist in your company?

(i) Joint Industrial Council: Yes ( ) No ( )

(ii) Trade Union: Yes ( ) No ( )

(If yes, how many employees are enrolled in the union?

Production Workers _____ : Administrators _____)

(iii) Quality Control Circles: Yes ( ) No ( )

b) What is the response of employees to the activities of the above organisations?

		Very Positive	Positive	Neutral	Negative	Very Negative
(i)	Joint Industrial Council	1	2	3	4	5
(ii)	Trade Union	1	2	3	4	5
(iii)	Quality Control Circles	1	2	3	4	5

2. How satisfied are the firm's employees (especially production workers) with the following?

		Very Satisfied	Satisfied	Inter-mediate	Diss-atisfied	Very dis-satisfied
a)	Wages	1	2	3	4	5
b)	Working Conditions (e.g. working time, work criteria,etc.)	1	2	3	4	5
c)	Working Environment (especially safety and health)	1	2	3	4	5
d)	Management Ability	1	2	3	4	5
e)	Managerial System	1	2	3	4	5

3. How much influence do the employees (especially the production workers) have on decision making in the following areas?

	Very Important Influence	Important Influence	Moderate Influence	Little Influence	No Influence
(i) Determination of wage levels	1	2	3	4	5
(ii) Determination of working conditions	1	2	3	4	5
(iii) Improvements in working environment	1	2	3	4	5
(iv) Changes of management personnel	1	2	3	4	5
(v) Improvements to managerial system	1	2	3	4	5

4.a) Have there been any industrial disputes in the company in the last five years?

Yes ( ) No ( )

b) If yes, please indicate :-

(i) The number of disputes
(ii) When they occured
(iii) Their reasons
(iv) The way in which they were settled and whether the government intervened, and what form this intervention took

5. How do you evaluate the government's influance on the settlement of industrial disputes or on labour-management relations in your company?

Very Positive	Positive	Neutral	Negative	Very Negative
1	2	3	4	5

6. In your company, have either of the following occured because of changes in product area or the introduction of new production processes (e.g. automated facilities) in the last five years?

a) A reduction in the number of production workers

Yes ( ) No ( )

b) Considerable changes in the methods or conditions of work for production workers

Yes ( ) No ( )

c) If yes to either a) or b), what was the response of the workers to these changes at the time?

___ (i) Very resistant
___(ii) Somewhat resistant but soon appeased
___(iii) No notable response
___(iv) Some positive interest
___ (v) Very positively received the changes

d) What is the present attitude of workers towards such technological changes?

___ (i) Very resistant
___(ii) Somewhat reluctant
___(iii) No real interest
___(iv) Largely positive
___ (v) Very positive

7. Please indicate how much you agree or disagree with each of the following statements by selecting the appropriate number.

Strongly Agree	Agree	Half & Half	Disagree	Strongly Disagree
1	2	3	4	5

a) In this company, there is little room for mutual intervention because of distinct job divisions _____

b) In this company, additional jobs and mutual intervention are not unusual because of ambiguous job divisions _____

c) Our workers perform their jobs according to the existing work criteria rather than to their supervisor's direction and command _____

d) Our workers perform their jobs mainly according to their supervisor's discretion and arbitary direction _____

e) There are frequent contacts and smooth communications between managers and workers in this company _____

f) There is a very cooperative spirit among the employees of this company _____

g) Fellow workers have frequent ~~informal~~ meetings _____

h) There are smooth contacts and communication between the different departments in this company _____

i) Our employees have high morale and motivation _____

j) Every employee percieves the objectives of the company as those of his own _____

k) Many employees are afraid of losing their present jobs _____

l) Many employees are considering leaving the company _____

VI. GOVERNMENT POLICY

(Respondent: Chief Executive or Managing Director)

. The goverment affects your operations in many ways. In each of the following areas how do you rate the effects of their involvement on your business?

	Very Positive		Neutral		Very Negative
a) Establishing business	1	2	3	4	5
b) Domestic marketing	1	2	3	4	5
c) Foreign marketing	1	2	3	4	5
d) Obtaining domestic financing	1	2	3	4	5
e) Obtaining foreign loans	1	2	3	4	5
f) Controlling unfair competition	1	2	3	4	5
g) Controlling wages	1	2	3	4	5
h) Controlling industrial disputes	1	2	3	4	5
i) Technological development	1	2	3	4	5

. Of the following government policies to promote technological development and its related activities in industrial firms, please select three policies, (i) which have been most helpful or have had great influence on your company so far and (ii) which your company will need most in the future.

(i) Those which have been most helpful: Please list in order of importance

( ) ( ) ( )

(ii) Those which your company needs most in the future : Please list in order of importance

( ) ( ) ( )

1. R&D subsidies; 2. tax exemption or reduction; 3. Technical information services; 4. Education and supply of technical personnel; 5. Technical training and assistance; 6. Support for joint or contract research; 7. Consultancy and assistance on technology imports; 8. Government procurement; 9. Protection measures on R&D results (e.g. patent, 1st Korean Machine etc.); 10. Protection of domestic market through import control, promotion of locally made machines, etc. ; 11. Special assistance programmes for small and medium firms; 12. Other (Please specify:)

3. To what extent can you (or your company) inflence government policy affecting your business?

__ (a) can obtain anything

__ (b) can frequently influence

__ (c) can sometimes influence

__ (d) seldom influence

__ (e) no inflence at all

__ (f) other (specify)

4. If you have some inflence on government industrial policy, how frequently do you use the following methods?

Very often used		Sometimes used		Never used
1	2	3	4	5

a) Direct formal impersonal approach to government _____

b) Direct informal personal appeal to government officials _____

c) Indirect appeal through the following business associations:

(i) Industrial Trade Association _____

(ii) Chamber of Commerce _____

(iii) Small and Medium Industrial Association _____

(iv) Federation of Korean Industries _____

(v) Korean Traders Association _____

d) Indirect personal appeal through politician _____

e) Indirect impersonal appeal through political party _____

f) Indirect impersonal appeal through newspaper _____

g) Other (Specify:) _____

VII. TECHNOLOGICAL DEVELOPMENT ACTIVITIES

Respondent: Technology Manager)

1. Are there any staff or department(s) which take exclusive charge of technological development activities within your company?

___ (i) We have a research institute

___ (ii) We have no research institute, but we have an R&D Dept.

___(iii) WE have a laboratory or design section which takes charge of them

___ (iv) We do not have such a department, but we have the staff who take exclusive charge of them

___ (v) We have no such exclusive staff, but production workers and technicians perform these functions as well

___ (vi) Mainly the cheif executive is responsible for them

___(vii) We have no staff or department for technological development

2. What was the amount of R&D expenditure in your company in the last three years?

1982	1983	1984
Won	Won	Won

3. How many staff are involved in technical development in your company?

a) By type of function:

(i) Staff who are exclusively responsible for technology development ; _____persons

(ii) Staff who also perform other functions ; _____persons

b) By levels of formal education:

Ph.D.	_____persons
M.Sc. (or M.A.)	_____persons
B.A. or B.Sc.	_____persons
Junior or technical college	_____persons
High school or lower levels	_____persons

4. What methods were used to recruit the above staff? Please indicate the importance of each of the following methods by writing the percentage figures.

(i) Selection from existing production workers or technicians

_____%

(ii) Employing new graduates _____%

(iii) Scout from small and medium firms in the same industry _____%

(iv) Scout from large firms in the same industry _____%

(v) Scout from research institutes or researchers in universities _____%

(vi) Inducing technicians from abroad _____%

(vii) Other (specify:) _____%

5. What methods of training do you use to improve the capabilities of the above staff? Please select three from the following and list them in order of importance.

( ) ( ) ( )

1. Internal technical training; 2. Invitation of external technicians; 3. Sending staff to licensor(s) and abroad; 4. Training by technical institution; 5. Leaving it to the individual; 6. Sending them to research institutes or universities; 7. Other ( )

5. How much have the following factors motivated technological development in your company?
Please rate the importance of each factor.

	very important		moderate		never important
a) Increased competition in domestic market	1	2	3	4	5
b) Increased competition in export markets	1	2	3	4	5
c) Demand by customers or foreign buyers	1	2	3	4	5
d) Policy changes, instructions or directions by the government	1	2	3	4	5
e) Increases in labour costs	1	2	3	4	5
f) Increases in the costs of materials or energy	1	2	3	4	5
g) Shortage of skilled workers	1	2	3	4	5
h) More strict control over production process	1	2	3	4	5

7. Which of the following are the major areas of technical development on which your company has concentrated its efforts?
Please list three in order of importance.

( ) ( ) ( )

1. Shortening production process; 2. Saving labour; 3. Mass production; 4. saving materials; 5. Saving energy; 6. Diversifying products; 7. Reducing the number of components; 8. Developing new products; 9. Improving existing products; 10. Diversifying the uses of products; 11. Developing new designs 12. Developing and utilising new materials 13. Other (Specify)

8. Who mainly proposed the plans or offered ideas for such technological developments? Please select three from the following and list in order of importance.

( ) ( ) ( )

1. Top manager or the executives; 2. R&D department; 3. Factory manager; 4. Production workers and technicians; 5. Sales staff; 6. Domestic customers; 7. Foreign buyers; 8. Technical institutions; 9. Suppliers of components or facilities; 10. Foreign licensor; 11. Other (Specify)

9. Please list below the licensing agreements your company has entered into since 1975.

Year	Source(Country)	No. of Contracts	Name of Technology, etc.

10. How many patents or utility models has your company applied for or registered in the country since 1975? (Those patents or utility models owned through licensing agreements are excluded.)

	Patents	Utility Models
a) Applied	_____	_____
b) Registered	_____	_____

11. Please indicate the number of new products your company has developed since 1980, and the number of new production processes your company has developed or introduced in the same period? (Include those developed throughor introduced by technology imports)

a) Number of new products _____

b) Number of new production processes _____

12. For the product and process innovations above, please break them down into the following categories:

a) By source of initiative,

(i) Internal development _____

(ii) Licensing agreement _____

(iii) Joint research with domestic institutions _____

(iv) Subcontract to domestic institutions _____

(v) Subcontract to foreign institutions _____

(vi) Other ( ) _____

Total : _____

b) By type of financing method (Please indicate the proportion in terms of the amount of each type as a percentage of the total)

(i) Internally reserved funds _____%

(ii) Loan through financing institutions _____%

(iii) Private loan _____%

(iv) Government subsidy _____%

(v) Foreign loan _____%

(vi) Contract deposit by customers or foreign buyers _____%

(vii) Other ( ) _____%

Total : 100 %

c) How many new products or processes is your company planning to develop? Please answer their number by sources of initiative.

(i) Internal development _____

(ii) Licensing agreement _____

(iii) Joint research with domestic institutions _____

(iv) Subcontract to domestic institutions _____

(v) Subcontract to foreign institutions _____

(vi) Other ( ) _____

Total: _____

13. The questions below inquire about your evaluation of the company's technological capabilities in several aspects compared with those of other firms in the same industry. Please indicate your evaluation by selecting an appropriate number.

	Very Inferior		Intermediate		Very Superior
a) Process technology	1	2	3	4	5
b) Operating technology	1	2	3	4	5
c) Design technology	1	2	3	4	5
d) Research and Development	1	2	3	4	5
e) Absorption and assimilation of imported technology	1	2	3	4	5

14. What are the principal difficulties your company has in the development of new products? Please select three from the following and list them in order of importance.

( ) ( ) ( )

1. Lack of technical information: 2. Lack of R&D funds; 3. Difficulties in recruiting technicians 4. Shortage of research equipment; 5. Shortage or outdatedness of production facilities; 6. Backwardness of related industrial technologies; 7. Lack of manager's interest and support; 8. Difficulties in marketing; 9. Customer's preference for low priced products; 10. Evasion of technology transfer by advanced countries; 11. Difficulties in technology import (high cost, disadvantageous terms, etc.); 12. Lack of assimilation capability for imported technology (language problems, shortage of existing technical potential, etc.); 13. Other ( )

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