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# Estimating UK investment in intangible assets and Intellectual Property Rights

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**Abstract**

This report estimates (a) the level of UK market sector investment in knowledge assets and (b) the proportions of those investments protected by Intellectual Property Rights (IPRs). Estimates for knowledge investment are produced as part of the UK Innovation Index. Our main findings are: 1) In 2011 the UK market sector invested £137.5bn in knowledge assets, compared to £89.8bn in tangible assets; 2) Since the recession of 2008-9, intangible investment has recovered and grew in 2010-11. In contrast investment in tangible assets has been flat; 3) In 2011, 48% (£65.6bn) of knowledge investment in the UK market sector was protected by IPRs 4) The majority of IPR investment is on assets protected by copyright (46%), unregistered design rights (21%) and trademarks (21%).

*Contacts: Jonathan Haskel and Peter Goodridge, Imperial College Business School, Imperial College, London. SW7 2AZ. j.haskel@ic.ac.uk, p.goodridge10@ic.ac.uk. We are very grateful for financial support for this research from NESTA and the UK Intellectual Property Office. This work was based on data from the Annual Survey of Hours and Earnings (ASHE), National Employers Skills Survey (NESS) and UK Innovation Survey (UKIS), produced by the Office for National Statistics and supplied by the Secure Data Service at the UK Data Archive. The data are Crown Copyright and reproduced with the permission of the controller of HMSO and Queen's Printer for Scotland. The use of the data in this work does not imply the endorsement of the ONS or Secure Data Service at the UK Data Archive in relation to the interpretation or analysis of the data. This work uses research datasets which may not exactly reproduce National Statistics aggregates. We thank Tony Clayton of the IPO for very helpful suggestions. Views expressed in this paper represent those of the authors and do not necessarily reflect those of affiliated institutions. All errors are of course our own.

# 1. Introduction

This report builds on previous work which estimated UK market sector investment in knowledge capital (Goodridge, Haskel and Wallis (2012)) and the proportions of those investments protected by formal intellectual property rights (IPRs) (Farooqui, Goodridge and Haskel (2011)). Investment in knowledge, or intangible, capital adds to the stock of intellectual property (IP) in the economy. Not all of that investment is protected by formal Intellectual Property Rights (IPRs) such as copyright and patents: investments in software are protected, but investments in workforce training are not. Thus this report attempts to answer the following questions: (a) how much does the UK invest in knowledge assets? and (b) what proportion of UK knowledge investment is protected by formal IPRs?

To answer these questions we first estimate UK market sector[1] investment in knowledge or intangible assets, using the comprehensive framework outlined in Corrado, Hulten et al. (2005), hereafter CHS. Second, we apportion various knowledge investments to investments in IPRs. Improvements to the data and methodologies used to estimate investment in artistic originals in the national accounts, based on our previous work (Goodridge and Haskel 2011; Goodridge, Haskel et al. 2012), means that, when combined with official UK software investment data (Chamberlin, Clayton et al. 2007), we can offer a better estimate for UK investment in copyright-protected assets. As well as other categories of knowledge assets, our dataset includes estimates of investment in research and development ('R&D'), 'Branding' (made up of 'Advertising' and 'Market Research') and 'Architectural and Engineering Design' (AED), upon which we base our estimates for investment in 'Patents', 'Trademarks' and 'Design Rights' (both registered and unregistered). Of course, not all such investment is protected by IPRs, so we use data from the Community Innovation Survey (CIS) to estimate the proportion that is protected. We estimate that: 38% of R&D is protected by patents and 3% by design registration; and 11% of AED is protected by design registration and 2% by patents.

It is worth noting that our estimates of IPR-protected investment are *not* measures of all UK spend on IPRs. Rather they are measures of all long-lived spending on creating knowledge assets, which contribute to the production of output over a period of greater than one year, and which is protected by formal IP mechanisms.

Our main findings are as follows:

1) In 2011, we estimate that the UK invested £137.5bn in intangible assets compared to £89.8bn in tangible assets;

[1] We define the market sector as sections A-K, MN, & RST according to the 2007 Standard Industrial Classification, thereby excluding Real Estate Activities (L), Public Administration & Defence (O), Education (P) and Health and Social Work (Q).

2) Since the recession of 2008-9, intangible investment has recovered and grew in 2010-11. In contrast investment in tangible assets has been flat;
3) In 2011, we estimate that approximately 48% of UK market sector investment in knowledge was protected by formal IPRs;
4) Of that investment in IPRs in 2011, we estimate that: 10% was in assets protected by patents; 46% in assets protected by copyright; 3% in assets protected by design registration; 21% in assets protected by unregistered design rights; and 21% in assets protected by trademark.

This report proceeds as follows. In section 2 we set out our conceptual framework. In section 3 we discuss our methods for measurement in the context of that framework and present our estimates for UK market sector investment in intangible assets. We also set out the measurement of tangible assets using the data available at time of writing from the Office of National Statistics. That data has been drastically revised since last year and so we present in the Appendix a detailed description of the changes. In section 4 we present our method and results on: the proportions of UK intangible investment protected by IPRs; and therefore our estimates of investment in IPR-protected assets. Section 5 concludes.

## 2. Conceptual Upstream-Downstream Framework

The following section is a summary of the appropriate conceptual framework to consider production of, investment in, and consumption of, intellectual property. It is based on the concept of 'upstream' and 'downstream' sectors, as applied in Corrado, Goodridge and Haskel (2011), where the upstream creates original IP assets and the downstream uses the IP to generate final output. For example, the upstream could produce film originals which are used by downstream cinema projectors or television broadcasters, or in the production and distribution of copies, in the generation of final output. Alternatively the upstream could consist of an R&D (or design) unit that produces commercial knowledge to be used in the downstream operations sector. This upstream-downstream framework can be applied to any form of long-lived knowledge that is used in the generation of final output.

Consider then an economy with an innovation (IP-producing) sector and a final output (IP-using) sector. The innovation sector (upstream) produces long-lasting knowledge assets which contribute to production in the final output (downstream) sector. In this economy we may write the value of gross output in the innovation sector as $P^N N$. This is equal to factor and intermediate costs in the sector multiplied by any mark-up (μ) over those costs, where μ represents the monopoly power earned by the innovator through the ownership of a unique knowledge asset, which may be formally protected by IPRs:

$$P^N N = \mu(P^L L^N + P^K K^N + P^M M^N + P^R R^N) \quad (1)$$

Where: $P^L L^N$, $P^K K^N$ and $P^M M^N$ are payments for labour, capital and intermediates. $P^R R^N$ are payments for intangible capital services, for instance royalty payments to use music in the production of a film original.

Consider next the final output or downstream sector, which uses the innovative good. They could purchase the asset rights (or some component of them) outright, for a cost $P^N N$ (or some proportion of $P^N N$). Alternatively they could rent the good by paying a licence fee, $P^R R$, for T years to the innovation sector. Capital market equilibrium implies that:

$$P^N N = \sum_{t=1}^{T} \frac{P^R R_t}{(1+r)^t} \quad (2)$$

Where R is the stock of knowledge from which they rent; using the perpetual inventory method (PIM) this might be represented by:

$$R_t = N_t + (1-\delta^R) R_{t-1} \quad (3)$$

Equation (2) says that the value of the asset must equal the discounted rental payments from the users of the good.

The final output sector, which uses the long-lived knowledge asset, produces output, $P^Y Y$.

$$P^Y Y = P^L L^Y + P^K K^Y + P^M M^Y + P^R R^Y \quad (4)$$

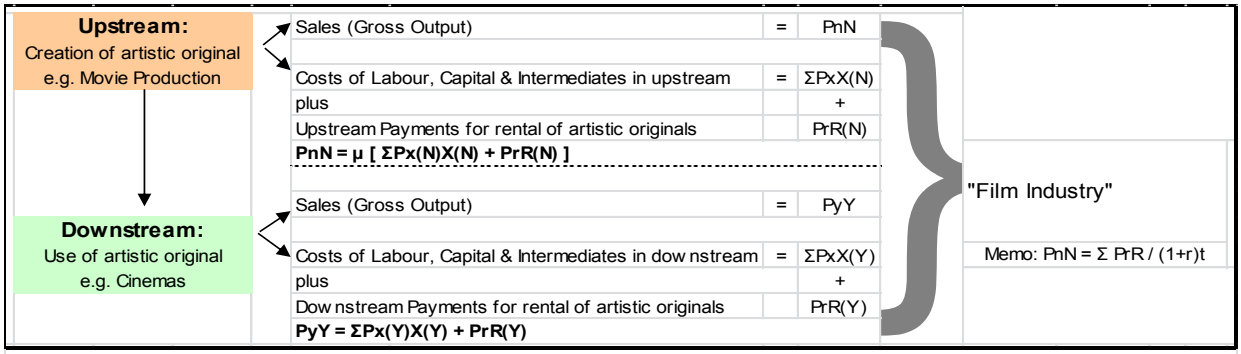
Where $P^L L^Y$, $P^K K^Y$ and $P^M M^Y$ are the payments to labour, physical capital and materials in the using sector, and $P^R R^Y$ are rental payments for using the IP created in the innovation sector. These payments could be explicit rentals, or implicit in the case where the IP is owned by the using firm. We assume that the final output sector is competitive and so there is no mark-up, μ. A similar income identity for the materials sector completes the model.

An adjusted concept of market sector value-added, that accounts for the capitalisation of intangible capital, consists of all the factor payments to labour and (tangible and intangible) capital, with intermediate payments excluded.

$$P^Q Q = P^L L + P^K K + P^R R \tag{5}$$

The following diagram provides a representation of the model using the example of film originals, but can be applied to any other form of IP.

**Figure 1**: Theoretical Framework. Upstream and Downstream in the Movie Industry




Note to Figure: To make the symmetry clear, a term for μ could also be included in the downstream. We assume that the downstream is competitive, so μ=1, always. Monopoly power does however exist in the upstream, due to the the ownership of rights to a unique asset. So in the upstream, μ>1.

To summarise, in this model, UK investment in IP is the production of long-lived (i.e. with a service life of at least one year) IP assets that are owned by UK residents. Consider then the following distinctions:

- 'UK IP production' is all IP production that takes places in the UK, regardless of ownership and duration of life;
- 'UK IP investment' is restricted to production of IP goods with a service life of more than one year repeatedly used in the production of output (assets), that are owned[2] by a UK resident;
- 'UK IP consumption' is the use of short- or long-lived IP, by firms resident in the UK, regardless of the residency of the owner;
- 'Consumption of UK IP' is the use of UK-owned short- or long-lived IP, in *all* downstream firms worldwide (not just those resident in the UK)
- 'UK consumption of UK IP' is use of short- or long-lived UK IP in UK downstream firms

[2] In the case of Film the relationships between funding, ownership and performance are clear. A film produced in the UK but with US funding and ownership is a US asset. With other knowledge assets, such as say R&D, these relationships are less clear. R&D performed in the UK with overseas funding may or may not be owned in the UK. Further, even if ownership resides overseas, some of the acquired knowledge remains in the UK. It is not 'forgotten'.

So, using our example of a film original, a feature movie produced in the UK but owned by an American firm would be classed as UK production but *not* UK investment. The projection of that same film in a UK cinema is 'UK IP consumption', but not 'consumption of UK IP'.

The above framework also highlights the weaknesses in analysing UK IP investment using official datasets. Suppose that we wish to measure the value of a TV or radio drama production ($P^N N$). Our framework illustrates why this is hard to do from published industry data as classified by the Standard Industrial Classification (SIC). Consider the SIC class "Television and Radio Activities'. This does not distinguish between the production of programmes and their broadcast. Moreover, production and broadcasting are often both undertaken by the same organisation. So, both upstream and downstream activities are included in this SIC class. Thus, a measure of sales for the whole industry includes: the downstream revenues earned by the broadcaster ($P^Y Y$), whether earned from long-lived IP assets or short-lived IP goods; all UK IP production, including short-lived news or sports programmes, and also UK production of assets owned in the Rest of the World (e.g. a US network funding and owning the rights to a programme produced in the UK); as well as UK IP investment ($P^N N$).

Therefore we cannot use published SIC data to identify UK IP investment. Instead, we identify UK production of IP assets owned in the UK. Continuing with the example of TV originals, we use data from production companies or network production arms. Such data are reported for ITV, BBC, Channel 4 in OFCOM reports. This allows us to make an estimate based on the upstream input costs of asset creation, as in (1). However, we have to undertake a number of adjustments. First, to identify investment, we must subtract the costs of production of short-lived goods such as news and sports. Second, we must deduct the costs of production for exported products (not UK-owned) and add in the value of imports (UK-owned). Third, converting such costs into output values requires an estimate of the mark-up, $\mu$, the value of which is uncertain. Alternatively, if available, measures of investment can be estimated using data on the income earned by that asset class ($P^R R$).[3] This latter approach is taken in the estimation of investment in literary and music originals.

## 3. Measurement

Our measurement approach is designed to be consistent with the UK National Accounts and therefore with official measures of output, income (accruing to labour and capital) and expenditure (including consumption and investment). We start by estimating investment in knowledge assets as identified by Corrado, Hulten et al. (2005) and applied in Goodridge, Haskel and Wallis (2012) for the UK. We

[3] In the steady-state, the value of investment is approximately equal to the value of capital compensation.

then adjust the official data from the National Accounts accurately to count spending on knowledge assets with a shelf-life of more than a year as investment rather than consumption, in a logically coherent framework that avoids double counting.

The categories of knowledge assets in our dataset are as featured in the NESTA Innovation Index, and discussed in greater detail below. Included are new estimates of investment in artistic originals, which have been revised in the national accounts, with the new estimates based on our previous work funded by the UK IPO (Goodridge and Haskel 2011; Goodridge, Haskel et al. 2012). As well as estimates of investment in knowledge by asset, we also present estimates of investment protected by IPRs, including splits between registered rights (patents, trademarks, registered design rights) and unregistered rights (copyright and unregistered design rights).

Below we provide a brief description of the methodologies and sources used to estimate expenditure and investment on UK production of knowledge goods, by asset type. For a more extensive description please consult past work such as Goodridge, Haskel and Wallis (2012).

Following Corrado, Hulten et al. (2005) we identify three broad groups of knowledge assets: i) Computerised information; ii) Innovative property; iii) Economic competencies. The following table sets out UK investment for each of these groups and the asset types within them. All estimates presented are new to this report.

**Table 1: UK Market Sector Investment; Tangible & Intangible, £bns nominal**

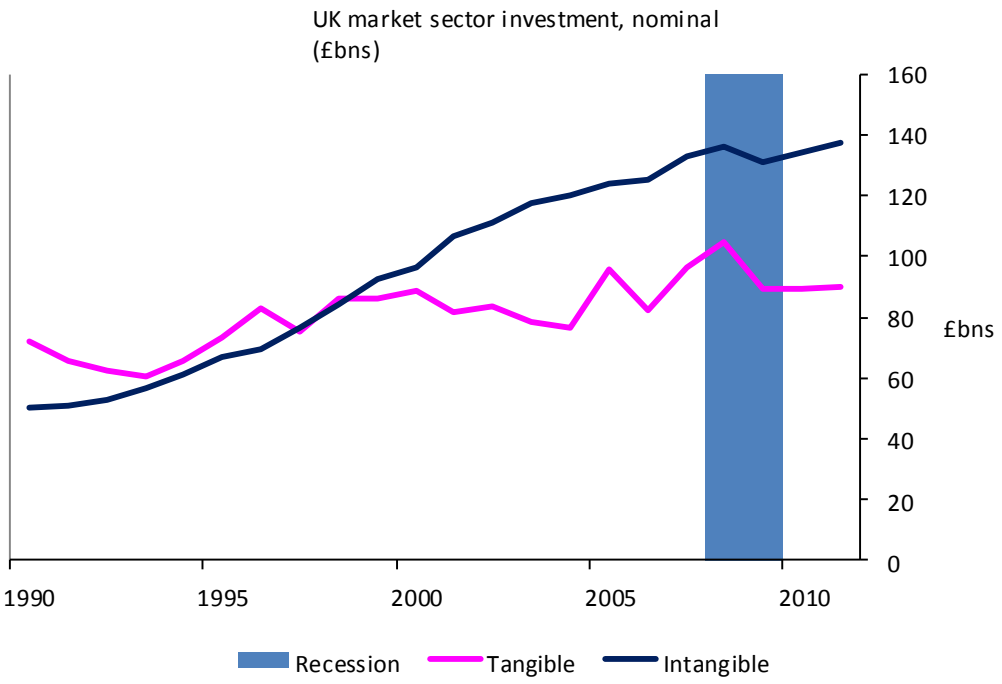
| Year | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Buildings | 27.0 | 20.5 | 31.5 | 33.7 | 41.7 | 50.6 |
| Plant & Machinery (incl. IT hardware and CT) | 35.3 | 42.6 | 47.9 | 51.2 | 34.3 | 35.0 |
| Vehicles | 9.8 | 10.3 | 9.1 | 10.7 | 13.6 | 4.2 |
| ***All tangibles*** | ***72.1*** | ***73.4*** | ***88.5*** | ***95.7*** | ***89.6*** | ***89.8*** |
| | | | | | | |
| **Intangible category** | | | | | | |
| **Computerised Information and databases** | **7.3** | **11.0** | **17.2** | **22.3** | **23.4** | **24.3** |
| Own-account Software | 4.8 | 5.8 | 9.9 | 11.9 | 12.9 | 13.2 |
| Purchased Software | 2.5 | 5.2 | 7.3 | 10.4 | 10.4 | 11.0 |
| | | | | | | |
| **Innovative property** | **18.9** | **20.9** | **27.8** | **35.5** | **39.0** | **40.7** |
| Scientific R&D | 7.3 | 8.3 | 10.7 | 12.7 | 14.8 | 15.9 |
| R&D in social sciences and humanities | 0.2 | 0.3 | 0.4 | 0.3 | 0.9 | 0.9 |
| Financial Product Innovation | 0.3 | 0.4 | 0.7 | 0.9 | 1.6 | 1.8 |
| Design (Own-account; Purchased) | 7.5 | 7.8 | 10.6 | 13.9 | 15.4 | 15.5 |
| Artistic Originals (Film; TV & Radio; Music; Books; Misc Art) | 1.9 | 3.0 | 4.9 | 7.0 | 5.7 | 5.8 |
| Mineral Exploration | 1.6 | 1.1 | 0.5 | 0.7 | 0.6 | 0.8 |
| | | | | | | |
| **Economic Competencies** | **24.1** | **34.9** | **51.2** | **66.0** | **72.1** | **72.6** |
| Branding (Advertising; Market Research) | 4.6 | 6.4 | 9.6 | 11.1 | 12.9 | 13.5 |
| Training | 13.7 | 16.9 | 23.6 | 29.2 | 32.2 | 33.6 |
| Organisational (Own-account; Purchased) | 5.9 | 11.7 | 18.1 | 25.7 | 27.0 | 25.5 |
| | | | | | | |
| ***All intangibles*** | ***50.2*** | ***66.8*** | ***96.2*** | ***123.8*** | ***134.5*** | ***137.5*** |

Source: Estimates for tangibles are ONS estimates of private sector investment plus that of public corporations, downloaded on 20th January 2014. Estimates for intangibles are constructed as described below. Note estimates of intangible investment do not equate to expenditure.

We note that these estimates for tangible investment are somewhat lower than we have presented in the past. This is due to ONS revisions to current price investment in the 1990s and 2000s. ONS (2014) reports that overall estimates of current price GFCF for combined assets has been revised down by about 3% on average over the period 1997 to 2010. Within that, tangible investment has been revised down by some 15% on average over that period, while intangible investment (referring only to intangibles already capitalised in the national accounts, namely purchased and own-account software, artistic originals and mineral exploration) has almost doubled in current prices. Changes to official estimates of intangible investment are due to: a) revisions to estimates of investment in artistic originals, based on our previous work (Goodridge and Haskel 2011; Goodridge, Haskel et al. 2012); and b) revisions to estimates of investment in own-account software to better account for net operating surplus in own-account software production (i.e. in terms of equation (1), to better account for $P^K K^N$).

The following chart presents estimates of aggregate market sector investment in tangible and intangible asset categories over the period 1990 to 2011. The recession is highlighted using the blue bar.

**Figure 2. UK market sector investment in tangible and intangible assets, Nominal £bns**




Source: ONS for tangible (downloaded 20th January 2014), this report for intangible

There are two main points to note from this chart. First, investment in intangibles has been consistently higher than investment in tangibles since 1999. Second, although investment in intangibles did decline during the recession it has since recovered and has been growing since 2010. Nominal intangible investment grew at rates of 2.7% in 2010 and 2.2% in 2011. In contrast, tangible investment collapsed in 2009 and has failed to recover since. Nominal tangible investment fell by 15.7% in 2009, and only grew by 0.2% in 2010 and also 2011.

On tangible investment, these are the latest ONS data and reflect recent revisions to official estimates of UK investment. They show that, in 2011, the level of nominal intangible investment is almost equal to its level in 2000 (£90bn in 2011 compared to £89bn in 2000). Therefore, according to the latest data, it seems that over the longest expansion in post-war economic history, nominal tangible investment barely grew at all. The story of the 2000s is one of a slow decline in tangible investment between 2000 and 2004, before a rise in the mid-2000s and then a collapse in the later recession. These data are studied in more depth in Appendix 2. They show that the rise in the mid-2000s is driven primarily by investment in commercial property and intangibles (i.e. those intangibles already capitalised in the national accounts, namely software, artistic originals and mineral exploration). Nominal investment in plant is recorded at a lower level in 2012 than in 1998 (£39bn in 2012 compared to £46bn in 1998). This reflects ONS revisions to nominal investment which primarily consist of a downward revision to investment in plant and an upward revision to investment in

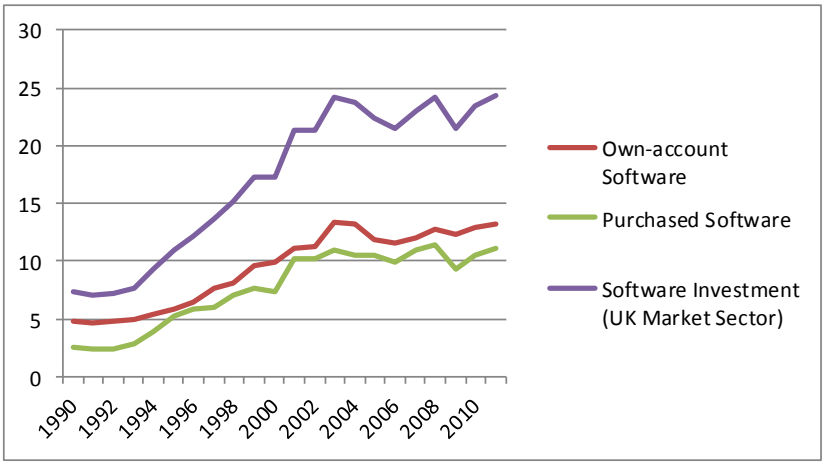
intangibles. Note that insofar as plant investment includes computers and software, whose price is falling, nominal investment might fall even if quantities rise.

We now go on to discuss our measurement, and estimates of investment for each asset in more detail.

### 3.1 Computerised Information and databases

As Table 2 shows, software investment in 2011 was considerable at approximately £24bn, comfortably exceeding Scientific R&D and also a broader definition of R&D that encompasses R&D in social sciences and financial product innovation. Total Software investment comprises both purchased and own-account[4], and also computerised databases. Software is already capitalised in the National Accounts, and so our source for computer software investment is contained in the ONS work described by Chamberlin, Clayton et al. (2007). Purchased software data are based on company investment surveys and own-account based on the wage bill of employees in computer software occupations, adjusted downwards for the fraction of time spent on creating new software (as opposed to, say routine maintenance) and then upwards for associated overhead costs (a method we use for design below). The data, which run from 1997 to 2011, are updated data provided by ONS. The data are backcast further using previous estimates of market sector software investment as reported in Goodridge, Haskel et al. (2012). Estimates are presented below. We assume that 100% of investment in this asset category is protected by copyright.

**Figure 3. Software: UK Investment, Nominal £bns**



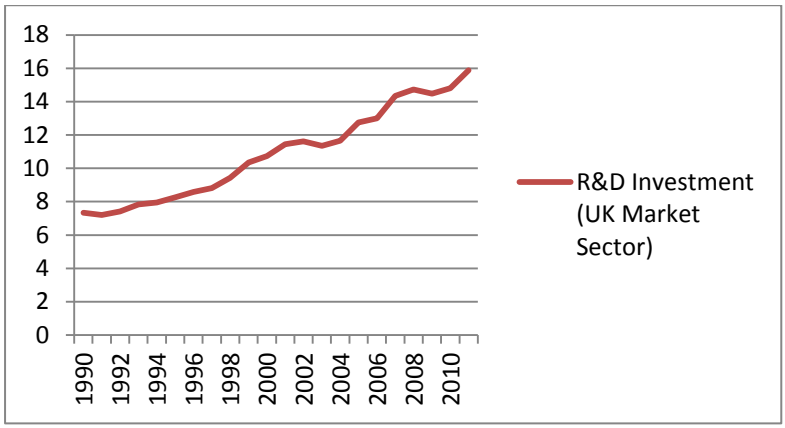

Source: ONS

[4] Own-account software is software developed by in-house employees

### 3.2 Scientific R&D[5]

As shown in Table 3, in 2011 investment in scientific R&D was approximately £16bn. For business *Scientific R&D* we use expenditure data by industry derived from the Business Enterprise R&D survey (BERD), which provides data back to 1981. To avoid double counting of R&D and software investment, we subtract R&D spending in "computer and related activities" (SIC 72) from R&D spending since this is already included in the software investment data. R&D that takes place in R&D products is assumed to take place in the R&D services industry, and that spend is allocated out using data on shares of R&D purchases in the Supply Use tables.[6] Since BERD also includes physical capital investments we convert those investments into a capital compensation term, using the resulting physical capital stocks for the R&D sector and the user cost relation[7]. Below we estimate that 38% of this investment is protected by patents and 3% by registered design rights.

**Figure 4. Scientific R&D: UK Investment, Nominal £bns**




Source: ONS, BERD

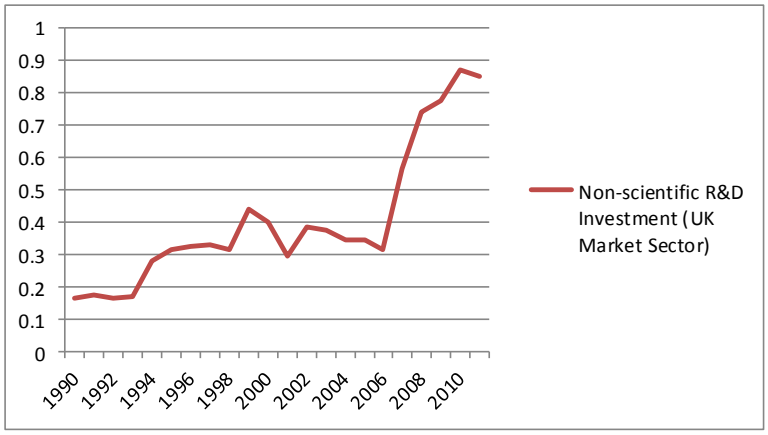
### 3.3 R&D in social sciences and humanities

In Table 4 the estimate for R&D in social sciences and humanities is £0.9bn in 2011. R&D in social sciences and humanities is estimated as twice the turnover of the industry "Research and experimental development on social sciences and humanities" (SIC07 72.2), where the doubling is assumed to capture own-account spending. Turnover data are taken from published data for the Annual Business

[5] Scientific R&D was capitalised in the 2008 revision to the System of National Accounts, and capitalisation in the UK is due to be implemented in 2014.
[6] The BERD data gives data on own-account spending. Spending is allocated to the industry within which the product upon which firms are spending belongs. That is we assume that R&D on say, pharmaceutical products takes place in the pharmaceutical industry. Spending on "R&D services" is allocated to business services. The R&D services are sold to purchasing firms. We therefore allocate this spending out to the purchasing industries using shares constructed from the supply use tables.
[7] $PK = PI(\rho+\delta)$, where PK is the rental price of physical capital; PI is the asset price, $\rho$ is the real rate of return and $\delta$ is the depreciation rate.

Survey (ABS) and previously the Annual Business Inquiry (ABI) and are available for 1997 to 2011. Data are backcast using turnover data published in the Service Sector review and Business Monitor. This is a small number and we suspect there is little marginal benefit to improving its measurement. We assume that this investment is not protected by formal IPRs. The series for non-scientific R&D is presented below.

**Figure 5. Non-Scientific R&D: UK Investment, Nominal £bns**

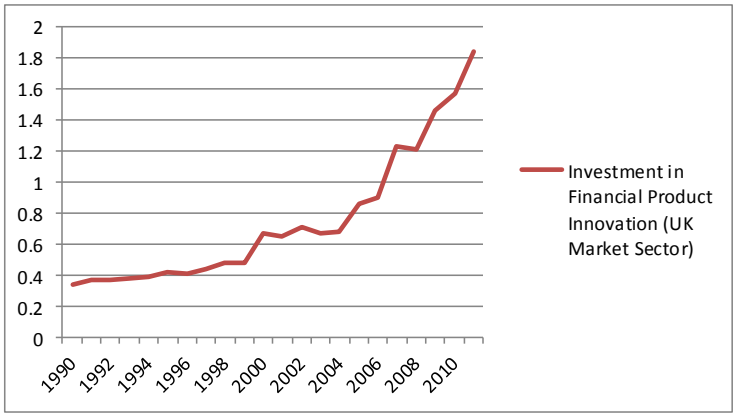



Source: ONS, ABS, ABI

### 3.4 Financial Product Innovation

In Table 5, investment in Financial Product Innovation is estimated at £1.8bn in 2011. The measurement methodology for *New products development costs in the financial industry* follows that of own account software. Further details are in Haskel and Pesole (2010) but a brief outline is as follows. First, we interviewed a number of financial firms to try to identify the job titles of workers who were responsible for product development. Second, we compared these titles with the available occupational and wage data from the Annual Survey on Hours and Earnings (ASHE). The occupational classification most aligned with the job titles was 'economists, statisticians and researchers'. Third, we asked our interviewees how much time was spent by these occupations on developing new products that would last more than a year. Some firms based their estimates on time sheets that staff filled out. Fourth, we asked firms about the associated overhead costs with such workers. Armed with these estimates, we went to the occupational data in the ASHE and derived a time series of earnings for those particular occupations in financial intermediation. Own-account investment in product development is therefore the wage bill, times a mark-up for other costs (capital, overheads etc.), times the fraction of time those occupations spend on building long-term projects. This provides data for 1997 to 2011. Data are backcast further using the growth rate of industry turnover. We assume that such investment is not covered by formal IP rights.

**Figure 6. Financial Product Development: UK Investment, Nominal £bns**




Source: Own estimates, based on ASHE

### 3.5 Architectural and Engineering Design

As shown in Table 6, for 2011 we estimate investment in Design at £15.5bn in 2011. Purchased data are taken from the Supply-Use Input Output (IO) tables. For own-account we use the own-account software method. Full details are set out in Galindo-Rueda, Haskel et al. (2008).

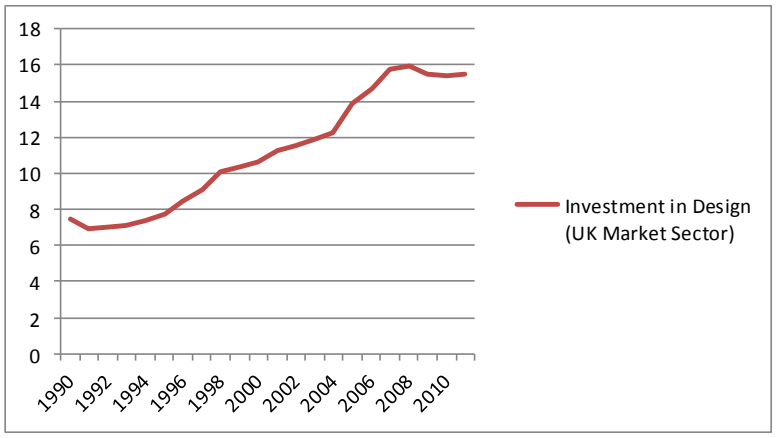
In the case of purchased investments, as in Goodridge, Haskel et al. (2012), we have chosen to exclude purchases of design by the industry itself ('Professional, Scientific and Technical Activities', SIC 69t74), since some of these purchases will certainly include outsourcing and subcontracting arrangements which would be double-counting. On own-account, the choice of occupations and the time allocation are, as in financial services, taken from interviews with a number of design firms. We focus on architectural, engineering and design (AED) activities, including architects, engineers (excluding software) and general designers (graphic, product and clothing designers). Interestingly, almost all of the design firms we interviewed have time sheets for their employees which break out their time into administration, design and client interaction/pitching for new business (almost all firms target, for example, that junior designers spend little time on administration and senior more time on pitching). Thus, for professional designers, we assigned 50% of their time to 'long lived design' and engineers only 10%, with 60% to the rest.

On engineers we note that here there is the potential for double-counting with R&D, since the wages and salaries of engineers that conduct R&D will be reported in the BERD data. Not all engineers will be involved in R&D however. This is another reason for choosing to only allocate 10% of the time of engineers to investment in design.

Further since some design expenditure/activity is short-lived rather than on the building of long-lived assets, we further reduce the estimate by 50% to account for this. This factor is again based on interviews conducted with design companies and the UK Design Council.

These methods provide estimates of investment for 1997 to 2011. Own-account estimates are extended back further using data from the New Earnings Survey (NES) and purchased using data from previous versions of the Supply Use Tables (back to 1992) and prior to that data on the turnover of the design industry as published in the Business Monitor. Our series for UK investment in architectural and engineering design is presented below. In a section below we estimate that 11% of this investment is protected by registered design rights, and 2% by patents. We assume the remaining 87% is protected by unregistered design rights.

**Figure 7. Architectural and Engineering Design: UK Investment, Nominal £bns**




Source: Own estimates, based on ASHE and ONS Supply Use Tables

### 3.6 Artistic Originals

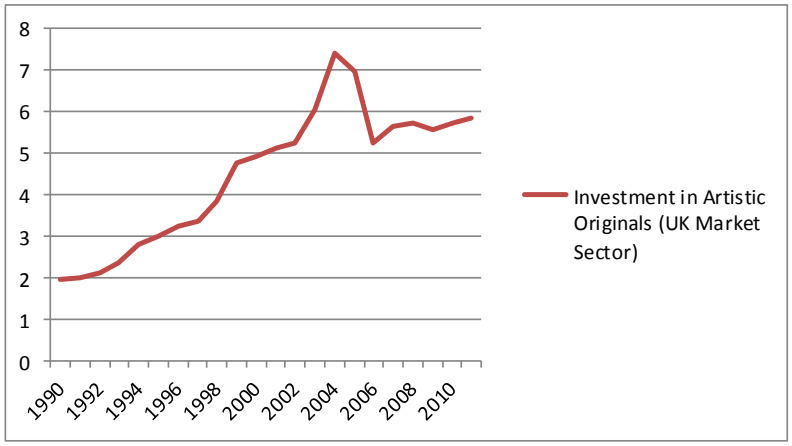
From Table 7, in 2011 the estimate for investment in 'Artistic Originals' is £5.8bn. Artistic Originals are already capitalised in the national accounts so we use those data. These estimates are revised from past estimates, using new methods and data, based on our previous work funded by the IPO (Goodridge and Haskel 2011; Goodridge, Haskel et al. 2012). We briefly describe the data and methods used below. The estimates incorporate measures of UK investment in: Film; TV & Radio; Music; Books; and Miscellaneous Art.

Estimates for investment in film originals are built bottom-up using data on budgets for UK productions using a microdata set of all UK films produced since 1991. The dataset includes information on co-producing partner countries and indicators on majority and minority funding. We use such information to construct UK ownership shares for each individual film, providing us with an estimate of investment in each UK-owned film original. Estimates for television and radio are based

on data for production costs for UK broadcasters, as published in OFCOM Annual Reports, excluding expenditure on short-lived genres or formats such as 'News' or 'Current Affairs'. Estimates for investment in literary originals are calculated using measures of the capital compensation that flows to the owners of rights (namely publishing houses and authors). Under the assumption of steady-state conditions, such compensation can be used as a proxy for investment. Similarly, estimates for investment in recorded originals (music) are also calculated using an income-based approach, with the data on income incorporating the revenues earned by the owners of rights through recording sales, royalties distributed by the music collecting societies, and revenues earned from live performance. For other forms of art that meet the criteria for artistic originals (photography/images, choreographed routines, fine art etc.), estimates are produced using data on the labour costs of relevant occupations as reported in ASHE, and reduced by 50% to account for the possibility of such professions earning a proportion of their income from other sources.

The official data for investment in Artistic Originals run from 1997 to 2011. We extend the estimates back further using a combination of our own estimates (Goodridge and Haskel 2011; Goodridge, Haskel et al. 2012) and the old national accounts estimates from prior to the revision. The series for investment in this asset category is presented below.[8] One of the criteria for identifying artistic originals is that they are covered by copyright. We therefore assume that 100% of investment in this asset category is protected by copyright.

**Figure 8. Artistic Originals: UK Investment, Nominal £bns**




Source: ONS, based on Goodridge and Haskel (2011) and Goodridge, Haskel et al. (2012).

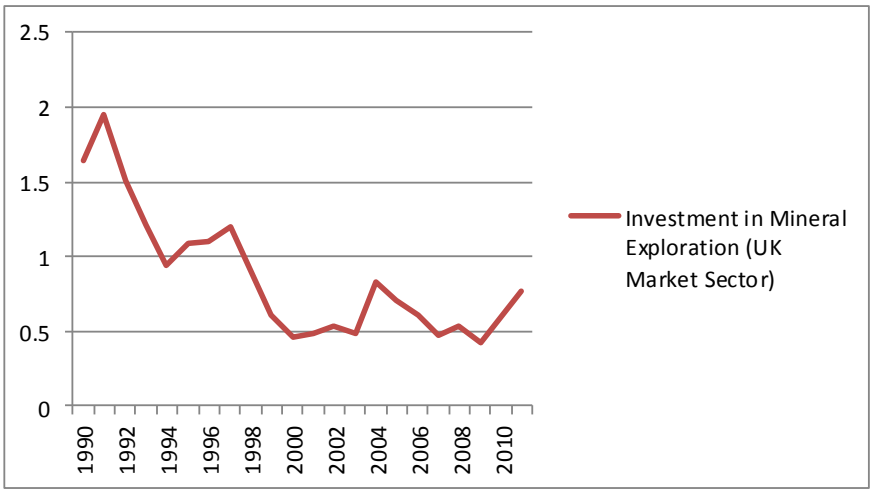
### 3.7 Mineral Exploration

As shown in Table 8, in 2011 investment in Mineral Exploration was £0.8bn. Like computerised information and artistic originals, *mineral exploration* is already capitalised in the National Accounts

[8] We note the unusual spike in the series in the mid-2000s which we intend to investigate further.

and the data here are simply data for Gross Fixed Capital Formation (GFCF) from the ONS, valued based on "payments made to contractors or costs incurred on own account. The costs of past exploration, not yet written-off, are re-valued (which in this case may well *reduce* the value). This expenditure covers the costs of drilling and related activities such as surveys. It is included in GFCF whether or not the exploration is successful." (ONS 1998). These data run from 1997 to 2011. They are extended back further using data from past releases of the national accounts.

**Figure 9. Mineral Exploration: UK Investment, Nominal £bns**

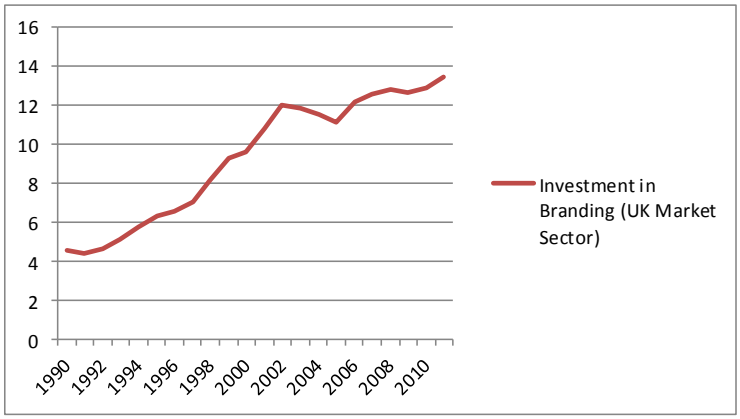



Source: ONS

### 3.8 Branding: Advertising and Market Research

As shown in Table 9, in 2011 we estimate total investment in Branding to have been around £13.5bn. Of this, advertising made up £9.9bn, and market research £3.6bn. Each category is estimated using data on purchases from the Supply Use Tables (product group 73: Advertising and market research services) across all industries. As with design, we exclude purchases made by the industry itself (SIC 69t74, Professional, Scientific and Technical Activities) since some of these purchases include outsourcing and subcontracting arrangements which would be double counting. Advertising and Market research are split using data from the ABS and estimates for market research are further doubled to allow for own-account expenditure. As with design, not all expenditure goes toward the building of reputational assets, since some is short-lived. To account for this we take 60% of the expenditure estimates and assume that proportion represents investment. These data are available from 1997 to 2011. Data are extended back further using previous estimates constructed from past releases of the Supply Use Tables. Our series for investment in Branding is presented below.

**Figure 10. Branding: UK Investment, Nominal £bns**

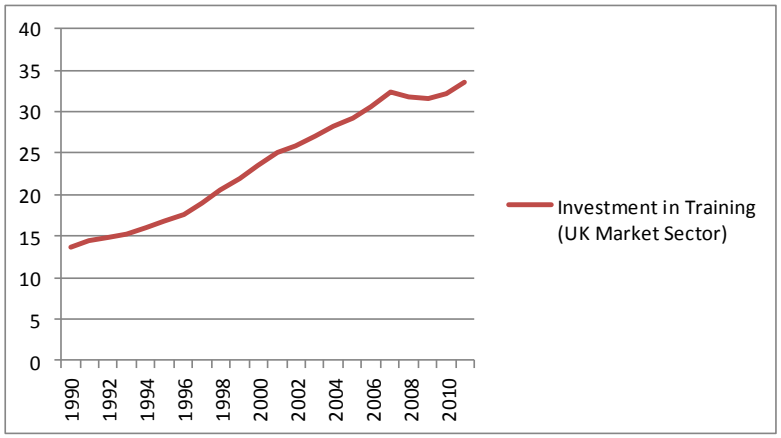



Source: Own estimates based on ONS Supply Use Tables

### 3.9 Firm-specific human capital (Training)

From Table 10, our estimate of investment in Training is £33.6bn in 2011. *Firm specific human capital* - training provided by firms - was estimated using cross sections from the National Employer Skills Survey for 2007 and 2009. We also have data for 1988 from an unpublished paper by John Barber. We thus backcast the series using the EU KLEMS[9] wage bill time series benchmarking the data to three cross sections, and extend the series forward with ONS compensation of employees. Our series for investment in Training is presented below.

**Figure 11. Training: UK Investment, Nominal £bns**




Source: Own estimates based on NESS

### 3.10 Organisational Structure

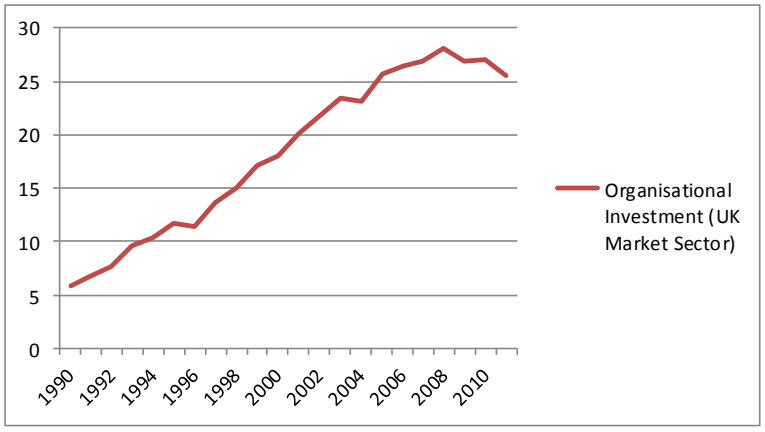
As shown in Table 11, for 2011 we estimate investment in organisational structure at £25.5bn. Our data on investment in *organisational structure* relies on purchased management consulting, on which we have consulted the Management Consultancy Association (MCA), and own-account time-spend,

[9] http://www.euklems.net/project_site.html

as before. On purchased, the MCA state that they represent 70% of the industry. We therefore apply an upward adjustment to account for the remainder of the industry. We have MCA data for the years 2002-05 and 2009-10. Estimates for other years are interpolated and extrapolated using data on the turnover of the management consulting industry from the ONS ABS and its predecessors. We also assume that not all purchased organisational knowledge represents investment. Therefore 20% of purchased consultancy is removed from the investment figure, on the basis that not all of the knowledge acquired is long-lived capital. The method for own-account relies on identifying managers by occupation. Then using ASHE, we take 20% of the managerial wagebill and assume that covers the own-account costs of investments in the improvement of organisational processes.

Our own-account estimates run from 1997 to 2011. They are backcast further using data from the NES. Our series for organisational investment is shown below. We assume that none of these investments are protected by formal IPRs.

**Figure 12. Organisational Structure: UK Investment, Nominal £bns**




Source: Own estimates based on data from the MCA and ASHE

All the above estimates are presented at the aggregate market sector level. Appendix 1 presents estimates of intangible investment at the industry-level. Appendix 2 discusses any changes to the above estimates compared to those we have published previously.

# 4. Estimating the proportions of knowledge investment protected by IPRs

In measuring investment in assets protected by different types of IPRs, we also need to estimate what proportion of investment is protected by IPRs. In this section we discuss our methods to do that.

IPRs can be split into two broad groups: registered and unregistered rights. The first requires formal application from innovators, the second are automatic and invoked by the innovator when necessary. Table 12 summarises the IP rights considered in this report, how they fit into each of these groups and previews our findings of what proportion of investment is protected by IPRs (by asset type).

**Table 2: Registered and Unregistered Rights; % of investment protected by IPRs**

| | Registered | | | Unregistered | | |
|---|---|---|---|---|---|---|
| Asset \ IPR | Patents | Trademarks | Design Registration | Copyright | Unregistered Design rights | % of investment protected by IPRs |
| Artistic Originals | 0% | 0% | 0% | 100% | 0% | 100% |
| Software | 0% | 0% | 0% | 100% | 0% | 100% |
| Branding | 0% | 100% | 0% | 0% | 0% | 100% |
| Scientific R&D | 38% | 0% | 3% | 0% | 0% | 41% |
| Design | 2% | 0% | 11% | 0% | 87% | 100% |

Note to table: estimates for percentage protected by IPRs based on this report. Note that shares of investment protected do not equate to shares of expenditure protected.

First consider 'Artistic Originals'. One of the criteria set out by Eurostat for classification as an artistic original is that it must be covered by copyright. Therefore we consider our estimates of investment in these assets to all fall within the category of 'investment in copyrights'. Regarding software, since all copyrighted works are recognised automatically when asserted by the owner, we classify all investment in software (own-account and purchased) as 'investment in copyrights', alongside investment in artistic originals.

For Branding, we also estimate that 100% of our measure of investment is protected by Trademarks. Our reasoning is as follows. We recognise that not all expenditure on advertising and market research constitutes investment. Based on industry discussions we estimate investment in brands as 60% of expenditure on advertising and market research. In doing so, we effectively remove all short-lived expenditure. Since the remaining investment is by definition long-lived, we allocate all of that to our category 'investment in trademarks'.

The remaining forms of intangible investment that can be protected by formal IPRs are Scientific R&D and Design, each of which can be protected by either patents or design registration. We estimate the proportions of these assets protected by these mechanisms below, using the Community Innovation Survey (CIS) and econometric analysis. On R&D, we estimate that 38% of R&D is protected by patents and 3% by registered design rights. On Design, we estimate that 11% is protected by registered design rights and 2% by patents. Since 'unregistered design rights' are

automatic, we allocate the remaining 87% of investment to this IPR category. We summarise our method and results below. We note that results in the wider literature are supportive of these findings.

### 4.1. Allocating IP protection to investment

To estimate the fraction of investment protected by IPRs we may proceed via a) a questionnaire or b) an econometric approach.

*a) Questionnaire*

There is a small body of work that attempts to ask what type of protection methods are used by firms. First, in US work a minority of firms report using formal IP protection methods, and instead typically report the use of first-mover advantages, secrecy or no formal protection at all. Cohen, Nelson et al. (2000) asked firms whether they introduced a process and/or product innovation and which IP protection mechanism they considered effective. In a sample of 1,065 American research laboratories in manufacturing, 1991-93, patents were considered effective in 34% of product innovations and for 23% of process innovations. Patents were considered most effective in pharmaceuticals (50%) and medical equipment (55%).

Second, in Europe, Arundel (2001) studies the question using the 1993 CIS for innovative manufacturing firms in Norway, Germany, Luxembourg, the Netherlands, Belgium, Denmark, and Ireland. He presents the percentage of the 2,848 R&D performing firms who give the highest rating to lead time, secrecy, complexity, patents and design registration. Patents score 11.2% and 7.3% for product and process innovations.

Third, Haskel and Pesole (2011) use the CIS to estimate how many firms report using design rights. They find that 15% of firms report registering a design and that this is in line with other studies.

Fourth, Farooqui, Goodridge and Haskel (2011) use data from the UK CIS. In a section "Protection of Innovation" firms are asked to report the relative importance (no, low, medium and high) of eight different protection mechanisms:

1) Design Registration
2) Trademarks
3) Patents

4) Copyright
5) Confidentiality Agreements
6) Secrecy
7) Complexity of Design
8) Lead time advantage over competitors

They found that the majority (52%) of firms report using none of these mechanisms, and those that do use a combination of them. They also found that those who do report using such mechanisms tend to be the largest spenders on R&D and other intangibles.

Table 2 from Farooqui, Goodridge and Haskel (2011) is reproduced below. It shows that, in manufacturing for instance, only 31% of firms report using patents but these firms also conducted 94% of industry expenditure on R&D and 81% of industry expenditure on Design. Similarly, in manufacturing, only 31% of firms report using design registration but conducted 49% of design expenditure and 82% of R&D. Similar patterns exist for other industries. In general those authors find that while attitudinal responses show a preference for informal IP mechanisms, the R&D spending relative to sales profile is skewed towards those firms that prefer formal IP mechanisms.

**Table 3: Reported importance of IP methods, by industry**

| Industry | Agric, Fish, Mining | | | Manufacturing | | | Gas Elect Water | | | Consttruction | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Firms | R&D spend (£'000s) | Design Spend (£'000s) | Firms | R&D spend (£'000s) | Design Spend (£'000s) | Firms | R&D spend (£'000s) | Design Spend (£'000s) | Firms | R&D spend (£'000s) | Design Spend (£'000s) |
| | 367 | 84209 | 6492 | 12819 | 4479866 | 760295 | 104 | 11262 | 910 | 3517 | 57174 | 99812 |
| | % | % | % | % | % | % | % | % | % | % | % | % |
| Firms using Patents | 17 | 94 | 81 | 31 | 94 | 81 | 15 | 2 | 91 | 9 | 71 | 90 |
| Firms using Trademarks | 19 | 88 | 66 | 35 | 92 | 80 | 17 | 89 | 94 | 13 | 80 | 89 |
| Firms using Design | 14 | 89 | 34 | 31 | 82 | 49 | 16 | 1 | 40 | 11 | 73 | 34 |
| Firms using Copyrights | 13 | 92 | 32 | 30 | 90 | 50 | 24 | 91 | 49 | 11 | 71 | 33 |

| Industry | Distbn, retails, hotels, restu | | | Financial intermed | | | Business Service | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Firms | R&D spend (£'000s) | Design Spend (£'000s) | Firms | R&D spend (£'000s) | Design Spend (£'000s) | Firms | R&D spend (£'000s) | Design Spend (£'000s) | Firms | R&D spend (£'000s) | Design Spend (£'000s) |
| | 11245 | 362422 | 130779 | 1533 | 130314 | 37942 | 8815 | 2095602 | 310993 | 132 | 3336 | 239 |
| | % | % | % | % | % | % | % | % | % | % | % | % |
| Firms using Patents | 13 | 72 | 45 | 11 | 52 | 20 | 17 | 89 | 91 | 14 | 5 | 24 |
| Firms using Trademarks | 20 | 70 | 84 | 20 | 62 | 50 | 23 | 85 | 81 | 21 | 19 | 25 |
| Firms using Design | 15 | 66 | 38 | 14 | 53 | 8 | 18 | 79 | 40 | 15 | 7 | 11 |
| Firms using Copyrights | 15 | 65 | 25 | 20 | 66 | 36 | 25 | 85 | 49 | 33 | 26 | 36 |

Note to table. Each cell shows, by industry, the percentage of firms using each protection type and the fraction of all spending on R&D and design in that industry that those using firms account for. Note that firms can report that they use more than one protection type.

Source: CIS.

*b) Econometric estimation*

To examine this for the UK, we use the fifth wave of the CIS (2004-2006). In the econometric approach there are two preliminary issues to be dealt with. First, firms use multiple protection methods. Second, the methods are subject to firm specific response bias. Therefore, in order to

isolate response specific variation, we compute the mean importance across all 8 mechanisms ($\overline{m}$), and the associated standard deviation ($\varpi$). All responses are then adjusted by the mean and standard deviation to correct for the response bias. Let $m$ denote the score of a particular mechanism and let $m_s$ denote its standardized value then

$$m_s = \frac{m - \overline{m}}{\varpi} \tag{6}$$

For example, let's say a firm reports an importance vector of (0, 1, 2, 1, 2, 2, 3, 3) for design registration, trademarks, patents, copyright, confidentiality, secrecy, complexity and lead-time respectively. The firm-specific mean is (0+1+2+1+2+2+3+3)/8=1.75, and the standard deviation is 1.035. The above transformation then returns an importance of (1-1.75)/1.035 = -0.72 for trademark and copyright, equivalently it returns an importance of (3-1.75)/1.035 = 1.2 for complexity and lead-time.

The standardization assumes that each individual response is taken from the same underlying normal distribution. It therefore endows each individual response the same measurement unit and amplifies the importance of those responses that are further away from the firm bias[10]. In doing so the transformation signifies relative importance to the others.

Consider now the allocation of spend. Each firm reports R&D and other intangible spend and the use of possible multiple methods of IP protection. Hence the question is: how do we allocate the spend in each firm to its reported IP?

Consider R&D. How much R&D is: (a) protected by patents; and (b) protected by registered design rights. To answer this we conduct a firm-level regression analysis that correlates the R&D to sales ratio with the different IP types. While the regression analysis does not make any causal assumptions, it can be regarded as a reduced form description of the sensitivity of R&D/sales to reported use of IP. The regression takes the following form:

$$y_{ijt} = \beta' \vec{X}_{ijt} + \gamma' \overrightarrow{\sigma(X)}_{ijt} + \lambda' \vec{Z}_{ijt} + \delta' \vec{D}_{jt} + \varepsilon_{ijt} \tag{7}$$

[10] We note that this transformation (a) requires the mean for each firm of the transformed variable is 0 and (b) transforms firm level responses to missing if there is no variation in returns i.e. all importance rankings are firm specific but not response specific.

Where on the left hand side we use R&D as a % of sales. On the right hand side, the vector $\overrightarrow{A}_{ijt}$ represents firm level IP use intensity and contains standardized responses for the individual IP mechanisms. The firm level mean and standard deviation of these responses is captured in the vector $\overrightarrow{\sigma(A)}_{ijt}$. The IP use vector can be expanded out as:

$$\begin{aligned}\overrightarrow{A}_{ijt} - \alpha + \beta_0 Design + \beta_1 Trademarks + \beta_2 Patents + \beta_3 Copyright \\ + \beta_4 Confidentiality + \beta_5 Secrecy + \beta_6 Complexity + \beta_7 Lead\ Time\end{aligned} \quad (8)$$

Where $\alpha$ captures the R&D/Sales intensity of those firms that do not rely on any IP mechanism, $\beta_2$ captures the elasticity of R&D intensity to patent use holding all other forms of IP use constant, and $\beta_0$ the elasticity of R&D intensity to the use of design registration holding all other forms constant. The $\beta$ coefficients are not structural parameters and therefore do not represent a causal change in demand for R&D intensity i.e. we are not saying that firms first decide on IP use and then how much to spend on R&D. Rather, they are the reduced form correlations and can be regarded as a summary of the various elasticities. As long as the use/importance of each IP mechanism is measured in the same units, we can calculate the ratio $\frac{\beta_i}{\Sigma_{i=0}^{7}\beta_i}$ which would give the share of spending that would be accounted for by firms using IP type i as protection, as a share of total spending by those firms using any form of protection.

As implied by (7) we also include a number of control variables. As noted we include the firm level mean and standard deviation of IP responses. We also include the % of employees with a degree in science or engineering, the log of employment and industry dummies.

The R&D relationship is analysed using standard OLS. For Design, we note that questions on design expenditure are less well answered on the CIS (Awano, Franklin, Haskel et al (2010a)). There are also many instances where firms respond positively to the question of whether they undertake activity but the expenditure estimate is zero or missing. Therefore we use the binary question on design activity and so employ a probit procedure. Since the questions on R&D expenditure appear to be better answered, we have more confidence in using the expenditure data in the case of R&D.

The results are presented below in Table 4. Column 1 presents a probit regression for design, where the left-hand side variable is a binary yes/no response and the right hand side includes demeaned responses for each IP protection mechanism as described above. Also included in the regression, but

not shown, are the control variables described above. Column 2 reports the marginal effects from this regression. Column 3 presents the results of an OLS estimation, where the left-hand side variable is R&D/Sales and the right hand side includes demeaned responses on the importance of IP mechanisms and the control variables. In each regression, in order to identify the idiosyncratic impact of the different mechanisms we assign one mechanism as the reference category and constrain its impact to zero.

**Table 4: Regression estimates of proportions of R&D and Design protected by IPRs**

| | | (1) | (2) | (3) |
|---|---|---|---|---|
| EQUATION | VARIABLES | Design (1/0) | Marg. Effects of Col (1) | R&D/Sales |
| | | | | |
| design_yn | Designd | 0.0549* | 0.0190* | 0.0368 |
| | | (0.0283) | (0.00981) | (0.145) |
| | Trademarksd | 0.0119 | 0.00412 | |
| | | (0.0263) | (0.00910) | |
| | Patentsd | 0.00958 | 0.00332 | 0.415*** |
| | | (0.0294) | (0.0102) | (0.146) |
| | Confidentialityd | 0.0250 | 0.00867 | 0.00889 |
| | | (0.0297) | (0.0103) | (0.118) |
| | Copyrightd | 0.0619** | 0.0214** | 0.160 |
| | | (0.0274) | (0.00947) | (0.137) |
| | Complexityd | 0.247*** | 0.0854*** | 0.343*** |
| | | (0.0292) | (0.0101) | (0.122) |
| | LeadTimed | 0.0948*** | 0.0328*** | 0.00972 |
| | | (0.0252) | (0.00871) | (0.111) |
| SINGLE | Secrecyd | | | 0.129 |
| | | | | (0.118) |
| | | | | |
| | Observations | 6,823 | 6,823 | 3,965 |
| | R-squared | | | 0.165 |
| | Standard errors in parentheses | | | |
| | *** p<0.01, ** p<0.05, * p<0.1 | | | |
| | | | | |
| | Sum of marginal effects: Σβi | | 0.17471 | 1.10241 |
| | % protected by Patents | | 1.9% | 37.6% |
| | % protected by Design rights | | 10.9% | 3.3% |

Note to table: Column 1 is a probit regression using a binary yes/no variable on whether firms conduct design as the regressor. Column 2 reports the marginal effects for the regression in column 1. Column 3 reports an OLS regression using the firm R&D/sales ratio as the regressor. Columns 1 and 3 include controls such as industry dummies, the mean and standard deviation of responses on IP mechanisms, employment and the proportion of employees with a degree in science or engineering.

Column 2 reports the marginal effects for the regression in Column 1. According to these estimates, the most important IP protection mechanisms for firms conducting design are: 1) Complexity; 2) Lead Time; 3) Copyright; 4) Design registration; in that order. We wish to determine what proportion of design is protected by: a) registered design rights; and b) patents. Taking the marginal effect for each of these mechanisms as the sum of all the marginal effects we estimate that: 11% of design is

protected by registered design rights; and 2% of design is protected by patents. By assumption, the remainder of design (87%) is protected by unregistered design rights.

Column 3 presents our results for R&D, this time using R&D intensity as the dependent variable. The results suggest that the most important protection mechanisms for R&D are: 1) Patents; 2) Complexity; 3) Copyright; 4) Secrecy; and 5) Design Registration. Since the coefficient on each mechanism provides an estimate of the marginal effect, taking the coefficient on patents and design registration as a sum of all the coefficients, we estimate that: 38% of R&D is protected by patents; and 3% of R&D is protected by registered design rights.

One might reasonably imagine that these effects vary by industry and hence we would wish to run separate regressions for each industry. We are however limited in our ability to conduct a similar regression exercise for each and every industry. On the one hand, most R&D activity is limited to specific sectors. On the other hand, the CIS survey simply does not survey enough firms in very detailed industries of interest, such as pharmaceuticals, and we are limited in our ability to exploit firm level variations and draw statistically meaningful conclusions. In addition, disclosure concerns dictate a certain degree of aggregation. With these trade-offs in mind, we only conduct our analysis at the aggregate market sector level.

Of the remaining assets not discussed in this section, such as Training and Organisational Structure, we assume that none of these investments are protected by formal IPRs. Of course certain licensing rights apply to activities such as Mineral Exploration, but not IPRs which are our interest in this report.

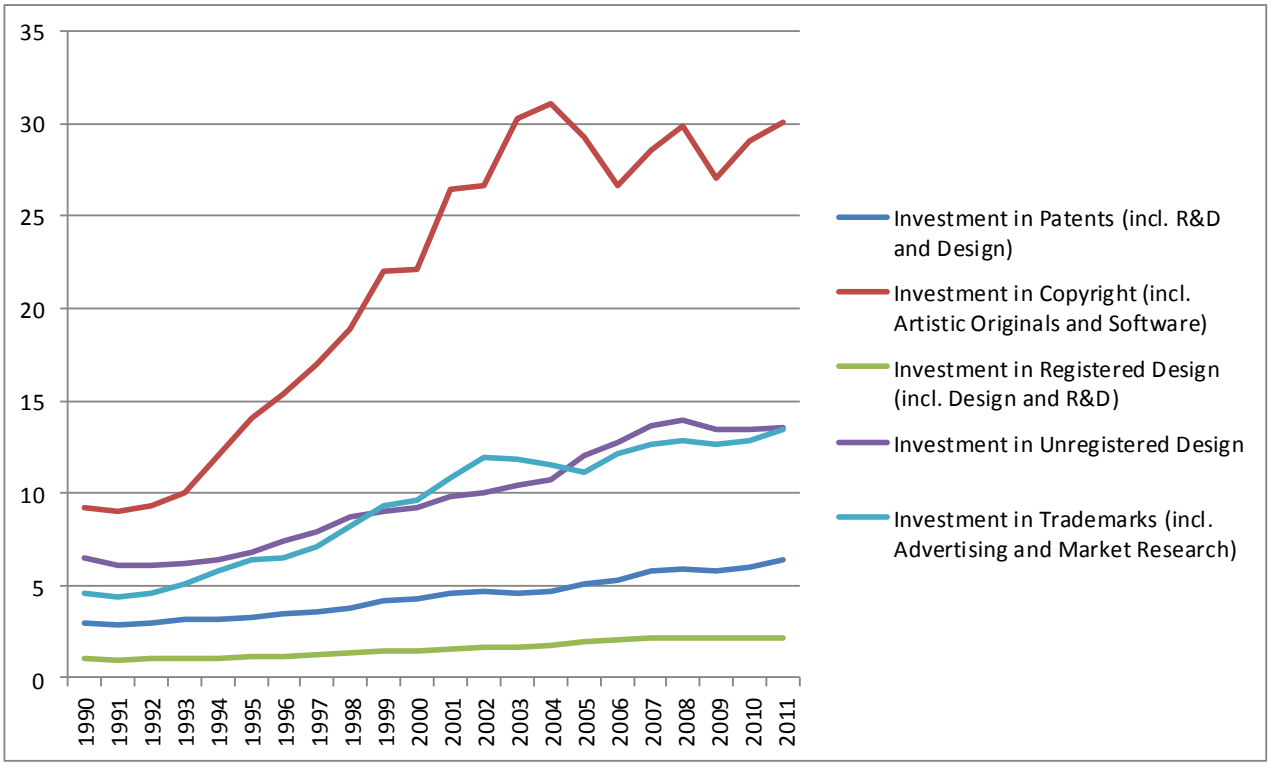
We now apply our estimates of what proportion of investment is protected by IPRs, to our dataset. Results are presented below in Table 5. We estimate that almost half (48% in 2011) of UK investment in intangibles is in assets protected by formal IPRs, amounting to £65.6bn in 2011. Of that, almost half (46% in 2011) is in assets protected by copyright, namely software and artistic originals. Of the remainder, trademarks and unregistered design rights each account for 21%, patents for 10%, and registered design rights for 3%. A chart showing estimated investment in each of the five types of IPR is presented below in Figure 13.

**Table 5: UK Market Sector Investment in Intellectual Property Rights (Nominal, £bns)**

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| Investment in Patents (incl. R&D and Design) | 2.9 | 3.3 | 4.3 | 5.1 | 5.2 | 5.8 | 5.9 | 5.8 | 5.9 | 6.3 |
| Investment in Copyright (incl. Artistic Originals and Software) | 9.2 | 14.0 | 22.1 | 29.3 | 26.7 | 28.6 | 29.9 | 27.0 | 29.1 | 30.1 |
| Investment in Registered Design (incl. Design and R&D) | 1.0 | 1.1 | 1.5 | 1.9 | 2.0 | 2.2 | 2.2 | 2.1 | 2.1 | 2.2 |
| Investment in Unregistered Design | 6.5 | 6.8 | 9.2 | 12.1 | 12.8 | 13.7 | 13.9 | 13.4 | 13.4 | 13.5 |
| Investment in Trademarks (incl. Advertising and Market Research) | 4.6 | 6.4 | 9.6 | 11.1 | 12.2 | 12.6 | 12.8 | 12.7 | 12.9 | 13.5 |
| | | | | | | | | | | |
| ***Total Investment in IPRs*** | ***24.2*** | ***31.5*** | ***46.8*** | ***59.5*** | ***58.8*** | ***62.8*** | ***64.8*** | ***61.1*** | ***63.5*** | ***65.6*** |
| | | | | | | | | | | |
| ***Total Investment in Intangibles*** | ***50.2*** | ***66.8*** | ***96.2*** | ***123.8*** | ***125.5*** | ***132.8*** | ***135.8*** | ***130.9*** | ***134.5*** | ***137.5*** |

Note to table: Investment in patents estimated as 38% of investment in scientific R&D plus 2% of investment in design. Investment in copyright estimated as 100% of investment in artistic originals and software. Investment in registered design estimated as 11% of investment in design plus 3% of investment in scientific R&D. Investment in unregistered design estimated at 87% of investment in design, that is, the remainder of design investment not allocated to patents or registered design. Investment in trademarks estimated as 100% of investment in advertising and market research.

**Figure 13. Total Investment in assets by IP coverage, Nominal £bns**




Source: Own estimates, see note to Table 5.

In this report we have presented nominal measures of investment in intangible assets, and on intangible asset protected by formal IPRs. Real, or volume, measures would require deflating these estimates with an appropriate price index. In this context it is worth saying something about real investment in R&D and therefore patented R&D. Here our estimate for investment in patented R&D is £6.4bn in 2011, having risen from £2.9bn in 1990. The average rate of growth in nominal patented R&D, over the period 1990 to 2011, is 3.7%. Applying an output price index such as a GDP deflator, as is typical for R&D, rising at a rate of approximately 3 to 4% p.a., would imply that there has been almost no rise in real R&D investment. However, recent studies suggest that the implicit price of R&D may have been falling rapidly due to technological innovation in the R&D upstream sector (Corrado, Goodridge and Haskel (2011)). Those authors estimate the price of R&D in the UK to have fallen at an average rate of approximately -7.5% p.a. over the period 1985 to 2005. Applying this price index would therefore imply that real patented R&D investment has grown at a rate of approximately 11% p.a. over the period considered here.

# 5. Conclusions

Applying the intangibles framework, as used in the NESTA Innovation Index, we find that total UK market sector investment in intangible assets reached £137.5bn in 2011, compared to £89.8bn of investment in tangible assets. We also note that since the recession of 2008-9, intangible investment

has recovered and grew in 2010-11. In contrast investment in tangible assets has been flat. Of the £137.5bn invested in intangibles in 2011, we estimate that approximately half (£65.6bn) was investment protected by formal IPRs (patents, copyright, registered design rights, unregistered design rights or trademarks). Of investment protected by IPRs, the largest component is investment in copyright, which stood at £30.1bn in 2011. Investment in unregistered design rights and trademarks were each £13.5bn in 2011, investment in patents, £6.3bn, and investment in registered design rights, £2.2bn.

In forming these estimates we first identify investment in each intangible asset, as set out in Corrado, Hulten et al. (2005). We then form estimates of how much investment in each asset type is formally protected by IPRs. In doing so, we allow for the fact that both scientific R&D and Architectural and Engineering Design can be protected by either patents or registered design rights. We estimate that 38% of investment in scientific R&D is protected by patents and 3% by registered design rights. We also estimate that 11% of investment in Design is protected by registered design rights and 2% by patents. The remainder of investment in Design is assumed to be protected by unregistered design rights. We further assume that 100% of investment in Artistic Originals and Software is protected by copyright, and that 100% of investment in Advertising and Market Research is protected by Trademarks.

We emphasise that this work estimates investment in knowledge assets and the proportions of that investment protected by formal IPRs. We take no stand on whether investment in knowledge assets is higher or lower than it would have been were those assets not protected by IPRs. That area requires further work. Whilst some evidence suggests that the ability to use IPRs increases investment in innovation through the incentive of monopolist revenues, others suggest that the same mechanism reduces innovation by removing the incentive to continually innovate.

Nevertheless, the scale of investment in IPR-protected assets is not fully appreciated. Investment in IPRs is higher than that in commercial buildings and also higher than plant & machinery (including ICT) and vehicles combined. The role of assets protected by IPRs, as drivers of growth, deserve greater consideration in both measurement and policy.

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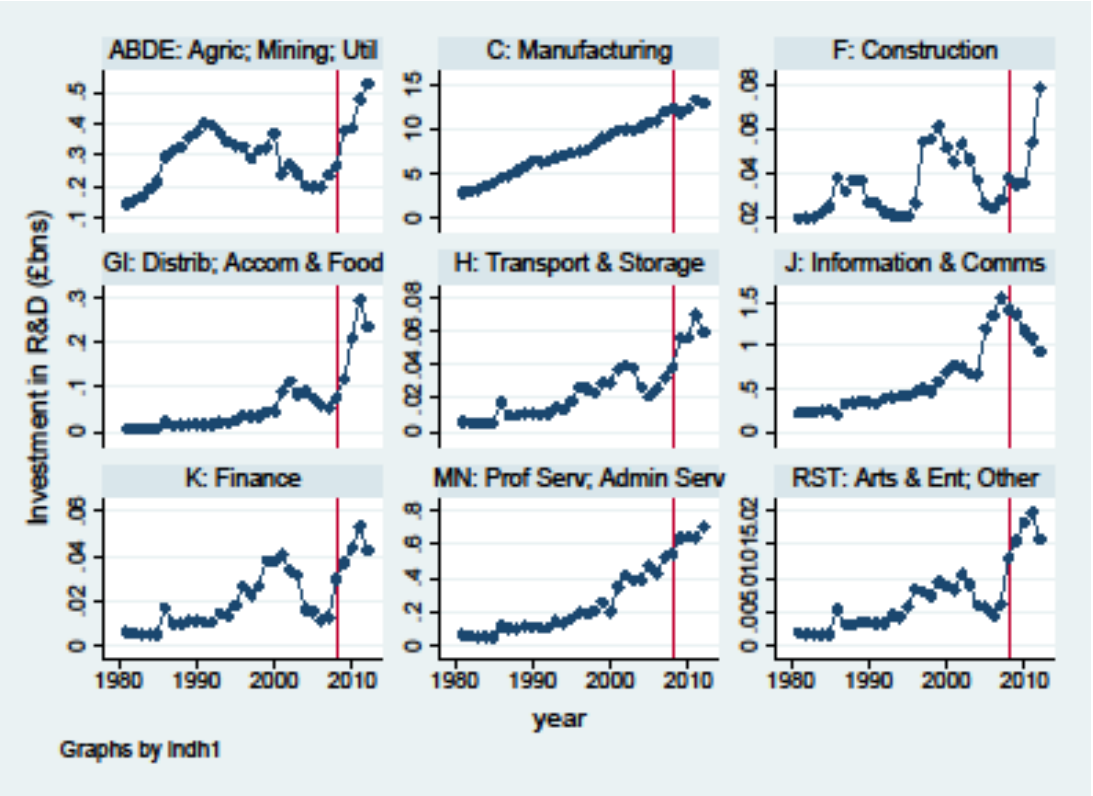
**Appendix 1: Industry-level Intangible Investment**

This appendix presents data for nominal intangible investment at the industry level, based on a nine industry breakdown. The following charts present industry data for each intangible asset. Where relevant, estimates of own-account and purchased estimates have been summed for that category. Estimates for advertising and market research have also been summed to form the asset category 'Branding'. In each chart the line at 2008 marks the start of the recent recession.

**Figure A1.1: Industry-level investment in R&D**




Note to figure: Y-axes for each chart have different scales

**Figure A1.2: Industry-level investment in Mineral Exploration**

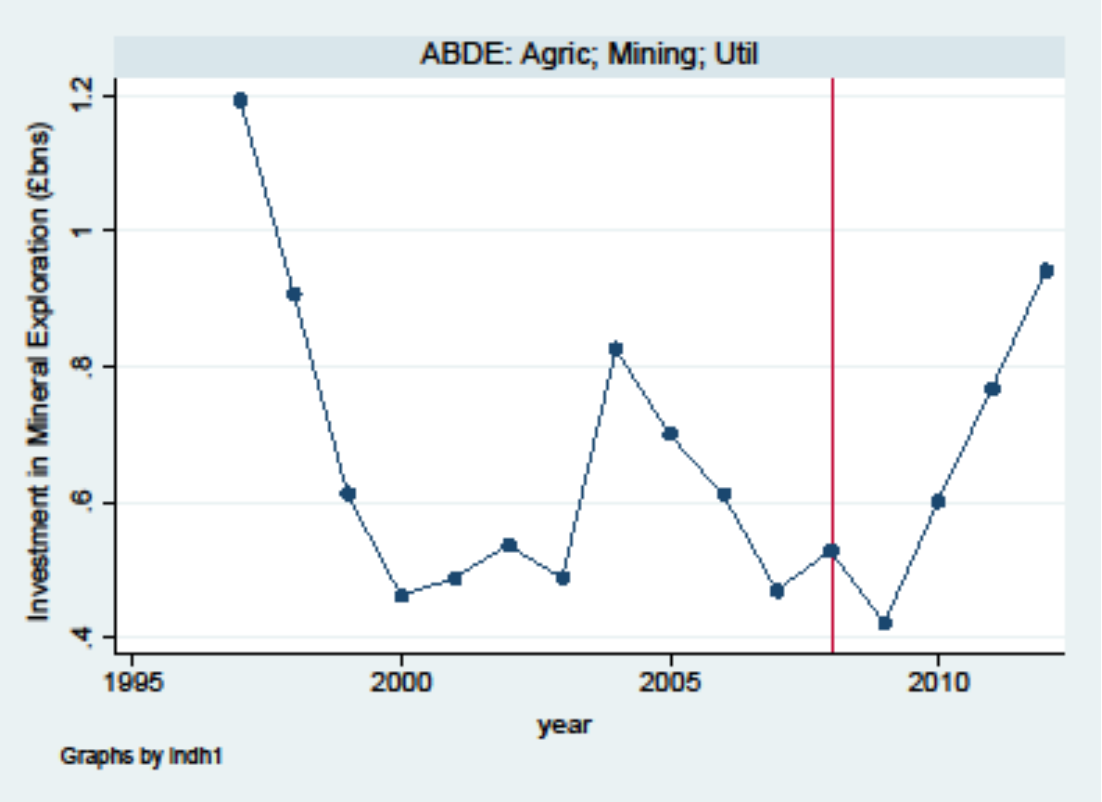



**Figure A1.3: Industry-level investment in Financial Product Innovation**

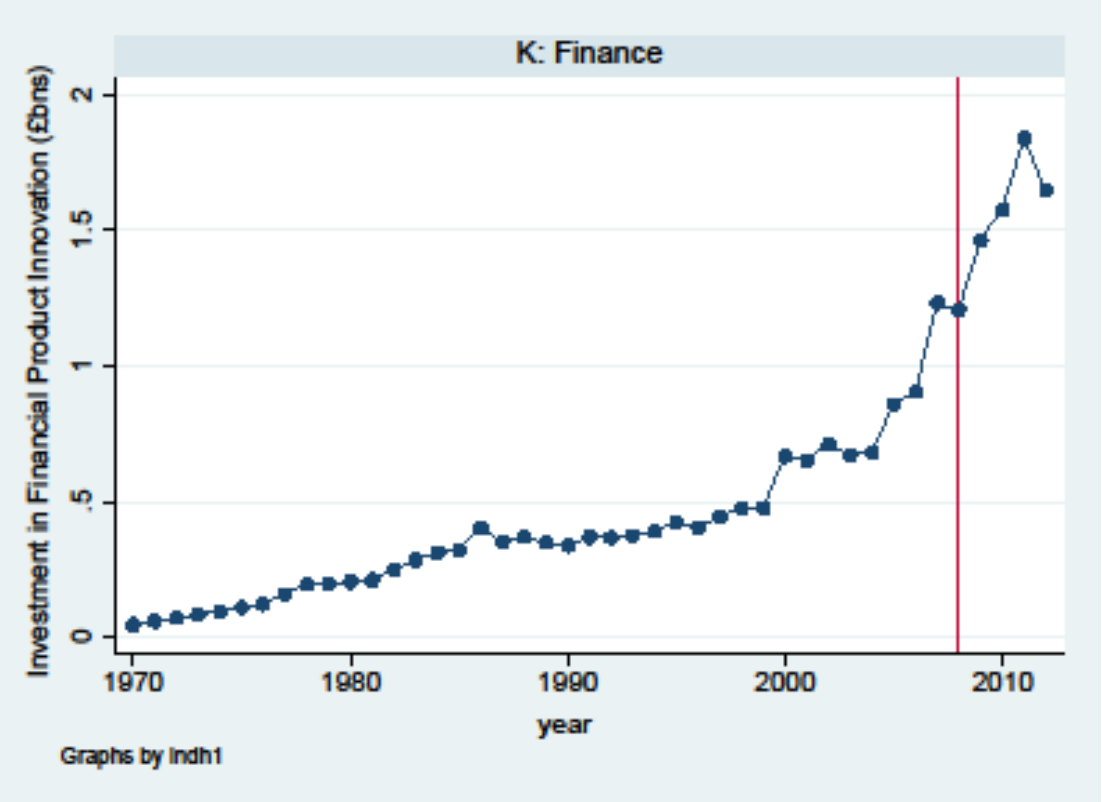


**Figure A1.4: Industry-level investment in Design**

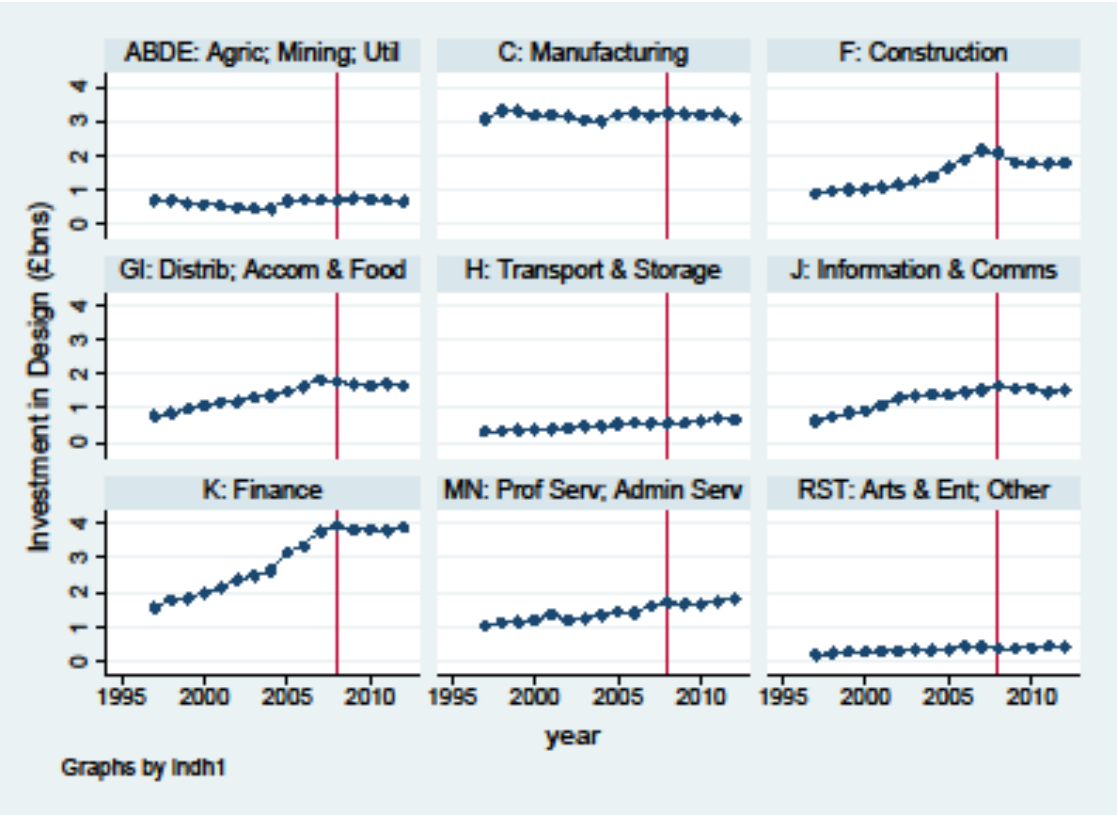



**Figure A1.5: Industry-level investment in Non-scientific R&D**

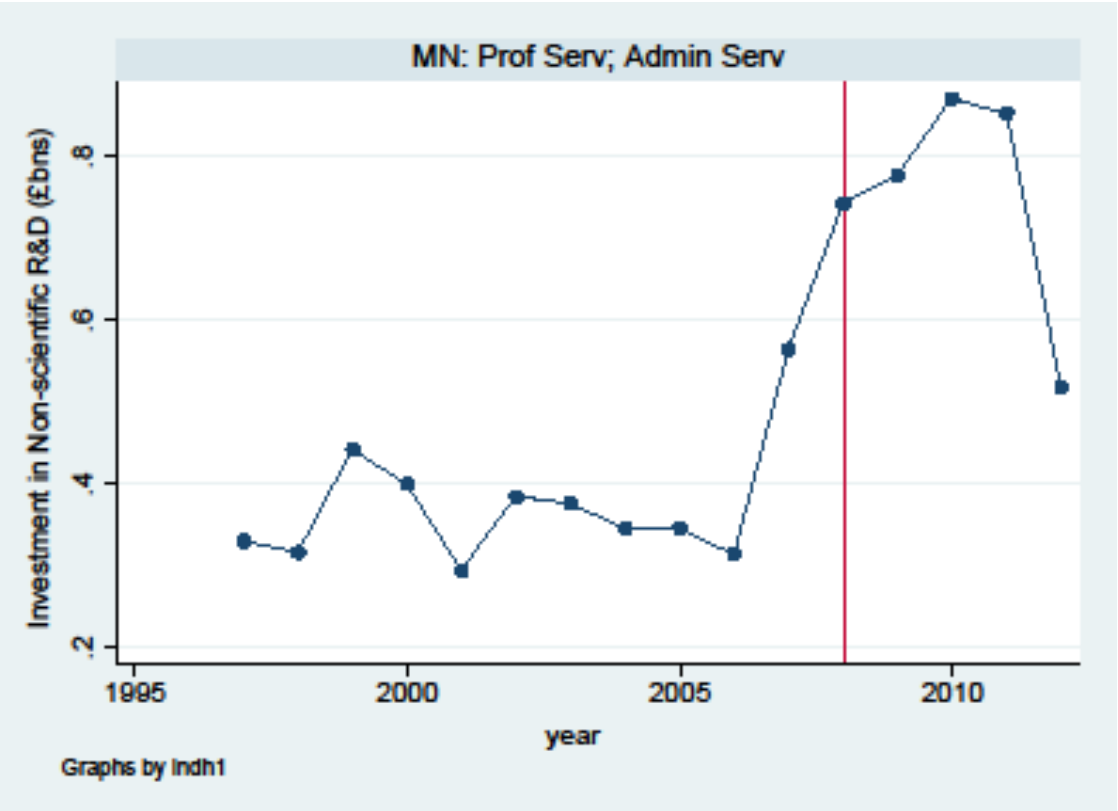


**Figure A1.6: Industry-level investment in Training**

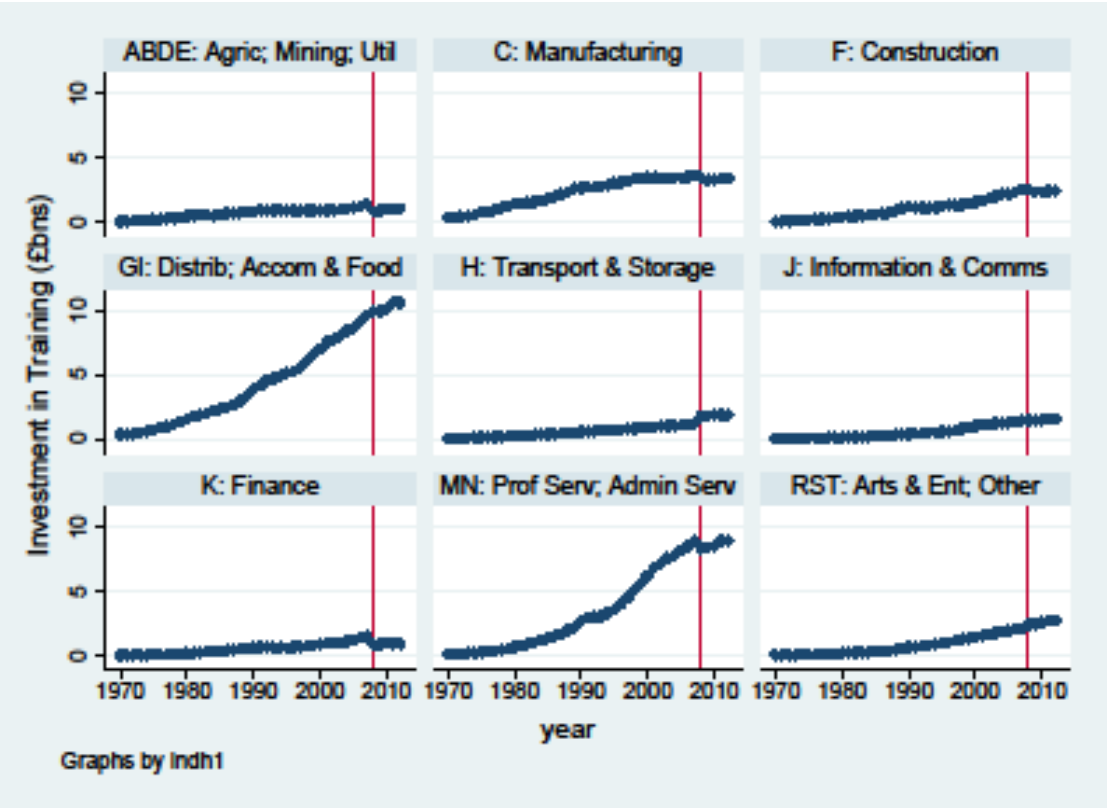



**Figure A1.7: Industry-level investment in Artistic Originals**

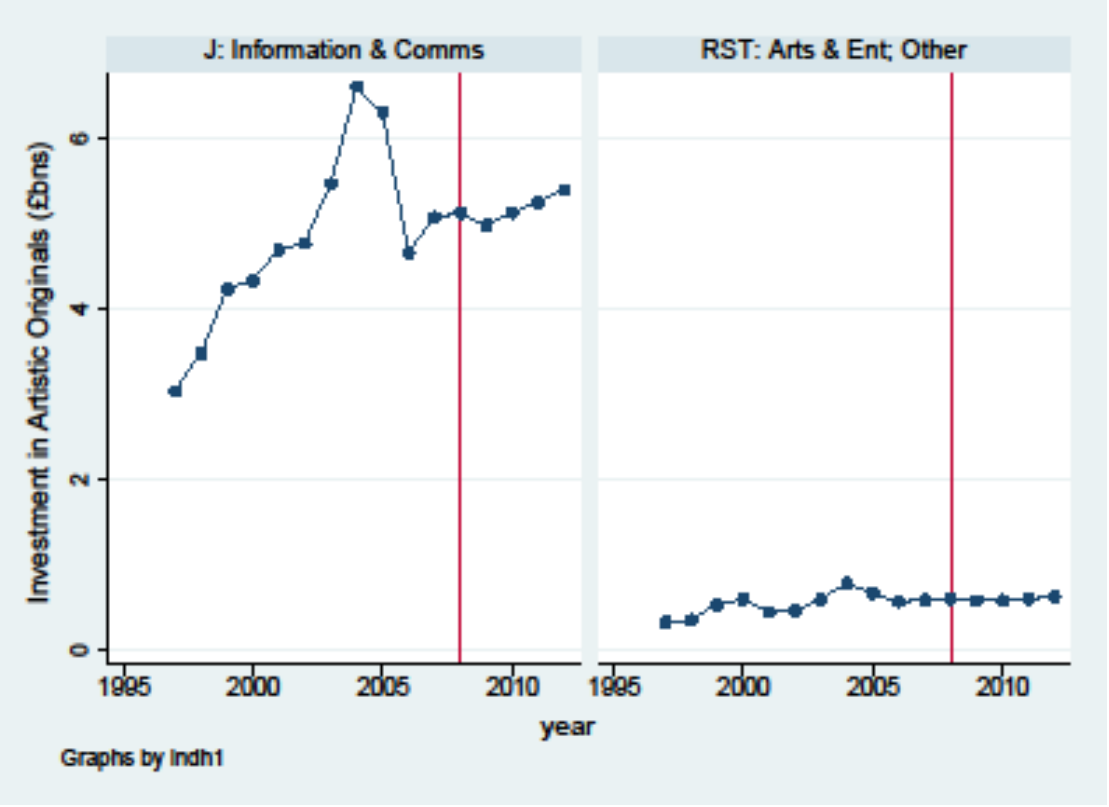


**Figure A1.8: Industry-level investment in Organisational Processes**

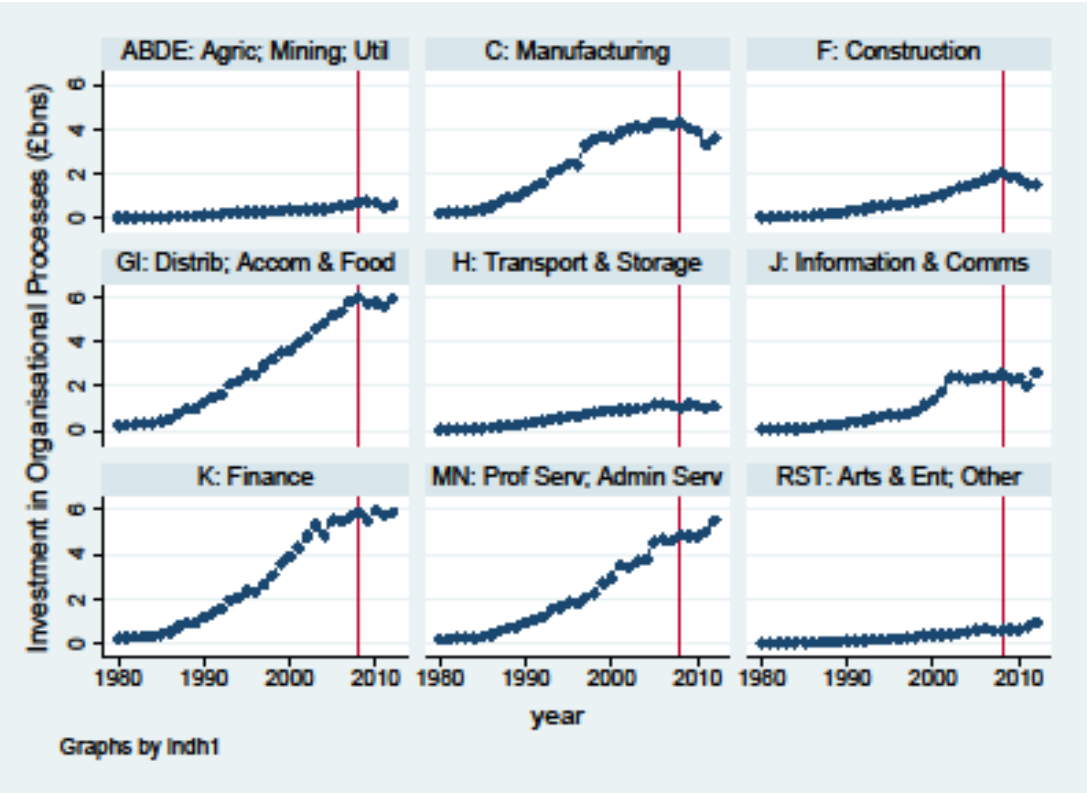



**Figure A1.9: Industry-level investment in Software**

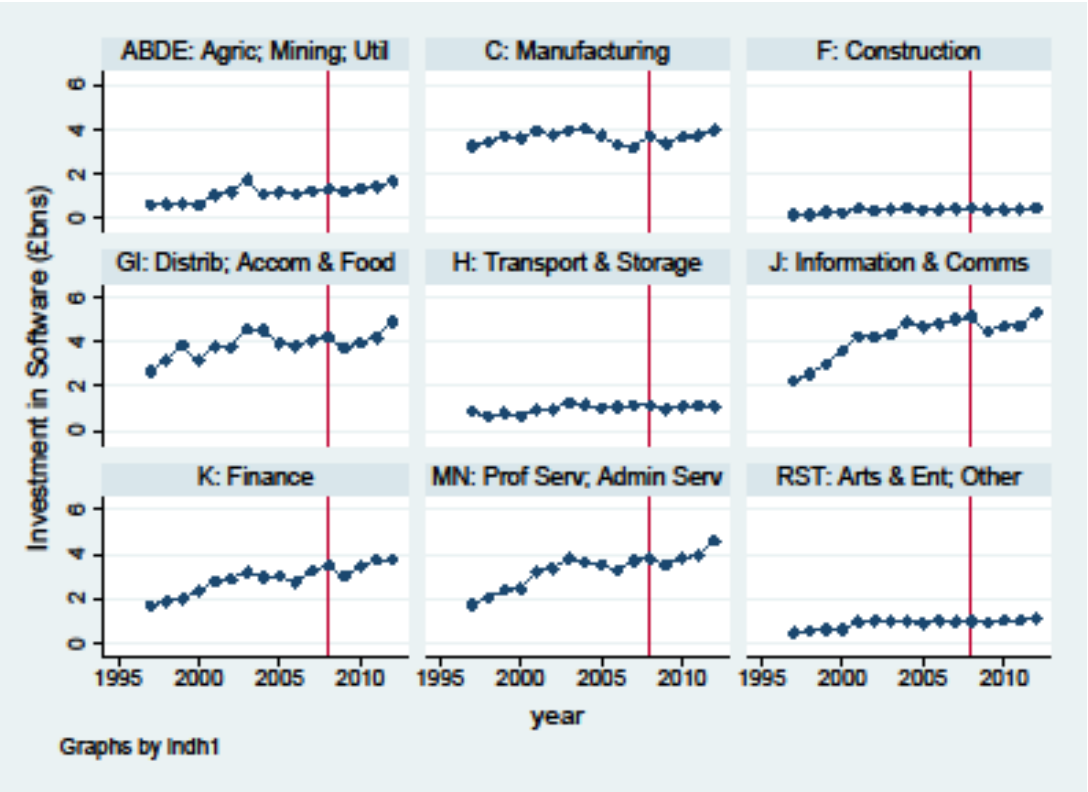
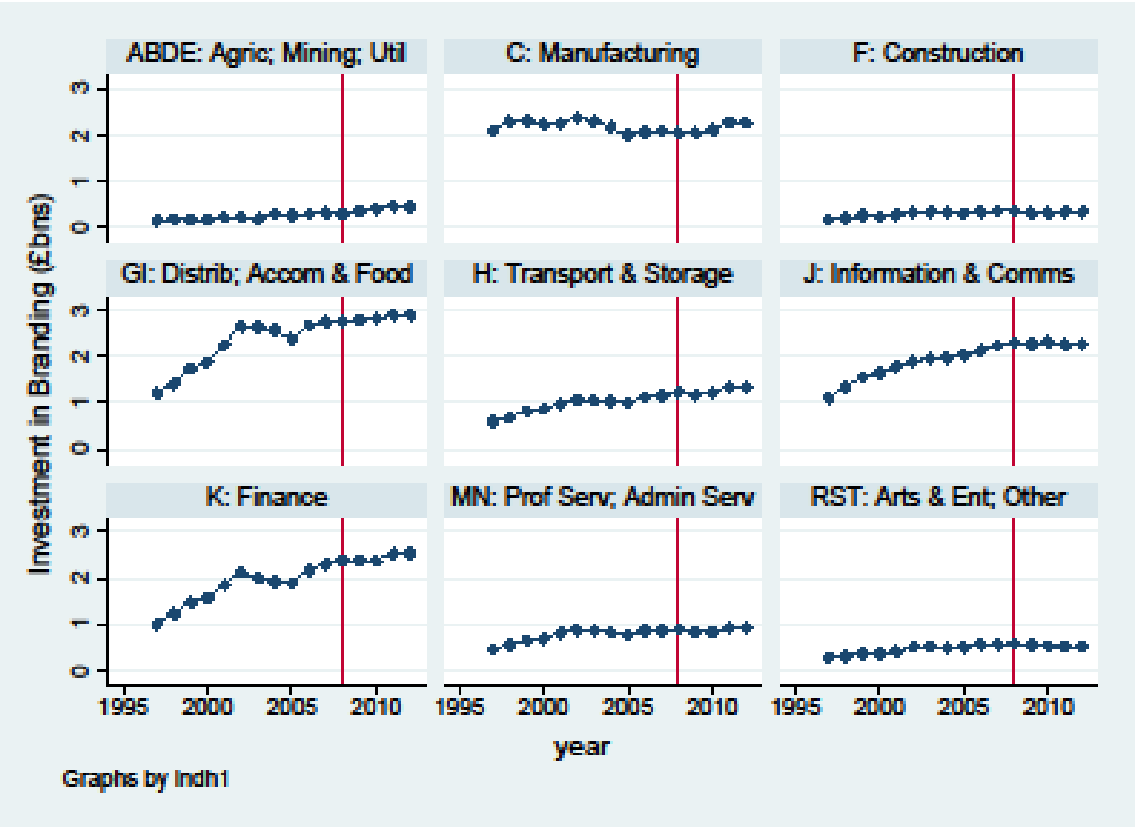


**Figure A1.10: Industry-level investment in Branding**




Data in the above charts, for 1997 to 2011, are summarised below in Table A1.1.

**Table A1.1: Intangible investment by asset, industry and year, Nominal £bns**

| | | Investment (£bns) in: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industry (SIC07) | year | Scientific R&D | Mineral Exploration | Financial Product Innovation | Design | Non-scientific R&D | Training | Artistic Originals | Organisational Structure | Software | Branding | *Intangibles (Total)* |
| **ABDE: Agric; Mining; Util** | 1997 | 0.29 | 1.19 | 0.00 | 0.69 | 0.00 | 0.89 | 0.00 | 0.29 | 0.60 | 0.15 | *4.09* |
| | 1998 | 0.32 | 0.91 | 0.00 | 0.69 | 0.00 | 0.95 | 0.00 | 0.33 | 0.65 | 0.18 | *4.02* |
| | 1999 | 0.32 | 0.61 | 0.00 | 0.61 | 0.00 | 0.94 | 0.00 | 0.36 | 0.65 | 0.17 | *3.67* |
| | 2000 | 0.37 | 0.46 | 0.00 | 0.58 | 0.00 | 0.95 | 0.00 | 0.39 | 0.61 | 0.16 | *3.52* |
| | 2001 | 0.24 | 0.49 | 0.00 | 0.55 | 0.00 | 0.96 | 0.00 | 0.36 | 1.04 | 0.23 | *3.87* |
| | 2002 | 0.27 | 0.54 | 0.00 | 0.48 | 0.00 | 0.95 | 0.00 | 0.39 | 1.17 | 0.23 | *4.02* |
| | 2003 | 0.24 | 0.49 | 0.00 | 0.46 | 0.00 | 1.02 | 0.00 | 0.40 | 1.74 | 0.20 | *4.54* |
| | 2004 | 0.20 | 0.83 | 0.00 | 0.46 | 0.00 | 1.09 | 0.00 | 0.41 | 1.08 | 0.28 | *4.35* |
| | 2005 | 0.20 | 0.70 | 0.00 | 0.68 | 0.00 | 1.14 | 0.00 | 0.47 | 1.17 | 0.26 | *4.62* |
| | 2006 | 0.20 | 0.61 | 0.00 | 0.72 | 0.00 | 1.23 | 0.00 | 0.55 | 1.08 | 0.29 | *4.69* |
| | 2007 | 0.24 | 0.47 | 0.00 | 0.71 | 0.00 | 1.39 | 0.00 | 0.60 | 1.24 | 0.31 | *4.95* |
| | 2008 | 0.26 | 0.53 | 0.00 | 0.70 | 0.00 | 0.86 | 0.00 | 0.74 | 1.31 | 0.30 | *4.71* |
| | 2009 | 0.38 | 0.42 | 0.00 | 0.74 | 0.00 | 0.94 | 0.00 | 0.77 | 1.19 | 0.37 | *4.82* |
| | 2010 | 0.39 | 0.60 | 0.00 | 0.71 | 0.00 | 1.00 | 0.00 | 0.71 | 1.32 | 0.40 | *5.13* |
| | 2011 | 0.48 | 0.77 | 0.00 | 0.71 | 0.00 | 1.08 | 0.00 | 0.49 | 1.42 | 0.46 | *5.40* |
| **C: Manufacturing** | 1997 | 7.69 | 0.00 | 0.00 | 3.05 | 0.00 | 3.26 | 0.00 | 3.27 | 3.23 | 2.09 | *22.59* |
| | 1998 | 8.28 | 0.00 | 0.00 | 3.30 | 0.00 | 3.41 | 0.00 | 3.53 | 3.44 | 2.28 | *24.25* |
| | 1999 | 9.00 | 0.00 | 0.00 | 3.30 | 0.00 | 3.45 | 0.00 | 3.67 | 3.69 | 2.30 | *25.41* |
| | 2000 | 9.30 | 0.00 | 0.00 | 3.17 | 0.00 | 3.51 | 0.00 | 3.60 | 3.58 | 2.22 | *25.39* |
| | 2001 | 9.86 | 0.00 | 0.00 | 3.18 | 0.00 | 3.51 | 0.00 | 3.86 | 3.94 | 2.24 | *26.59* |
| | 2002 | 9.94 | 0.00 | 0.00 | 3.16 | 0.00 | 3.46 | 0.00 | 4.01 | 3.74 | 2.36 | *26.68* |
| | 2003 | 9.83 | 0.00 | 0.00 | 3.03 | 0.00 | 3.48 | 0.00 | 4.12 | 3.94 | 2.29 | *26.68* |
| | 2004 | 10.23 | 0.00 | 0.00 | 2.99 | 0.00 | 3.48 | 0.00 | 4.05 | 4.03 | 2.16 | *26.94* |
| | 2005 | 10.73 | 0.00 | 0.00 | 3.19 | 0.00 | 3.48 | 0.00 | 4.27 | 3.71 | 1.98 | *27.37* |
| | 2006 | 10.90 | 0.00 | 0.00 | 3.24 | 0.00 | 3.55 | 0.00 | 4.30 | 3.30 | 2.07 | *27.37* |
| | 2007 | 11.90 | 0.00 | 0.00 | 3.16 | 0.00 | 3.68 | 0.00 | 4.19 | 3.15 | 2.08 | *28.17* |
| | 2008 | 12.30 | 0.00 | 0.00 | 3.23 | 0.00 | 3.50 | 0.00 | 4.33 | 3.69 | 2.04 | *29.09* |
| | 2009 | 11.85 | 0.00 | 0.00 | 3.22 | 0.00 | 3.29 | 0.00 | 4.06 | 3.34 | 2.04 | *27.81* |
| | 2010 | 12.24 | 0.00 | 0.00 | 3.19 | 0.00 | 3.34 | 0.00 | 3.90 | 3.64 | 2.10 | *28.41* |
| | 2011 | 13.20 | 0.00 | 0.00 | 3.21 | 0.00 | 3.42 | 0.00 | 3.29 | 3.71 | 2.25 | *29.08* |

| | | Investment (£bns) in: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industry (SIC07)** | **year** | **Scientific R&D** | **Mineral Exploration** | **Financial Product Innovation** | **Design** | **Non-scientific R&D** | **Training** | **Artistic Originals** | **Organisational Structure** | **Software** | **Branding** | ***Intangibles (Total)*** |
| **F: Construction** | 1997 | 0.05 | 0.00 | 0.00 | 0.90 | 0.00 | 1.35 | 0.00 | 0.69 | 0.16 | 0.17 | *3.33* |
| | 1998 | 0.05 | 0.00 | 0.00 | 0.97 | 0.00 | 1.35 | 0.00 | 0.75 | 0.18 | 0.21 | *3.51* |
| | 1999 | 0.06 | 0.00 | 0.00 | 1.03 | 0.00 | 1.44 | 0.00 | 0.86 | 0.26 | 0.25 | *3.89* |
| | 2000 | 0.05 | 0.00 | 0.00 | 1.03 | 0.00 | 1.58 | 0.00 | 0.96 | 0.24 | 0.23 | *4.09* |
| | 2001 | 0.04 | 0.00 | 0.00 | 1.08 | 0.00 | 1.70 | 0.00 | 1.05 | 0.45 | 0.27 | *4.60* |
| | 2002 | 0.05 | 0.00 | 0.00 | 1.16 | 0.00 | 1.88 | 0.00 | 1.23 | 0.34 | 0.33 | *4.99* |
| | 2003 | 0.05 | 0.00 | 0.00 | 1.24 | 0.00 | 2.03 | 0.00 | 1.39 | 0.42 | 0.34 | *5.47* |
| | 2004 | 0.04 | 0.00 | 0.00 | 1.37 | 0.00 | 2.20 | 0.00 | 1.44 | 0.47 | 0.32 | *5.84* |
| | 2005 | 0.03 | 0.00 | 0.00 | 1.66 | 0.00 | 2.20 | 0.00 | 1.58 | 0.36 | 0.31 | *6.14* |
| | 2006 | 0.02 | 0.00 | 0.00 | 1.87 | 0.00 | 2.35 | 0.00 | 1.76 | 0.38 | 0.34 | *6.72* |
| | 2007 | 0.03 | 0.00 | 0.00 | 2.16 | 0.00 | 2.57 | 0.00 | 1.89 | 0.44 | 0.36 | *7.44* |
| | 2008 | 0.04 | 0.00 | 0.00 | 2.06 | 0.00 | 2.58 | 0.00 | 2.06 | 0.45 | 0.37 | *7.56* |
| | 2009 | 0.03 | 0.00 | 0.00 | 1.81 | 0.00 | 2.40 | 0.00 | 1.84 | 0.38 | 0.31 | *6.77* |
| | 2010 | 0.04 | 0.00 | 0.00 | 1.77 | 0.00 | 2.40 | 0.00 | 1.79 | 0.40 | 0.31 | *6.71* |
| | 2011 | 0.05 | 0.00 | 0.00 | 1.77 | 0.00 | 2.46 | 0.00 | 1.55 | 0.40 | 0.34 | *6.56* |
| **GI: Distrib; Accom & Food** | 1997 | 0.03 | 0.00 | 0.00 | 0.78 | 0.00 | 5.55 | 0.00 | 2.92 | 2.66 | 1.20 | *13.15* |
| | 1998 | 0.03 | 0.00 | 0.00 | 0.86 | 0.00 | 6.06 | 0.00 | 3.20 | 3.16 | 1.40 | *14.72* |
| | 1999 | 0.04 | 0.00 | 0.00 | 0.98 | 0.00 | 6.59 | 0.00 | 3.52 | 3.82 | 1.72 | *16.68* |
| | 2000 | 0.05 | 0.00 | 0.00 | 1.08 | 0.00 | 7.03 | 0.00 | 3.61 | 3.15 | 1.87 | *16.79* |
| | 2001 | 0.09 | 0.00 | 0.00 | 1.18 | 0.00 | 7.51 | 0.00 | 3.94 | 3.77 | 2.24 | *18.73* |
| | 2002 | 0.11 | 0.00 | 0.00 | 1.20 | 0.00 | 7.73 | 0.00 | 4.22 | 3.74 | 2.63 | *19.63* |
| | 2003 | 0.09 | 0.00 | 0.00 | 1.32 | 0.00 | 8.02 | 0.00 | 4.58 | 4.56 | 2.62 | *21.18* |
| | 2004 | 0.09 | 0.00 | 0.00 | 1.35 | 0.00 | 8.46 | 0.00 | 4.83 | 4.51 | 2.55 | *21.80* |
| | 2005 | 0.08 | 0.00 | 0.00 | 1.48 | 0.00 | 8.69 | 0.00 | 5.17 | 3.92 | 2.37 | *21.70* |
| | 2006 | 0.06 | 0.00 | 0.00 | 1.63 | 0.00 | 9.12 | 0.00 | 5.35 | 3.79 | 2.66 | *22.62* |
| | 2007 | 0.05 | 0.00 | 0.00 | 1.83 | 0.00 | 9.63 | 0.00 | 5.79 | 4.03 | 2.74 | *24.07* |
| | 2008 | 0.08 | 0.00 | 0.00 | 1.78 | 0.00 | 9.92 | 0.00 | 6.01 | 4.22 | 2.76 | *24.76* |
| | 2009 | 0.12 | 0.00 | 0.00 | 1.71 | 0.00 | 9.95 | 0.00 | 5.70 | 3.72 | 2.79 | *23.98* |
| | 2010 | 0.21 | 0.00 | 0.00 | 1.65 | 0.00 | 10.11 | 0.00 | 5.75 | 3.94 | 2.81 | *24.47* |
| | 2011 | 0.30 | 0.00 | 0.00 | 1.71 | 0.00 | 10.61 | 0.00 | 5.58 | 4.18 | 2.88 | *25.26* |

| | | Investment (£bns) in: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industry (SIC07)** | **year** | **Scientific R&D** | **Mineral Exploration** | **Financial Product Innovation** | **Design** | **Non-scientific R&D** | **Training** | **Artistic Originals** | **Organisational Structure** | **Software** | **Branding** | ***Intangibles (Total)*** |
| **H: Transport & Storage** | 1997 | 0.03 | 0.00 | 0.00 | 0.32 | 0.00 | 0.77 | 0.00 | 0.76 | 0.86 | 0.60 | *3.34* |
| | 1998 | 0.02 | 0.00 | 0.00 | 0.34 | 0.00 | 0.83 | 0.00 | 0.82 | 0.65 | 0.68 | *3.34* |
| | 1999 | 0.03 | 0.00 | 0.00 | 0.37 | 0.00 | 0.86 | 0.00 | 0.89 | 0.80 | 0.82 | *3.76* |
| | 2000 | 0.03 | 0.00 | 0.00 | 0.39 | 0.00 | 0.91 | 0.00 | 0.91 | 0.66 | 0.86 | *3.76* |
| | 2001 | 0.04 | 0.00 | 0.00 | 0.40 | 0.00 | 0.95 | 0.00 | 0.95 | 0.93 | 0.96 | *4.23* |
| | 2002 | 0.04 | 0.00 | 0.00 | 0.41 | 0.00 | 1.02 | 0.00 | 0.97 | 0.94 | 1.05 | *4.43* |
| | 2003 | 0.04 | 0.00 | 0.00 | 0.48 | 0.00 | 1.03 | 0.00 | 1.01 | 1.26 | 1.04 | *4.87* |
| | 2004 | 0.03 | 0.00 | 0.00 | 0.47 | 0.00 | 1.06 | 0.00 | 1.02 | 1.17 | 1.03 | *4.77* |
| | 2005 | 0.02 | 0.00 | 0.00 | 0.54 | 0.00 | 1.10 | 0.00 | 1.19 | 1.04 | 0.99 | *4.87* |
| | 2006 | 0.03 | 0.00 | 0.00 | 0.58 | 0.00 | 1.14 | 0.00 | 1.21 | 1.07 | 1.12 | *5.15* |
| | 2007 | 0.03 | 0.00 | 0.00 | 0.57 | 0.00 | 1.20 | 0.00 | 1.16 | 1.16 | 1.15 | *5.26* |
| | 2008 | 0.04 | 0.00 | 0.00 | 0.56 | 0.00 | 1.82 | 0.00 | 1.02 | 1.13 | 1.22 | *5.79* |
| | 2009 | 0.06 | 0.00 | 0.00 | 0.57 | 0.00 | 1.83 | 0.00 | 1.18 | 0.97 | 1.16 | *5.77* |
| | 2010 | 0.06 | 0.00 | 0.00 | 0.64 | 0.00 | 1.85 | 0.00 | 1.14 | 1.10 | 1.22 | *6.00* |
| | 2011 | 0.07 | 0.00 | 0.00 | 0.71 | 0.00 | 1.87 | 0.00 | 1.01 | 1.14 | 1.34 | *6.14* |
| **J: Information & Comms** | 1997 | 0.50 | 0.00 | 0.00 | 0.63 | 0.00 | 0.65 | 3.04 | 0.77 | 2.24 | 1.10 | *8.93* |
| | 1998 | 0.47 | 0.00 | 0.00 | 0.75 | 0.00 | 0.79 | 3.48 | 0.89 | 2.53 | 1.32 | *10.24* |
| | 1999 | 0.58 | 0.00 | 0.00 | 0.87 | 0.00 | 0.90 | 4.24 | 1.16 | 2.99 | 1.56 | *12.29* |
| | 2000 | 0.69 | 0.00 | 0.00 | 0.93 | 0.00 | 0.99 | 4.34 | 1.37 | 3.57 | 1.64 | *13.52* |
| | 2001 | 0.77 | 0.00 | 0.00 | 1.08 | 0.00 | 1.09 | 4.69 | 1.76 | 4.24 | 1.77 | *15.40* |
| | 2002 | 0.75 | 0.00 | 0.00 | 1.30 | 0.00 | 1.14 | 4.78 | 2.42 | 4.22 | 1.88 | *16.47* |
| | 2003 | 0.68 | 0.00 | 0.00 | 1.36 | 0.00 | 1.21 | 5.48 | 2.42 | 4.32 | 1.96 | *17.42* |
| | 2004 | 0.66 | 0.00 | 0.00 | 1.40 | 0.00 | 1.27 | 6.62 | 2.29 | 4.85 | 1.96 | *19.06* |
| | 2005 | 1.19 | 0.00 | 0.00 | 1.39 | 0.00 | 1.28 | 6.32 | 2.35 | 4.66 | 2.03 | *19.22* |
| | 2006 | 1.35 | 0.00 | 0.00 | 1.46 | 0.00 | 1.30 | 4.66 | 2.44 | 4.78 | 2.13 | *18.12* |
| | 2007 | 1.55 | 0.00 | 0.00 | 1.53 | 0.00 | 1.47 | 5.08 | 2.35 | 5.01 | 2.23 | *19.22* |
| | 2008 | 1.42 | 0.00 | 0.00 | 1.64 | 0.00 | 1.51 | 5.14 | 2.56 | 5.10 | 2.28 | *19.65* |
| | 2009 | 1.35 | 0.00 | 0.00 | 1.57 | 0.00 | 1.45 | 4.99 | 2.33 | 4.45 | 2.26 | *18.40* |
| | 2010 | 1.17 | 0.00 | 0.00 | 1.59 | 0.00 | 1.49 | 5.14 | 2.37 | 4.70 | 2.31 | *18.76* |
| | 2011 | 1.08 | 0.00 | 0.00 | 1.46 | 0.00 | 1.58 | 5.25 | 2.02 | 4.71 | 2.25 | *18.36* |

| | | Investment (£bns) in: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industry (SIC07)** | **year** | **Scientific R&D** | **Mineral Exploration** | **Financial Product Innovation** | **Design** | **Non-scientific R&D** | **Training** | **Artistic Originals** | **Organisational Structure** | **Software** | **Branding** | ***Intangibles (Total)*** |
| **K: Finance** | 1997 | 0.02 | 0.00 | 0.44 | 1.56 | 0.00 | 0.71 | 0.00 | 2.64 | 1.69 | 1.00 | *8.06* |
| | 1998 | 0.03 | 0.00 | 0.48 | 1.78 | 0.00 | 0.75 | 0.00 | 3.04 | 1.87 | 1.23 | *9.18* |
| | 1999 | 0.04 | 0.00 | 0.48 | 1.83 | 0.00 | 0.80 | 0.00 | 3.57 | 2.00 | 1.47 | *10.17* |
| | 2000 | 0.04 | 0.00 | 0.67 | 1.97 | 0.00 | 0.90 | 0.00 | 3.88 | 2.33 | 1.58 | *11.36* |
| | 2001 | 0.04 | 0.00 | 0.65 | 2.13 | 0.00 | 0.94 | 0.00 | 4.29 | 2.77 | 1.84 | *12.66* |
| | 2002 | 0.03 | 0.00 | 0.71 | 2.37 | 0.00 | 0.95 | 0.00 | 4.81 | 2.88 | 2.11 | *13.88* |
| | 2003 | 0.03 | 0.00 | 0.67 | 2.48 | 0.00 | 1.02 | 0.00 | 5.33 | 3.18 | 1.99 | *14.70* |
| | 2004 | 0.02 | 0.00 | 0.68 | 2.62 | 0.00 | 1.13 | 0.00 | 4.83 | 2.98 | 1.91 | *14.16* |
| | 2005 | 0.02 | 0.00 | 0.86 | 3.15 | 0.00 | 1.24 | 0.00 | 5.54 | 3.03 | 1.88 | *15.71* |
| | 2006 | 0.01 | 0.00 | 0.90 | 3.34 | 0.00 | 1.41 | 0.00 | 5.50 | 2.74 | 2.15 | *16.06* |
| | 2007 | 0.01 | 0.00 | 1.23 | 3.77 | 0.00 | 1.49 | 0.00 | 5.69 | 3.24 | 2.29 | *17.72* |
| | 2008 | 0.03 | 0.00 | 1.21 | 3.94 | 0.00 | 0.84 | 0.00 | 5.86 | 3.49 | 2.38 | *17.75* |
| | 2009 | 0.04 | 0.00 | 1.46 | 3.81 | 0.00 | 0.93 | 0.00 | 5.54 | 3.00 | 2.36 | *17.14* |
| | 2010 | 0.04 | 0.00 | 1.58 | 3.83 | 0.00 | 0.96 | 0.00 | 5.97 | 3.44 | 2.36 | *18.18* |
| | 2011 | 0.05 | 0.00 | 1.84 | 3.78 | 0.00 | 0.92 | 0.00 | 5.76 | 3.74 | 2.52 | *18.61* |
| **MN: Prof Serv; Admin Serv** | 1997 | 0.19 | 0.00 | 0.00 | 1.02 | 0.33 | 4.53 | 0.00 | 2.06 | 1.72 | 0.45 | *10.30* |
| | 1998 | 0.21 | 0.00 | 0.00 | 1.13 | 0.32 | 5.15 | 0.00 | 2.24 | 2.05 | 0.56 | *11.65* |
| | 1999 | 0.26 | 0.00 | 0.00 | 1.14 | 0.44 | 5.67 | 0.00 | 2.70 | 2.38 | 0.65 | *13.23* |
| | 2000 | 0.20 | 0.00 | 0.00 | 1.19 | 0.40 | 6.24 | 0.00 | 2.94 | 2.44 | 0.69 | *14.11* |
| | 2001 | 0.35 | 0.00 | 0.00 | 1.35 | 0.29 | 6.90 | 0.00 | 3.53 | 3.22 | 0.82 | *16.46* |
| | 2002 | 0.42 | 0.00 | 0.00 | 1.18 | 0.38 | 7.18 | 0.00 | 3.41 | 3.35 | 0.88 | *16.80* |
| | 2003 | 0.38 | 0.00 | 0.00 | 1.24 | 0.38 | 7.60 | 0.00 | 3.69 | 3.81 | 0.86 | *17.95* |
| | 2004 | 0.39 | 0.00 | 0.00 | 1.32 | 0.35 | 7.79 | 0.00 | 3.77 | 3.64 | 0.83 | *18.09* |
| | 2005 | 0.48 | 0.00 | 0.00 | 1.43 | 0.35 | 8.17 | 0.00 | 4.54 | 3.54 | 0.78 | *19.28* |
| | 2006 | 0.43 | 0.00 | 0.00 | 1.41 | 0.31 | 8.53 | 0.00 | 4.66 | 3.27 | 0.86 | *19.48* |
| | 2007 | 0.53 | 0.00 | 0.00 | 1.61 | 0.56 | 8.95 | 0.00 | 4.61 | 3.70 | 0.87 | *20.83* |
| | 2008 | 0.55 | 0.00 | 0.00 | 1.72 | 0.74 | 8.33 | 0.00 | 4.88 | 3.81 | 0.89 | *20.93* |
| | 2009 | 0.64 | 0.00 | 0.00 | 1.66 | 0.78 | 8.44 | 0.00 | 4.80 | 3.52 | 0.84 | *20.67* |
| | 2010 | 0.65 | 0.00 | 0.00 | 1.65 | 0.87 | 8.47 | 0.00 | 4.79 | 3.82 | 0.83 | *21.07* |
| | 2011 | 0.64 | 0.00 | 0.00 | 1.74 | 0.85 | 8.93 | 0.00 | 5.02 | 3.94 | 0.93 | *22.05* |

| | | Investment (£bns) in: | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industry (SIC07)** | **year** | **Scientific R&D** | **Mineral Exploration** | **Financial Product Innovation** | **Design** | **Non-scientific R&D** | **Training** | **Artistic Originals** | **Organisational Structure** | **Software** | **Branding** | ***Intangibles (Total)*** |
| **RST: Arts & Ent; Other** | 1997 | 0.01 | 0.00 | 0.00 | 0.19 | 0.00 | 1.18 | 0.32 | 0.24 | 0.48 | 0.29 | *2.70* |
| | 1998 | 0.01 | 0.00 | 0.00 | 0.23 | 0.00 | 1.28 | 0.34 | 0.27 | 0.57 | 0.32 | *3.02* |
| | 1999 | 0.01 | 0.00 | 0.00 | 0.27 | 0.00 | 1.36 | 0.52 | 0.36 | 0.63 | 0.37 | *3.52* |
| | 2000 | 0.01 | 0.00 | 0.00 | 0.28 | 0.00 | 1.45 | 0.59 | 0.39 | 0.61 | 0.37 | *3.69* |
| | 2001 | 0.01 | 0.00 | 0.00 | 0.29 | 0.00 | 1.53 | 0.44 | 0.39 | 0.96 | 0.42 | *4.04* |
| | 2002 | 0.01 | 0.00 | 0.00 | 0.29 | 0.00 | 1.63 | 0.45 | 0.39 | 1.00 | 0.51 | *4.29* |
| | 2003 | 0.01 | 0.00 | 0.00 | 0.31 | 0.00 | 1.75 | 0.58 | 0.45 | 0.98 | 0.52 | *4.61* |
| | 2004 | 0.01 | 0.00 | 0.00 | 0.31 | 0.00 | 1.83 | 0.78 | 0.49 | 0.98 | 0.49 | *4.88* |
| | 2005 | 0.01 | 0.00 | 0.00 | 0.33 | 0.00 | 1.93 | 0.66 | 0.60 | 0.89 | 0.50 | *4.91* |
| | 2006 | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 | 2.04 | 0.56 | 0.67 | 1.01 | 0.57 | *5.28* |
| | 2007 | 0.01 | 0.00 | 0.00 | 0.40 | 0.00 | 2.09 | 0.58 | 0.57 | 0.96 | 0.57 | *5.18* |
| | 2008 | 0.01 | 0.00 | 0.00 | 0.36 | 0.00 | 2.46 | 0.60 | 0.59 | 0.97 | 0.60 | *5.58* |
| | 2009 | 0.02 | 0.00 | 0.00 | 0.38 | 0.00 | 2.44 | 0.57 | 0.63 | 0.92 | 0.55 | *5.51* |
| | 2010 | 0.02 | 0.00 | 0.00 | 0.38 | 0.00 | 2.60 | 0.58 | 0.61 | 1.03 | 0.53 | *5.74* |
| | 2011 | 0.02 | 0.00 | 0.00 | 0.44 | 0.00 | 2.72 | 0.59 | 0.76 | 1.03 | 0.52 | *6.07* |

**Appendix 2: Revisions: comparison with previously published estimates**

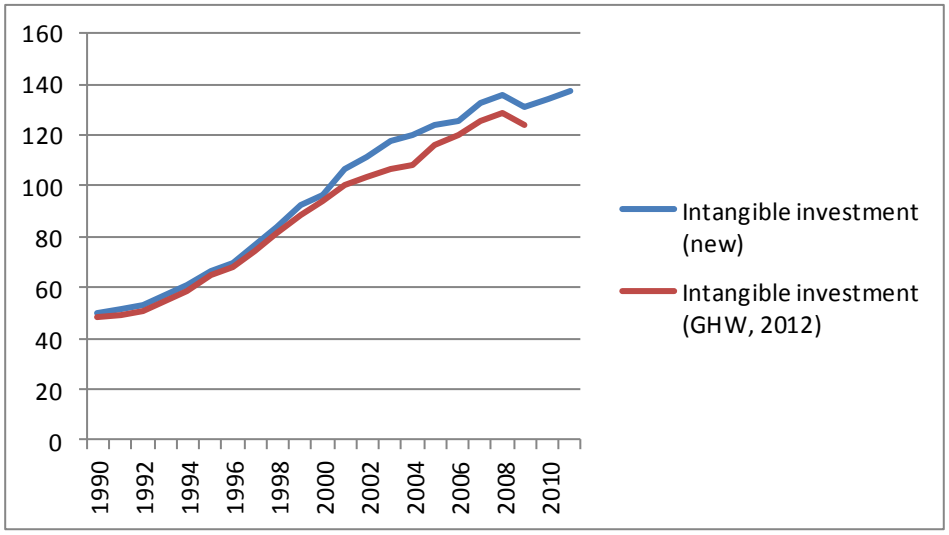
This appendix outlines revisions to estimates of intangible investment and estimates of the proportion of investment protected by IPRs. Our most recent past publication of intangible investment was Goodridge, Haskel and Wallis (GHW, 2012). Our previous estimation of the proportions of intangible investment protected by IPRs was published in Farooqui, Goodridge and Haskel (2011).

**A2.1 Revisions to measures of intangible investment**

One difference between the estimates of investment published in this report and those in GHW (2012) is the industrial classification at which they are published. Previous estimates we constructed according to a market sector definition based on SIC03, sections A-K & OP. New estimates are constructed for the market sector but based on SIC07, sections A-K, MN & RST.

Our new estimates for intangible investment extend to 2011 and include revisions in the back-series. A comparison with past estimates is presented in Figure A2.1 below.

**Figure A2.1.1: Nominal UK market sector intangible investment, old and new estimates (£bns)**




Source: This report and GHW (2012)

As can be seen there has been a small upward revision to estimates of intangible investment. This revision is due to the following changes. Estimates for investment in Market Research have been revised upward due to changes in the product classification of the Supply Use tables as a result of the revisions to the SIC. In past estimates, the product category used was "Market research, management consultancy" and market research was separated out using information from the ABS and ABI. The new product category is 'Advertising and market research services'. Therefore management consultancy no longer has to be subtracted and the resulting estimates for market research are higher than those previously published. Estimates for investment in training are also higher than previously

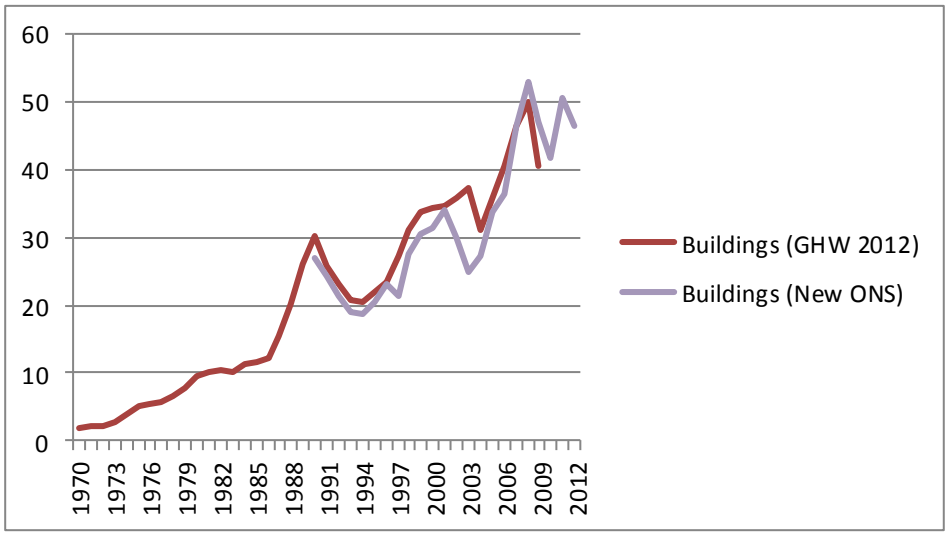
published. Past estimates were adjusted downward using estimates of the component of training that is Health and Safety and/or Induction training. Since some of this training likely does contribute to growth in productivity, such an adjustment has not been made to the estimates included in this report. In this report, estimates for investment in Artistic Originals are taken from the national accounts. In GHW (2012) we used our own estimates for investment in this asset category. The national accounts estimates are slightly higher than those we used in previous reports. National accounts estimates for investment in both own-account and purchased software have also been revised up, in the case of own-account to better account for net operating surplus in own-account software production.

**A2.2 Revisions to official ONS measures of investment**

In the main text we noted that the estimates for nominal tangible investment presented in this report are lower than those we have presented previously (Goodridge, Haskel and Wallis 2012). This is due to ONS revisions. In summary, overall investment as recorded in the national accounts is similar to that previously published. However, within that, tangible investment has been revised down and intangible (software, artistic originals and mineral exploration) investment has been revised up. Below we present some charts of the new nominal investment data compared to those we published in Goodridge, Haskel and Wallis (2012).

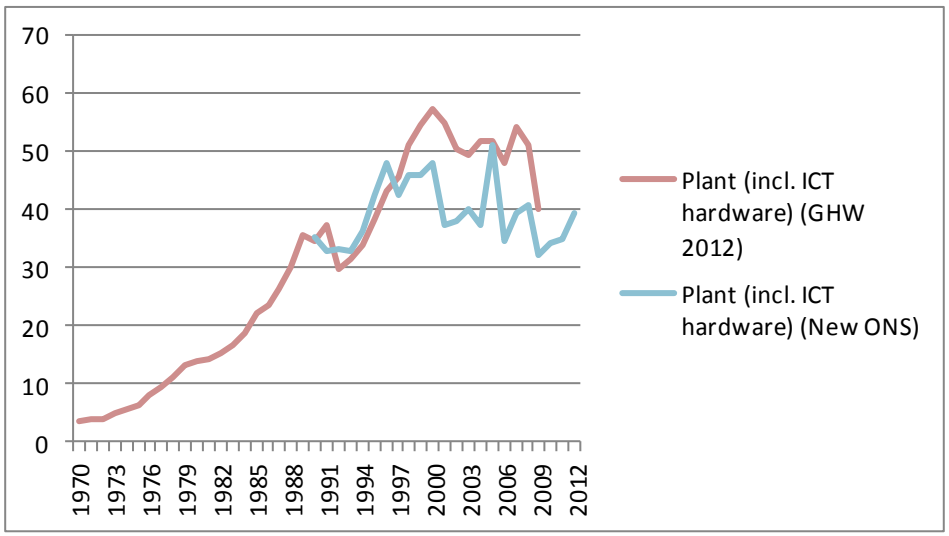
First we show new data for market sector (private sector and public corporations) investment in buildings. There has been some downward revision to investment in buildings in the late 1990s and early 2000s. Overall however the series are similar and the new data still show a strong rise over much of the 2000s.

**Figure A2.2.1: Nominal UK market sector investment in buildings, old and new estimates (£bns)**



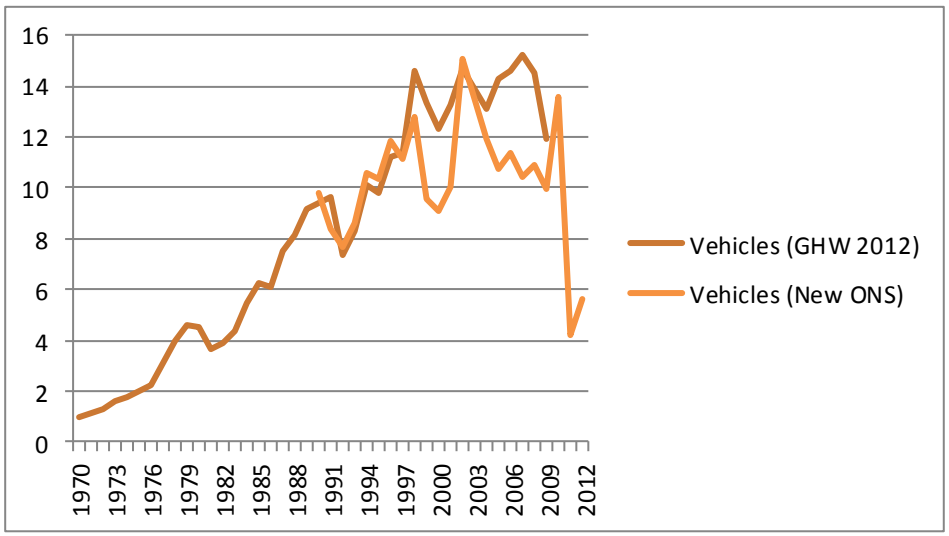
Next we look at the data for plant & machinery which includes ICT hardware. The chart shows that revisions to investment in this category have been significant. In 2001, estimates of investment have been revised down from £55bn to £37bn, a reduction of approximately one third. Although the new series is fairly volatile, estimates of investment in 2012 are similar to the level seen in 2001 (£40bn in 2012 compared to £37bn in 2001).

**Figure A2.2.2: Nominal UK market sector investment in plant (incl. ICT hardware), old and new estimates (£bns)**



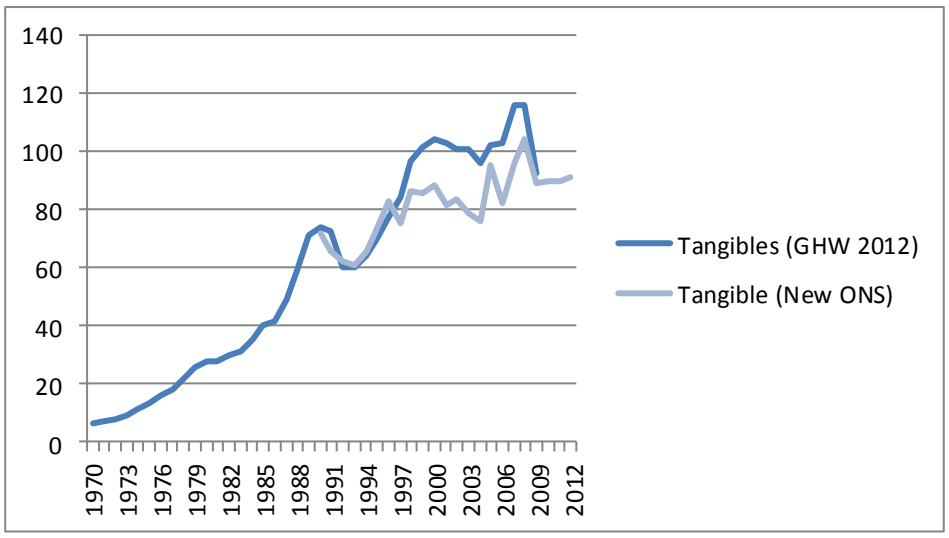

The next chart shows old and new data for investment in vehicles. Again there have been downward revisions. Investment has been revised down by approximately £3bn in 1999 and 2000, and by around £5bn in 2007. The latter is a downward revision of approximately 50% (£15bn to £10bn).

**Figure A2.2.3: Nominal UK market sector investment in vehicles, old and new estimates (£bns)**



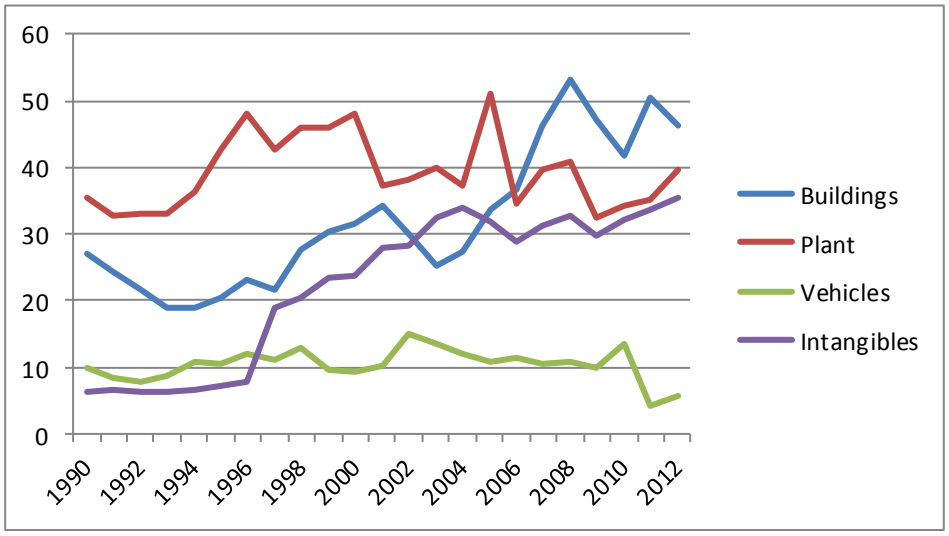
The next chart looks at how the above revisions to each of the three tangible asset types contribute to the overall revision in tangible investment. As can be seen, the run up in tangible investment in the late 1990s has largely been revised away. In particular, in Total market sector tangible investment has been revised down in 1999 and 2000, total tangible investment has been revised down by approximately £15bn, in 2001 the revision was approximately £21bn, a reduction of around 20%. On average, between 1997 and 2012, tangible investment has been revised down by approximately £15bn, which equates to 15%.

**Figure A2.2.3: Nominal UK market sector investment in tangibles, old and new estimates (£bns)**




Having looked at the revisions to each asset category, the next chart plots the new series for investment in each category, plus official estimates of investment in intangibles. The chart shows that growth in nominal investment since 2000s is driven by buildings and intangibles. Vehicles is relatively flat and similarly plant is at a similar level in 2012 to the level seen in 2000 (although there was a rise and then a fall in the mid-2000s in this asset category).

**Figure A2.2.3: Nominal UK market sector investment, by asset, new estimates (£bns)**




### A2.3 Revisions to proportions of investment protected by IPRs

We have also revised our estimates of the proportions of intangible investment protected by IPRs. In Farooqui, Goodridge and Haskel (2011) we assumed the following:

- 100% of investment in Software and Artistic Originals is protected by copyright
- 100% of investment in Design is protected by (registered or unregistered) design rights
- 100% of investment in Advertising and Market Research is protected by trademark
- 30% of investment in Scientific R&D is protected by patents.

The estimate for patents was chosen as a central estimate based on our own analysis using a mix of averaging and regression methods and results in the wider literature. Those methods were.

In the previous report we assumed that all investment in Design was protected by unregistered design rights, since such rights are automatic. In this report we estimate the proportion of design that is protected by registered design rights. We also take account of the fact the some investment in design can be protected by patents and so we estimate that proportion too. Similarly for R&D we account for the ability to protect R&D either by patents or design registration. In each case we apply a regression method, as was used in Farooqui, Goodridge and Haskel (2011) to determine the proportion of R&D protected by patents. Compared to above, our assumptions therefore change to the following:

- 100% of investment in Software and Artistic Originals is protected by copyright
- 11% of investment in Design is protected by design registration
- 2% of investment in Design is protected by patents
- 87% of investment in Design is protected by unregistered design rights
- 100% of investment in Advertising and Market Research is protected by trademark

- 38% of investment in Scientific R&D is protected by patents
- 3% of investment in Scientific R&D is protected by design registration

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