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Macroeconomic impacts of changes in life expectancy and fertility

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ABSTRACT

This paper analyses economic implications of the different ways in which the population structure of countries becomes older: longer lives and declines in fertility both generate ageing populations but have very different impacts upon the aggregate population. If lower fertility persists populations in many countries will decline. Having reviewed the evidence for this, I consider both why fertility rates have fallen and may stay low. I then analyse the economic implications of populations that may stop growing and start to fall, focusing on how this may play out in the UK. I consider policy implications of such a demographic shift. Despite many predictions of the dire consequences of falling populations the economic impacts are likely, on balance, to be positive.

Introduction

This paper assesses the overall economic impact of an ageing population – that is one where the proportion of those above a (somewhat arbitrary) age is higher than in the past and on a rising trajectory. There are two ways in which a population ages[1]:

- People live longer – which all else equal raises the population trajectory
- Fewer people are born and the growth of the population declines, possibly turning negative

Both have been happening across the world – at different rates in different places. The tendency to longer lives and to fewer children (a decline in fertility) has been most marked in the richer economies.

There is a key difference in the way in which these two forces change population structure: ageing coming about through people living longer (holding constant fertility) raises population when life expectancy is going up. Ageing coming about because of a decline in fertility reduces population – and can mean that population declines (potentially continuously, even if fertility stops falling). For the world as a whole ageing is likely to come with continuously and quite rapidly rising world population (See Fig. 1). But that is much less likely in most richer countries and in some large emerging economies – a key point I consider below where I analyse some of the macroeconomic implications of a declining population. Such a decline looks increasingly likely to become common, as I document below, and has come about as fertility has dropped far faster than most forecasts had anticipated (Bricker and Ibbitson, 2019)).

In this paper I analyse the aggregate economic consequences of ageing (and in many cases declining) populations. I conclude that they are, on the whole, positive and that predictions of dire effects are implausible. I consider a possible transition to an older and smaller population in the UK – a country where it is, in the absence of high and continuing net immigration, likely that there will be a decline in population as it ages. I quantify some of the aggregate economic effects of such a transition.

The projected structure of the future world populations shown in Fig. 1 are not reliable forecasts – they depend upon the evolution of fertility rates and of longevity about which there is great uncertainty and where past projections have often proved inaccurate. So the UN population projections should be thought of as scenarios based on assumed changes in behaviour (the key to trends in fertility) and in technological shifts and resources devoted to medical care (the key to trends in life expectancy). But it is highly likely that population will be rising for decades – even as forecasts for fertility have declined projections of very substantial growth in world population for several decades to come have persisted. Indeed the latest UN projections for world population in 2050 have been increased and now stand at around 10 billion, with the 2100 projection at around 11 billion. It can be easy to lose sight of this given the focus on a "crisis of fertility" and the predicted damage from declining populations. (See Zeihan (2022)) for a strident account of the supposed, near apocalyptic, economic crisis to come from low fertility and declining populations).

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[1] Here I ignore large scale immigration or emigration of groups with a very different distribution of ages to that of the existing population.

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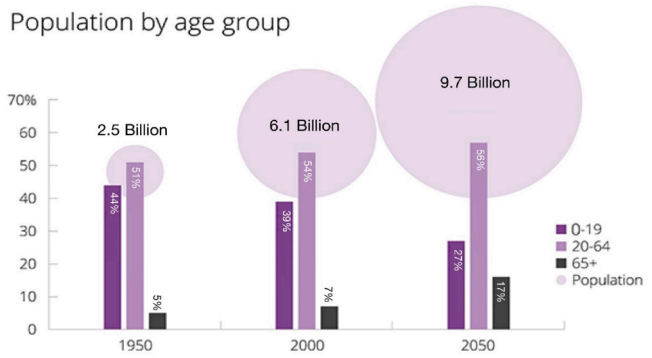


Fig. 1. World population structure yesterday, today and tomorrow: United Nations projections.

But while the global population predictions imply rising numbers of people, populations are likely to decline in many countries over the next few decades, as is now widely recognised. Table 1 shows a list of just some of the larger countries where United Nations central forecasts show population lower by 2070.

Ageing of the populations within rich countries looks set to be steady and ultimately quite dramatic. Fig. 2 shows projections of how the age dependency ratio (defined as the population over the age of 65 relative to total national populations) might change within rich countries over the next 50 years. In most countries that ratio close to doubles. What can we expect the economic implications of this to be? I turn to this question in the next section.

Economic effects of changes in population

Substantial changes in demographic structure will alter the aggregate amount of incomes and output produced (GDP) and how it is allocated between consumption and investment – a split which affects asset prices and rates of return on saving. In thinking through how demographic shifts affect GDP it is useful to think of those aggregate incomes as being generated by two factors combined: labour and capital. That allows an assessment of some of the most significant economic impacts of shifts in population and age structure. I use some simple notation and make plausible, and widely used, assumptions about the nature of the production relation:

L = aggregate labour input (millions of hours a year).

K = the aggregate stock of capital (broadly defined) which reflects past saving (that is investment).

Denoting total incomes by Y we summarise the relation between Y, K and L by the production function:

$$Y = A^{*}f(K,L) \tag{1}$$

A is a multiplicative factor – generally rising over time and reflecting productivity improvements. f(K,L) is a function that reflects how combinations of total labour supply and the capital stock generate incomes (output); f is an increasing function of L and K but with diminishing returns to each factor. Balanced growth in K and L which leaves (K/L) unchanged is assumed to raise Y by their common growth rate.

Ageing affects L – possibly very substantially and directly if retirement ages don't change much.

Ageing affects K – possibly substantially since the amount of wealth (capital) people accumulate depends on age, typically rising towards retirement and falling gently thereafter.

Increases in population, holding age structure constant, raise L and aggregate output Y.

We first use the simple production relation between K, L and incomes (Y) to consider the relation between the growth of population and sustainable standards of living. Suppose the growth rate of population in an economy is at annual rate *n*. The aggregate capital stock, K, changes from one year to the next as a result of total investment (I) net of worn out capital which I assume depreciates at a per annum rate of *d*. So capital in period t relative to period t-1 is given by:

$$K_t - K_{t-1} = I_t - dK_{t-1} \tag{2}$$

Assume that total income Y (GDP) is either consumed (denoted by C) or invested (so we assume no additions to the capital stock from *net* overseas inward investment).

$$Y_t = A\,f(K_t, L_t) = I_t + C_t \tag{3}$$

Aggregate saving (S) is income minus consumption:

$$S_t = Y_t - C_t = I_t \tag{4}$$

On a sustainable, equilibrium path we require K and L to grow in line and assuming that the labour force grows at the same rate as population (at annual rate *n*) this requires:

$$(K_t - K_{t-1})/K_{t-1} = (L_t - L_{t-1})/L_{t-1} = n \tag{5}$$

Combining these simple relations yields:

$$Y_t - C_t = (d+n)K_{t-1} \tag{6}$$

So on a sustainable path with K, L growing at a common rate equal to population growth we have

$$C_t/L_t = Y_t/L_t - [(d+n)/(1+n)]\,K_t/L_t \tag{7}$$

Thus for a given capital to labour ratio (K/L) the sustainable level of consumption relative to population (C/L) is lower the faster the growth rate of population (*n*).

This is a fundamental point often ignored by those who predict that a declining population spells economic immiseration. The sensitivity of sustainable consumption to plausible shifts in *n* is large. In the UK the labour force in 2022 is just over 33 million. The capital stock (taking a wide definition of tangible capital including machines, roads, vehicles, buildings and houses) is around three and a half times annual GDP at roughly £8500 billion in 2022. Consumption in aggregate is about £1,500 billion. So C/L is around £45,500 (the labour force is around half the population so consumption per capita is roughly £22,500). The capital stock per worker is around £250,000. Using this information and equation (7) we can show the impact on sustainable C/L of a fall in *n*. If population growth falls from 1 % a year to zero sustainable consumption rises by £2,500, a rise of 5.5 %. If population stops rising at 1 % and starts to fall at 1 % a year consumption per worker rises by £5,000, or 11 %. These are permanent gains – generating higher sustainable consumption for as long as population growth stays at lower levels.

But a change in the growth of population changes demographic structure and not just the aggregate population and those impacts are both significant and create major challenges. Government spending depends on the age structure of population – most obviously via expenditure on education, health and on state (and public sector)

Table 1
Population in 2021 and UN central projections for 2070, millions. Source United Nations.

	2021	2070
Germany	83	74
France	65	64
Italy	59	44
Spain	47	38
Russia	145	122
Ukraine	44	27
Europe	745	648
China	1425	1085
Japan	125	89
South Korea	52	36
Hong Kong	7.5	6
Eastern Asia	1664	1265

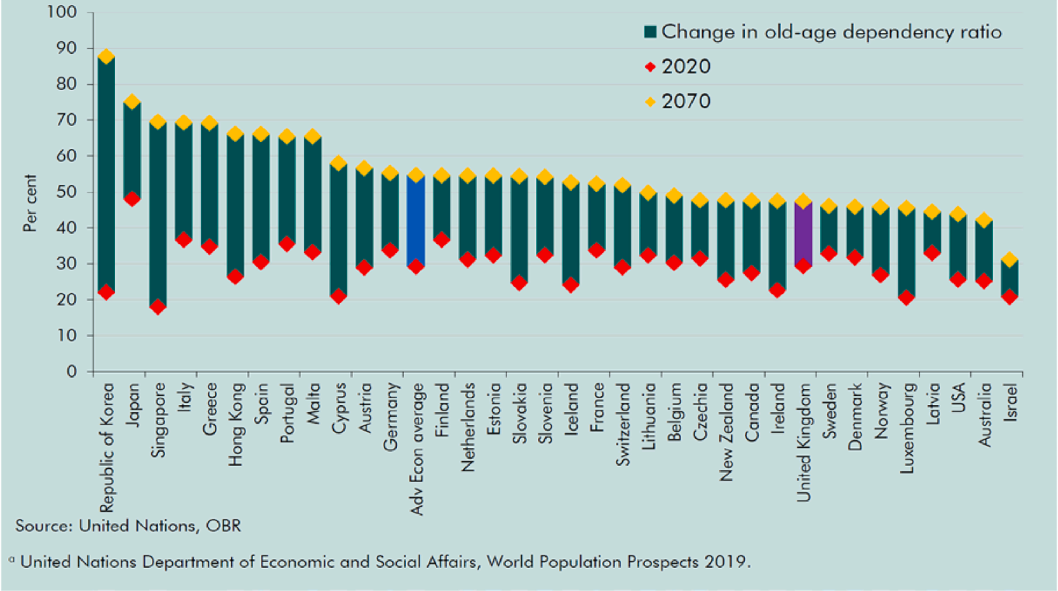


Fig. 2. Projected old-age Dependency ratios in rich economies 2020–2070.

pensions. Tax revenues depend on total incomes – and marginal tax rates are higher than average rates so ageing related effects on GDP translate to major changes in revenues.

An indication of the potential scale of some of these economic impacts of an ageing population (that is a change in the structure of the population rather than its absolute size) is given by Fig. 3, where I continue to use UK figure to illustrate magnitudes. This shows estimates used by the UK Office for Budget Responsibility of the age profile of government spending on various public services – and also of tax revenue raised – from UK citizens. The very substantial rise in spending on, and fall in tax revenue received from, people as they age is a key factor behind the great fiscal challenges posed by ageing population, something I return to below.

Pressure on fiscal deficits, taxes and the stock of debt can rise greatly with ageing – though that depends on what drives ageing and can be offset by policy (eg on state pensions, employment legislation, child care and child benefits).

But since household saving rates and accumulated wealth also follow a very marked life cycle profile changes in age structure generate not only fiscal pressures but also shifts in the stock of wealth (which is also a claim on capital used in production and the creation of incomes). Here the impact of demographic change creates fewer problems than it does for governments because saving rates amongst older cohorts are relatively high, so the large deterioration in net tax revenue to the government as people age generates much less of a negative impact on saving. This means that the amount of capital relative to the population is not likely to fall much, and may rise in many countries, with an ageing and slowly growing (in many cases falling) population.

Since saving behaviour and labour supply varies by age shifts in age composition likely influence the balance between aggregate capital (K) and labour (L). As Auclert (2021) and others have persuasively argued the fact that the run down in savings as people age is slow while the fall off in labour supply is very sharp means it is likely that ageing has, and will continue, to raise the ratio of K to L. And in a standard model of output and growth this will mean that the return on capital will likely stay low and may even decline. This follows from the plausible idea that beyond some point the greater is the amount of capital per worker the lower becomes the return from that investment (in other words that the f (k,L) relation is concave in capital). That, in turn is likely to have been a factor behind the fall in real (inflation adjusted) interest rates in recent decades, something which may well not be reversed as ageing continues. The scale of that decline in recent decades is illustrated by Fig. 4 which shows a measure of the real interest rate on investments in safe assets of varying maturities in the UK over the past 40 years. The decline over this period has been dramatic and is matched by similar falls across rich countries where populations have aged (Rachel and Summers, 2019).

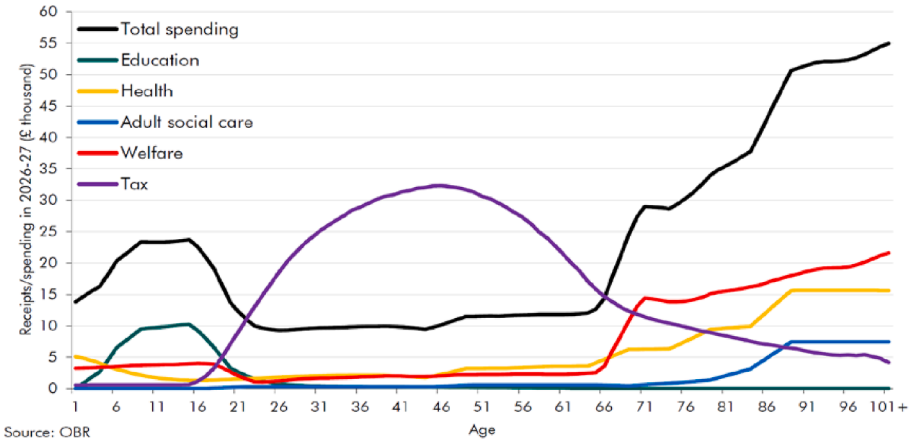


Fig. 3. Representative profiles for tax, public services and welfare spending.

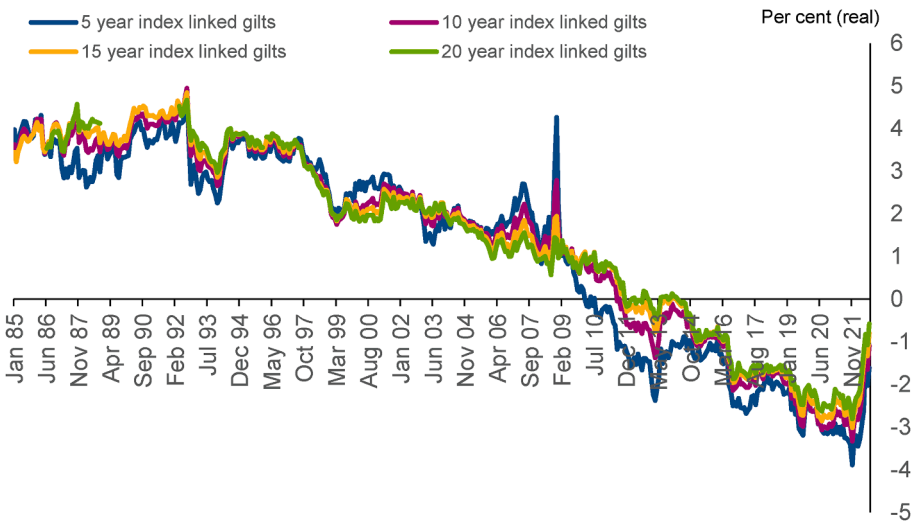


Fig. 4. Real interest rates in the UK since the mid 1980's.

Two important points about the effects of the ageing of populations on standards of living and on pressures on governments emerge from this. First, while a fall in labour input is likely to reduce aggregate GDP (Y) this is not a good indicator of how standards of living will evolve. What matters for standards of living is average incomes of the population and not aggregate national incomes. Furthermore, it is likely that health and longevity effects themselves are of greater significance for welfare of people than is per capita GDP (see Murphy and Topel (2006) and Scott et al. (2021)). But while GDP per capita is a very imperfect measure of welfare, it is certainly a better measure of the quality of life of people than is aggregate GDP. While aggregate GDP is likely to grow less and could decline as populations age and possibly fall, it is far less clear that GDP per capita will be hit. Indeed if capital per person (K/L) rises then standards of living may not fall at all. And if we think of consumption as a better and more direct measure of satisfaction than income then the sustainable rate can certainly be higher with a smaller population; the calculations described earlier suggest this can be a significant factor.

The second point to emphasis is that while shifts in fertility and in life expectancy are central to the evolution of demographic structure – and hence are key factors behind the path of economic outcomes and of fiscal pressures on governments – they can be offset by migration flows.

Figs. 5 and 6 give an indication of the difference that the scale of migration flows can make in the UK over the next fifty years. Fig. 5 shows population under different assumptions about likely average migration per year over the next 50 years. The difference between the 2020 Office for National Statistics population projection and that made by the Office for Budget Responsibility (OBR) in July 2022 reflects a difference in assumed annual migration of just over 200,000 on the ONS projection and 129,000 on the OBR "low migration" projection. The "low migration" path was an assessment made by the OBR in its long-term projections to reflect the new migration rules adopted by the UK government after its decision to leave the European union which brought an end to free movement from the rest of the EU into the UK. The ONS figure was more mechanically based on averages of net migration over the last several years before the adoption of the new visa regime.

The difference this makes is between one of flat and then gradually declining population on the long-term OBR projections and of steadily rising population on the ONS projections. On the OBR projections aggregate UK population is some 1.3 millions *lower* by 2072 than in 2022. On the ONS projections it is 5 million higher by 2072. The 6.3 million difference in the central estimate of UK population by 2072 is around 9 % of the current UK population.

Fig. 6 illustrates the impact this difference in projected UK demographics might have on a key measure of fiscal strains – which is how the stock of government debt would evolve with current patterns of tax and spending assumed to remain unchanged. This is the basis on which the OBR made its long-term fiscal projections (see OBR, 2022). The stock of government debt is projected to be lower by 2072 by around 50 % of GDP (at around 220 percent of annual GDP rather than 270 of GDP) with the higher population based on ONS projections rather than those the OBR thinks more likely with the new UK migration regime. But both paths are on an unsustainable trajectory which implies that higher migration is not a means to maintain fiscal sustainability in the UK – more fundamental changes in the role of the state which alter the balance of its spending against the tax revenue it raises will be needed.

Nor is the fact that higher migration might make the long term fiscal challenge somewhat less a convincing argument that it is welfare improving since its impact on the balance between government spending and revenue is only one part of the impact of a higher population – the effect upon housing, on population density and what total population size means for environmental challenges are of great significance and all suggest that lower population growth (indeed a declining population) brings benefits. I consider this further in section 4.

Fertility and population size and structure: What next?

In the past few years improvements in life expectancy have slowed in some richer countries, and in some countries life expectancy has declined. Fertility rates have remained well under 2 in most rich countries, though after steady declines since the mid twentieth century the rate of decline has more recently slowed (United Nations (2020)). Fig. 7 shows the long run trends for the UK of the total fertility rate, that is the average number of children that would be born to a woman over her life. Changes in fertility that are sustained have a dramatic impact on long run population levels and on demographic structure. Whether ageing comes about through rising life expectancy with no change in population growth or whether it also means slower growth (or declines) in population matters a great deal. Central to this issue is an understanding of why fertility has declined so much.

The question is important. Low fertility might mean we get a bigger decline in the labour force (certainly absolutely and probably relative to overall population) than if ageing was driven by rising longevity. Population falling along with ageing is very different from population rising with ageing and it is much more likely if low fertility is the driver of ageing. Slow growth in GDP – even falling GDP – is likely if population declines steadily, though this need not come with a decline in either the

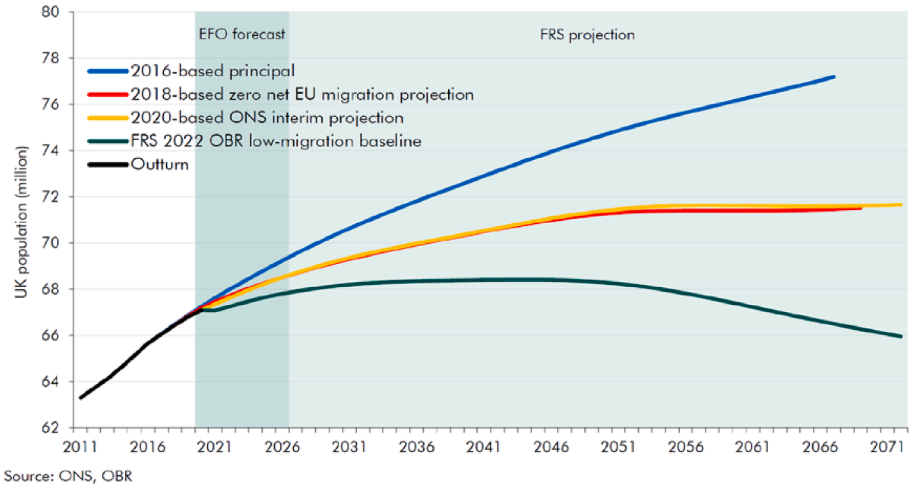


Fig. 5. UK population projections 2011–2072 Notes – FRS 2022 is the Office for Budget Responsibility central forecast made in July 2022 in its Fiscal Risk and Sustainability Report (FRS). Other lines are those made at earlier times which reflected higher immigration before a change in UK migration regime and when birth rates were higher and life expectancy expected to rise more strongly.

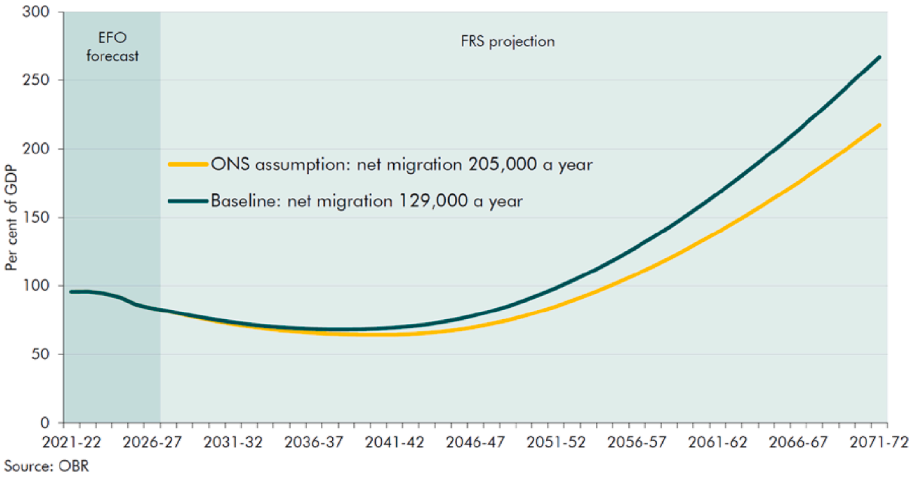


Fig. 6. UK net debt and population.

level, nor the rate of change, of GDP per capita. It can mean sustainable consumption is higher.

Population declines are no longer implausible in many rich countries and reflect fertility rates that potentially have greater implications for demographic structure than have changes seen in life expectancy. They certainly have dramatically different implications for the trajectory of total population.

Consider again the simple analytics of changes in life expectancy, fertility and population dynamics.

A rise in life expectancy raises population for a given fertility rate - but population does not keep rising unless life expectancy keeps rising.

A fall in fertility that takes it beneath the reproduction number - that is the level of fertility to keep the population constant in the absence of net migration, a number around 2.1 for rich countries - means population will keep falling if the fertility rate stays there. The fertility rate does not need to keep falling – stabilising beneath the reproduction rate of just over 2 will cause population to keep falling unless offset by rising immigration. This is the asymmetry between ageing and fertility changes; it means that very persistent fertility changes either side of 2.1 are highly significant in the long run.

An example from a highly stylized model of population dynamics is illuminating. Suppose we initially start from a stable population with a fertility rate equal to the reproduction rate and where all people live until they reach life expectancy and then die. In this world the fertility rate starts at 2. With an initial stable population and a life expectancy stable at 80 then the demographic structure is flat so that (for example) the proportion of the population over 65 is simply (80–65)/80 = 0.1875 and the proportion of working age (assumed to be 18–65) to the total population is 0.60.

A gradual rise in life expectancy by 0.25 years a year over 20 years raises the length of life from 80 to 85. Over this transition period the population rises by 6.25 %. The fraction of the population over 65 rises to 23.5 % and the ratio of those aged 18–65 to total population falls to 56.5 %. With no further rise in life expectancy population size and population structure then remains the same.

A fall in the fertility rate from the reproduction rate (which in this stylized model is 2) which has a similar effect on the demographic structure – but over a 50 year period rather than 20 years – is for it to fall to 1.5. This would make the proportion of the population over 65 close to 23.5 %. But the effect on the aggregate population is far bigger and in the opposite direction. After 20 years population has *fallen* by just over 6 % rather than rise by 6.25 %. After 50 years – when the proportion of the population over 65 is the same as when life expectancy rose from 80 to 85 - the population has declined by 20 %, and it keeps on falling. After 75 years of this lower fertility rate population has fallen by about 36 % though the proportion of the population over 65 has long since stabilised

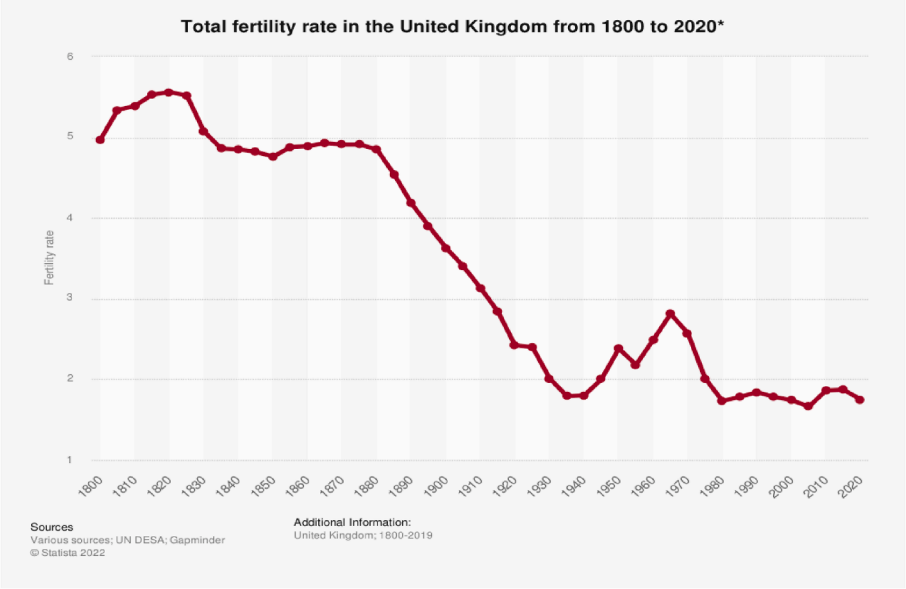


Fig. 7. Total fertility rate in the UK.

and remains little different to the case where life expectancy rises from 80 to 85. (The over 65 s make up 24 % or so of population by 50 years after the decline in fertility and then remains roughly constant as the population declines at a rate of about 8.5 % a decade.).

Why has fertility fallen so far in many rich countries – particularly in Europe – and will it stay well below the reproduction level? In considering this I focus on what I believe to be very significant economic and social factors. (For a discussion of a wide range of factors see Doepke et al (2022); and for a summary see https://voxeu.org/article/new-era-economics-fertility. For a survey of economic factors behind the fertility transition to low birth rates see Guinnane (2011)).

In the past – by which I mean any time up to about 70 or so years ago – in most countries, and including what are today's rich countries, economic necessity was a major factor behind the long-term partnership model adopted by most couples. Men had an advantage in work and wages – they had more job opportunities and were paid more than women in the relatively few jobs that were equally open to both sexes. Women had a unique ability to give birth. Children were seen by many as needed for old age when state pensions were not generous and saving for retirement had been barely possible for most people.

Over the past fifty years men have lost a good deal of the great economic advantages that they brought to the partnership. Women in rich countries now don't need them so much for purely economic reasons as their job market opportunities have greatly widened and the gender wage gap has substantially narrowed. There has been a great deal of analysis of the implication of such changes – as much from sociologists, anthropologists and political commentators as from economists (see, for example, Rosin (2010), Bourdieu (2007), Reeves (2022)[2]).

Many of the relevant factors behind a decline in fertilty have been at play over long periods and are likely to be enduring: single parenting remains difficult; having children as a means of securing help in one's old age is not very reliable compared to saving; for most women there is far greater control of their fertility with the wide availability of contraceptives.

Some other relevant factors for fertility have changed over more recent decades – housing is much more expensive in many rich countries than it was (Miles and Monro (2021)) and with rising female earnings and a great increase in career options child-care has become more expensive.

This combination of factors has reduced the attractions to many women - and for many men too - of starting to have several children in their 20s. The options available to many women, in addition to the previously dominant one of a settled relation with one man that began in early adulthood after which children followed in a matter of a few years, have greatly expanded. The economic cost of having several children remains high – indeed has probably increased for most women.

This sounds a typically dismal economist's view of human life. But this is a case where the analysis done by economists (for influential early work see Becker and Barro (1988) and Becker et al. (1990) and Barro and Becker (1989)) and by other social scientists points in the same direction. Bordieu's "The Bachelor's Ball" (2007) certainly adopts a different approach to that adopted in the analysis of Becker and co-authors but the French sociologist and the American economist reach similar conclusions: there are strong social and economic forces behind today's much lower levels of fertility and they are likely to persist.

The conclusion that women do not want to have as many children as they once did does not sound a particularly optimistic one. Yet there are great benefits to slower population growth. Furthermore, nearly all of these changes that have brought lower birth rates are positive and are likely to prove enduring; one hopes that it is only in dystopian fiction such as *The Handmaid's Tale* that these great changes are reversed. It is not surprising that so many women chose to have far fewer children than in the past. (For a recent and comprehensive analysis of this and its implications see Skirbeck (2022)).

So falling population is quite plausibly what we get in many richer countries from now on. Is that bad? In the final section I consider that question drawing upon trends that may play out in the UK and some of whose features are illustrated in Fig. 8. This figure shows OBR projections for 50 years ahead and look back 50 years. It shows that not just do the OBR central projections (based on a constant fertility rate of 1.59) show a relative decline in the proportion of the population under 65, but also an absolute fall in the numbers aged under 54 despite net immigration over the 50 years amounting to around 6.5 million people. Without that, population would decline by close to 10 million rather

[2] Here for example is Rosin on the decline in the advantages men brought to potential partnerships with women: " The postindustrial economy is indifferent to men's size and strength. The attributes that are most valuable today—social intelligence, open communication, the ability to sit still and focus—are, at a minimum, not predominantly male. In fact, the opposite may be true….."- Hanna Rosin "The End of Men" https://www.theatlantic.com/magazine/archive/2010/07/the-end-of-men/308135/.

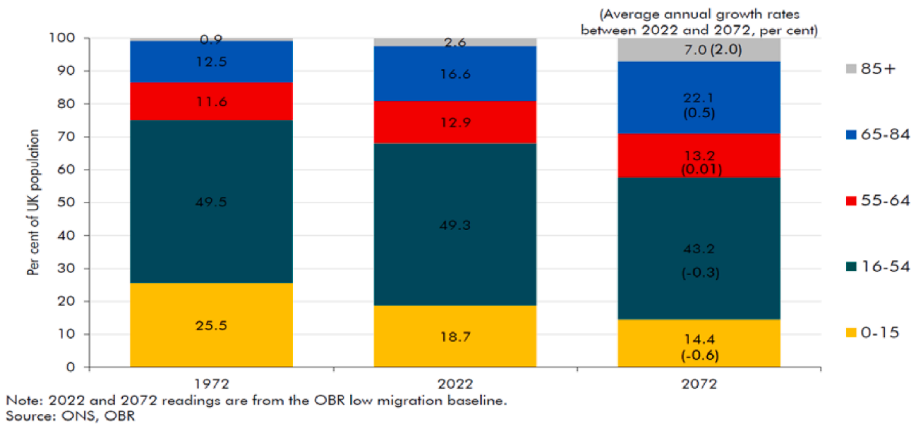


Fig. 8. UK population structure 1972, 2022, 2072.

than the 1.3 million decline predicted by the OBR to occur between 2022 and 2072.

Implications for policy in the UK

The UK population has risen by about 10 million over the past 25 years – up around 400,000 a year. Just over half of this is due to net inwards migration and just under half is from the balance between births and deaths of the resident population. Population growth is set to continue for some years – though if the OBR central long-term projection is right it will level off in the early 2030s and then gradually decline; ONS projections based on higher net migration suggest it will flatten off but still rise gently for several decades.

Whether a continuing rise in the UK population at the rate of the past few decades is a good thing is a hard question to answer. It raises some deep issues – how do we value the happiness of the unborn? How do we value the happiness that having a lot of children might bring? What are the costs from more congestion and the extra production of pollutants that more people is likely to bring? Are the benefits of more space, cheaper housing and fewer people to create environment damage enough to outweigh costs of a smaller population in terms of aggregate national economic heft, a smaller pool from which exceptional talent can emerge and fewer people of what we now consider to be normal working ages?

When faced with a very hard to answer question there is something to be said for asking a more modest question that at least gets at an important part of the issue and might be amenable to some quantification. So here is an easier and narrower question: What rate of population growth might generate a level of average consumption per person which is sustainable and as high as it can be? For the UK there are some strong reasons to believe that the answer to that question is likely to be a lower rate of growth than we have seen in recent decades – probably-one that would mean a fall in the overall level of the population.

Why might that be true? The economics is fairly simple and we illustrated it above with the stylised model of an economy where population grew at a rate n. In the absence of large inward investment from other economies a country's saving rate has to generate enough investment to replace depreciating assets (roads, buildings, vehicles, factories and computers wear out and need repair or replacement). Investment financed from domestic saving is that part of income not available for satisfying today's wants. Investment is not done for its own sake – but to satisfy needs and wants in the future. If a country has a growing population then for sustainably meeting needs of each person investment needs to replace worn out assets but also raise the stock of capital assets further in line with growing numbers of people. The higher is population growth the less is your ability to maintain assets per person unless you raise savings – but that means lower consumption.

This is a simple and powerful piece of economic reasoning. It is what underlies models of economic growth developed by Robert Solow many years ago and for which he won a Nobel prize. (For an excellent analysis of the Solow model and many other forces at work in the growth of economies see Acemoglu (2009).)

The UK has a relatively low savings rate. There are many signs that it has not collectively saved and invested enough to keep many of its capital assets - schools, the rail network, roads, some types of corporate assets - at a level that can keep up with the demands on them from an ever rising population. The UK appears collectively unable to save enough to stop its infrastructure (public and private) falling behind (see Pisu et al. (2015)).

Of course this is different if the new people that arrive bring capital with them; but we cannot expect the new born to do that and migrants – while they do bring substantial skills and human capital – do not bring schools, roads, hospitals and houses with them.

Calculations from demographers and economists suggest the anecdotal evidence from just looking at the UK's crowded roads, trains and ever-shrinking houses might not be such a bad guide. Ronald Lee – one of the world's leading demographers – led a team of researchers from across the world in a project to estimate what levels of population growth might be best for living standards. For the UK the calculations from one of Lee's teams (Professor James Sefton) suggested that to achieve the highest sustainable standard of living per person the population should decline. This is because a growing population requires greater capital investment just to preserve the level of real wages (which it is plausible to assume depend upon the amount of capital per worker). That requires a higher saving rate which in turn means less of available incomes can be spent on satisfying todays needs.

There is empirical evidence from the UK's past history that the economic forces that lie behind this conclusion have been powerful. Crafts and Mills (2022) estimate that the rapid expansion of the UK population which coincided with the onset of the industrial revolution significantly held back growth in average real wages. Had population growth not accelerated average real wage growth during this period of rising aggregate GDP would have been far higher. Conversely had the sharp rise in population that started in the mid-eighteenth century come in earlier periods that pre-dated the productivity rises that came with industrialisation it would have had catastrophic effects on real incomes.

Miles (1999) presents simulations of the effect of an ageing and more slowly growing UK population on saving, capital accumulation and the ratio of capital to labour (and hence real wages). His simulations show that the aggregate labour supply falls as the UK population ages (absent large scale inward migration) and that this boosts the ratio of capital to labour and generates higher real wages. His simulations mirror similar results in Auclert et al (2021) where population ageing and slower population growth raise the overall economy wealth to income ratio. This keeps real interest rates low and would tend to have as its counterpart more capital per worker which keeps real wages up.

How does that square with the frequently heard argument that to help preserve the affordability of public services- in particular state pensions and public health care – we need a rising population to generate enough tax revenue? Lee (2014) reports that for the UK the growth rate in population that is best for fiscal sustainability is probably substantially positive while the population growth rate for the highest sustainable standard of living of the population is negative. His research concludes "…modest population decline favour higher material standards of living."

Why do we get such different answers? The fiscal calculations focus on balancing the public budget – something that can be helped by rapid population growth if the young (on balance) pay more taxes than they consume public services while the older are net consumers. Figs. 3 and 6 above, based on OBR calculations, suggest this condition is satisfied in the UK so that the longer term fiscal outlook is somewhat improved if population growth over the next 50 years is higher (and positive) due to more net migration. If you raise the population fast enough you keep the ratio of the relatively old to the relatively young down. But what that leaves out of the picture is the extra resources needed to maintain capital assets per person. If the public sector is unable (or unwilling) to do that maintenance then the fiscal position can improve with fast population growth while the quality of life may decline.

There are certainly many economists who take a radically different view on all this. Some argue that the UK and other European countries need to raise the birth rate or maintain very high levels of net migration so as to counter the impacts of an ageing population.

A better strategy to address fiscal challenges that an ageing population brings is to encourage and expect some continued labour force participation among those who in the past might have left the world of work completely (see Cooley et al. (2019)). Gratton and Scott (2016) spell out many ways in that might happen - most of which require a fundamental rethink about the pattern of careers over longer lives and the ways (and ages) at which people learn new skills. For most European countries the alternative strategy of encouraging continuing large scale population growth so as to slow the rise in dependency ratios requires either sharp rises in fertility or high levels of immigration. For a densely populated country with a low saving rate like the UK this is likely to be a poor strategy.

Conclusion

In many countries ageing populations reflect two forces at work: rises in longevity and declines in fertility. Those two forces work in opposite directions on the trajectory of overall populations. Holding all else constant, if lengths of life increase populations grow faster; but lower (though not necessarily falling) fertility will slow population growth. Low fertility will likely generate falling populations in the coming decades in many countries. In this paper I have considered the causes of that and argue they are likely to be highly persistent, and that this is a good thing since many of the driving forces behind low fertility are in themselves positive. While some argue that the side effect of falling populations will be highly problematic, the evidence and analysis in this paper suggest the opposite. The transition to falling populations can however bring challenges; a shift in attitudes towards the trajectories of working lives and ongoing investment in new skills can do much to ease that.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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