Demographics, higher investment and the future potential growth rate of the Irish economy

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January 17, 2025

Abstract

The Irish economy's recovery from the global financial crisis (GFC) has been striking with both economic output and the labour market registering significant increases in activity since 2013. This resurgence in performance followed the sharp decline witnessed in the economy during the period 2008 - 2012. Furthermore, it drew comparisons with the earlier growth observed during the "Celtic tiger" period. However, the recovery in the economy has coincided with acknowledged deficits in both social and physical infrastructure. A legacy of the post GFC crash has been a fall-off in investment rates in the Irish economy. This comes at a time when there has been an unexpected increase in recent population levels. We use a standard Solow growth model framework to decompose the past performance of the Irish economy over the period 1995 - 2023. We then parameterise the model to generate long-run forecasts for the domestic economy under a baseline and alternative scenarios related to population growth and rates of investment. The paper finds that increasing investment rates, even to rates below those at the peak of the Celtic Tiger era, would result in output growth increasing by up to 0.9 per cent per annum above the baseline rate.

JEL classification: O40, O47, O16.
Keywords: Growth, Ireland, Demographics, Investment

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1. Introduction

While the Irish economy did experience a profound downturn in the immediate period after the global financial crisis (GFC), in general, over the period 1995 to 2023, it has witnessed a truly seismic transformation in its fortunes. The "Celtic tiger" era, which had initially been chararacterised by sustainable export led growth, gave way to a credit-fueled housing bubble, followed by a substantial deterioration in performance between 2007 and 2012, however, in the period since 2013 the domestic economy has recovered in a persistent and substantial manner. Arguably, the most telling indicator of performance over the period, those in employment, has over doubled between 1995 and 2023 from 1.3 million to 2.7 million. The latter represents a historically unprecedented level of employment in the Irish economy. Given the significant improvement in Irish economic conditions, unsurprisingly, this strong performance has gone hand-in-hand with significant changes in Irish demographic trends. The Irish population alone between 1995 and 2023 increased by over 42 per cent with much of the inward migration being facilitated by Ireland's membership of the European Union (EU).

A significant literature has addressed Ireland's fortunes over the period in question. In addressing the progress of the "Celtic Tiger" era (mid-1990s to mid-2000s) studies by Barry (1999) and Honohan and Walsh (2002) highlight how Ireland's adoption of pro-business policies, coupled with substantial inflows of foreign direct investment (FDI), particularly from the United States, propelled this growth. Barry (1999) emphasizes the role of low corporate tax rates and an educated, English-speaking workforce as critical attractors for multinational corporations. Honohan and Walsh (2002) attribute Ireland's economic miracle to a combination of factors including EU membership, which facilitated market access and structural funds that bolstered infrastructure development.

The global financial crisis of 2008 had a profound impact on Ireland, plunging the country into a severe recession. McCarthy and McQuinn (2017), using unique access to loan level data, chronicle the scale of difficulties experienced by Irish financial institutions due to distress in the mortgage market. Whelan (2013) provides an analysis of the bailout by the International Monetary Fund (IMF) and the European Union (EU), and the stringent austerity measures implemented as a condition for financial assistance. These measures, while necessary for stabilization, led to significant social and economic hardships.

The recovery of the Irish economy post-2013 has been examined by Kostarakos, McQuinn and Varthalitis (2023), who focus on the growth contribution of tangible and intangible assets to the Irish recovery, while McQuinn and Varthalitis (2019) and Fitzgerald (2018) highlight the role of export-led growth and a flexible labor market in facilitating Ireland's economic recovery. Cronin, Dunne and McQuinn (2019) highlight the dramatic improvement in Ireland's fiscal performance after the GFC.

One major challenge in assessing recent Irish economic performance has been difficulties associated with the distortionary impact of certain multinational related transactions on the Irish national accounts. For example, redomiciled PLCs, which are essentially foreign-owned funds operating in Ireland, receive their investment income here. However, because their foreign owners take much of the return on their investments in the form of capital gains, there is no income outflow corresponding to the investment income received. This increases Irish GNI, while the income recorded is of no benefit to those living in Ireland. Further globalisation developments, including aircraft leasing operations in Ireland and, even more important, the location by foreign MNEs of much of their very large intellectual property in Ireland, have affected the traditional national accounting aggregate GNI. A number of studies have examined the difficulties posed by these MNE transactions while some have offered alternative indicators of economic activity more reflective of the underlying performance of the Irish economy. These include but are not confined to Lane (2017), FitzGerald (2018), FitzGerald (2020), Honohan (2021), FitzGerald (2023) and Kostarakos et al. (2023).

This difficulty doesn't just apply to headline GDP but also to other macroeconomic indicators such as investment. For example, Fitzgerald and McQuinn (2024) highlight the difference between the headline investment rate for the Irish economy and that estimated using alternative indicators both for economic output and investment. The alternative indicator importantly reveals the decline in overall investment rates in the Irish economy particularly in the aftermath of the global financial crisis. While the crisis had a significant impact on many western economies, the implications of financial sector dislocation and associated macro-financial consequences were especially felt in the Irish case (see Egan, O'Toole and McQuinn (2024) for details). This was particularly the case in the housing market where completion levels which had averaged approximately 85,000 units in the period immediately preceding the GFC fell away completely to just 4,000 houses being

built in 2014.

In a review of the Irish Government's national development plan (NDP), Barrett et al. (2024), highlight infrastructural deficits in limiting the growth potential of the domestic economy with a particular focus on the housing market, healthcare, education and climate change. As noted in McQuinn and Walsh (2024), the Irish Government's capital investment was particularly adversely impacted after the GFC with investment levels dropping sharply from 2009 to 2017; the swift and persistent recovery in the economy since that period has meant that overall economic activity outpaced the level of Government expenditure. In 2024, for instance, capital expenditure was only at the same rate of national output as it was in 1999. Ireland is clearly not alone across the European Union in identifying greater levels of investment as a key vehicle for future growth. The European Commission (2024), for example, argues that to digitalise and decarbonise the European economy, the investment share in Europe will have to rise by around 5 percentage points of GDP to levels last seen in the 1960s and 70s.

Clearly related to the issue of greater investment is the likely outlook for future Irish population levels. Demographics have played a crucial role in shaping the domestic economy, influencing both its current performance and future potential. Ireland's open and attractive immigration policies have allowed it to supplement its workforce with skilled talent from abroad, particularly in sectors such as technology, healthcare, and education, which are vital to its economic growth. However, an aging population presents future challenges, including the need for sustainable pension systems and increased healthcare services, which require careful planning and investment to ensure long-term economic stability. Additionally, as noted by McQuinn and Whelan (2018, 2016, 2008), in a series of assessments of Euro Area economic performance, an aging population population has already adversely impacted overall European economic performance. Understanding the likely path of Irish population levels is important in assessing the future economic performance of the domestic economy.

Therefore, in this paper we avail of the approach adopted in McQuinn and Whelan (2018, 2016, 2008) and assess prospects for growth in the Irish economy under a number of scenarios for population levels and investment rates. We use a standard Solow growth model framework to decompose the past performance of the Irish economy over the period 1995 - 2023. Based on this review, we then parameterise the model to generate long-run

forecasts for the domestic economy under a series of baseline and alternative scenario forecasts.

Our analysis leads to the following conclusions:

- In evaluating Irish economic performance it is essential to move beyond headline economic data. This is true not just for overall output levels but also for key economic aggregates such as investment levels in the economy. This reflects the highly influential role played by foreign owned multinational enterprises in the domestic economy. Accordingly, in this study we use alternative estimates of both economic output and investment levels.

- Our analysis suggests that in recent years most of the growth which has been experienced in the Irish economy has come off the back of significant increases in population and consequently the labour force. This is against an exceptional set of circumstances including Covid-19 and the subsequent significant return to work and the war in the Ukraine which has seen an unexpected increase in the number of migrants coming into the country.

  Over the longer-term, the work-age population of the Irish economy is set to peak in about 10 years, while the proportion of people in the key 15-64 age category is already declining and is set to decline over the forecast period. This will ultimately have a negative impact on growth over the longer-term as well as posing key fiscal issues around the sustainability of the domestic pension system.

- It is evident that other key determinants of growth such as the pace of change in total factor productivity (TFP) and the rate of investment have been making more modest contributions to the recent growth performance. This correlates with the findings in McQuinn and Whelan (2008, 2016, 2018) for the Euro area and suggests that policy-makers will have to address this issue if TFP growth is to be a long-term determinant of changing domestic living standards. Lower rates of investment may well be traced back to the fiscal challenges experienced by the domestic economy as a result of the global financial crisis (GFC) when the Irish State was forced to enter a programme of support with the European Commission (EC), the European Central Bank (ECB) and the International Monetary Fund (IMF) (commonly referred to as the 'Troika').

Given the uncertainty around population movements and the relatively low rate of investment in the domestic economy, we accompany our baseline forecast with two sets of scenarios:

1. **Investment scenario**: Currently the underlying rate of investment in the Irish economy is around 20 per cent. Based on historical rates of investment, we simulate what the impact on key headline variables would be if the investment rate were to increase to 25 and 30 per cent over a plausible period in the forecast horizon. This would still not, however, result in the rates reaching those at the peak of the "Celtic tiger".

2. **Demographic scenario**: Along with our baseline forecast, we also use two different scenarios for migration and consequently overall population levels. These are based on those population scenarios adopted in Bergin and Egan (2024) and over the longer-period (2050 - 2100) follow those of the European Commission. Basically these scenarios are for a low and high migration scenario.

Another recent contribution to assess long-term growth prospects for the Irish economy is that of Conefrey, Keenan, Staunton and Walsh (2024). Like the present paper, Conefrey et al. (2024) examine the sensitivity of a long-term baseline forecast to variations in future population levels under different migration scenarios, however, under their baseline scenario they assume a higher rate of inward migration than the present approach. They also assess the role of climate change and the green transition on longer term domestic prospects while the present paper focusses on higher investment rates and uncertainty around future TFP and unemployment rate assumptions.

The rest of the paper is structured as follows; in the next section we outline some of the difficulties with measuring the investment ratio in an Irish context. We then outline the growth accounting approach and we present the results of our growth decomposition for the domestic economy. The following section presents the Solow model that we use to forecast key economic variables followed by a detailed discussion of the results. A final section presents some concluding comments.

2. Issues with the Irish National Accounts

In this section we briefly summarise some of the difficulties associated with achieving an accurate measurement of Irish economic performance. In particular, we focus on issues associated with economic output and overall investment in the economy.

One way to illustrate the difficulties associated with the Irish national accounts is through the prism of the investment share; the ratio of investment levels to overall economic activity. In the Irish case such measures are bedeviled by the well-known issues concerning the representativeness or otherwise of key headline indicators in the national accounts.

A wide variety of studies have commented on these issues with some seeking to advance the case of alternative indicators as presenting a more accurate assessment of domestic economic activity. Given the significant role played by multi-nationals in the Irish economy, both estimates of overall output levels and headline investment levels are subject to considerable distortions. Consequently, this makes it acutely difficult to generate a representative estimate of the investment share in an Irish context.

Consequently, we avail of recent work by Fitzgerald and McQuinn (2024), to present an improved estimate of Ireland's investment share. Our preferred measure of economic output is, following Fitzgerald (2023) and Fitzgerald (2020), net national product at market prices (NNP). NNP is preferred, for example, over alternative measures such as GNI* because it excludes depreciation. Depreciation, owing to certain multinational related transactions, has been responsible for many of the distortions in the national accounts. Fitzgerald (2018) also advocates NNP as a measure of output over GNI* as the contributions to it by individual sectors of the economy can be identified separately. Finally, as an indicator of output, NNP is being increasingly published by other countries and hence, can be compared on a cross-country basis.

We then combine this with the series on modified gross fixed capital formation as published by the Central Statistics Office. Modified investment which is part of modified domestic demand (MDD) indicator, now published by the CSO, excludes certain items which are contained in the headline investment figure. These include aeroplanes purchased by leasing companies in Ireland but then operated in other countries. Also excluded are intellectual property (IP) purchases which typically only relate to foreign-owned corpora-

tions and generate profits that flow out of the economy. While modified investment does not wash out all of the distortions in headline investment levels, it is the most accurate estimate of investment in the Irish economy.

In Figure 1 below we we plot the resulting share based on our preferred measurements of output and investment levels. We also, as a comparison, plot the headline investment share according to headline GDP and total investment levels. From the graph it is clear that both indicators demonstrate that particularly in the period after the GFC (2008 – 2012), the decline in investment was more severe than the fall in output. This reflects the profound impact of the GFC on the Irish residential and commercial property markets. There have been periods where the growth rate of investment exceeded that of output; in the latter period of the Celtic tiger era, when housing output grew persistently and in the post-GFC recovery period, 2012 – 2017. Both output and investment levels experienced a sharp decline in 2020 due to the health restrictions imposed due to the Covid-19 virus.

However, as can be seen a significant difference emerges between both series. In the period preceding the GFC, the underlying share is consistently higher than what the headline rate indicates. However, in more recent times it is evident that the headline rate is greatly in excess of what the underlying rate is. Therefore, the importance of estimating these alternative indicators in assessing the state of the domestic economy is quite clear.

From a policy perspective, for example, it suggests using the actual, headline data would provide a very misleading account of investment levels in the domestic economy. The underlying investment share has fallen quite consistently since 2007 and despite the strong recovery of the Irish economy is still at a rate comparable to what it was back in the mid-1990's before the emergence of the Celtic tiger. This highlights that one way to increase economic growth over the medium-term is to increase this ratio on a persistent basis from its current position. The scale of change required is only evident from the underlying indicator.

3. Accounting for Irish Growth

In this section, we review the historical sources of growth for the Irish economy. As a benchmark, we compare Irish performance over the period 2001 - 2023 with that of the European Union.

3.1. Growth Accounting

In our analysis, we use a simple Cobb-Douglas production function

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

where Y_t is real output as defined in section 2, K_t is capital input, L_t is labour input (defined in this paper as total hours worked), and A_t is total factor productivity. Output growth can then be written as

$$\frac{\dot{Y}_t}{Y_t} = \frac{\dot{A}_t}{A_t} + \alpha \frac{\dot{K}_t}{K_t} + (1-\alpha)\frac{\dot{L}_t}{L_t} \tag{2}$$

With data on output, capital, and labour growth to hand and a value for α, this equation can be used to calculate TFP growth.

We could look to break out capital further into the contributions from human as well as physical capital.[1] In an Irish context there are a number of studies which have assessed the role that investment in human capital played in Ireland's catch-up with European living standards over the period from the 1970s to the early 2000s. These include but are not restricted to Walsh (1993, 1998), Borooah (1995), Durkan, Fitzgerald and Harmon (1999), Barrett, Fitzgerald and Nolan (2002), Bergin and Kearney (2007), Fitzgerald (2012, 2019) and Siedschlag and Koecklin (2019). We don't include the breakdown here as we feel that the human capital effect is likely to have reached a plateau.[2]

For capital inputs, national statistical agencies typically do not provide standardised measures of the productive capital stocks, so we construct this series ourselves by accumulating investment data. We assume that the initial stock of capital in 1995 equals the steady-state value implied by the Solow growth model in this year (this is discussed in further detail below) based on prevailing trends at that point for output growth, the investment share of output and the growth rate of labour input. We then derive the rest of the series from a perpetual inventory method according to the definition

$$K_t = (1-\delta)K_{t-1} + I_{t-1} \tag{3}$$

[1] Along the lines of the augmented human capital model in Mankiw, Romer Weil (1992).

[2] While incorporating an estimate of human capital would impact our historical estimates of TFP, the additional robustness analysis we have conducted on future TFP rates in Section 7 significantly reduces the impact of the issue in the future.

with a depreciation rate of six percent per year.

In adopting a methodology for the elasticity of output with respect to capital, α, we follow the approach of McQuinn and Whelan (2008, 2016, 2018). They argue that, traditionally, a value of about one-third has often been used based on the observation that for countries with good income-side national accounts such as the United States, the labour share of income has traditionally been around two-thirds. However, this share has declined since the 1980s in Europe and has also been declining in recent years in the US. While there seems to be an absence of any single clear explanation for this pattern (see Elsby, Hobijn and Sahin, 2013, and Lawless and Whelan, 2011) the changes in this share seem to have little to do with structural changes in the substitutability of capital and labour. In the absence of clear guidance from income data, our approach is to use the standard value of $\alpha = \frac{1}{3}$ for all cases. We also test the sensitivity of our output forecast to these assumptions of the initial capital stock and the alpha parameter (see Section 6).

The data in our paper are annual and mainly cover the period 1995 to 2023. Real output, real investment, employment, unemployment rates and total population for Ireland are all sourced from the CSO while the corresponding data for the European Union is sourced from AMECO, the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN).[3]

Table 1 presents results for Ireland and the European Union of the growth accounting exercise which allocates output growth according to the three components in equation (2), Figure 2 charts the key population dynamics for the Irish economy over the period 1995 to 2023 while Figure 3 presents a decomposition of the main determinants of Irish growth.[4] A number of trends are evident from both Figures.

- Figure 2 shows that the population aged 15-64, a proxy for the working age cohort, stands at approximately 3.39 million people as of 2022. This equates to 65.4 per cent of the total population of 5.18 million. The fraction of this cohort relative to the whole population was almost 69 per cent pre financial crisis, before falling rapidly in the aftermath. The crisis triggered a sharp reversal in migration flows, with immigration suddenly halting and emigration increasing. As Ireland is exceptionally open to international migration flows, its working age population is highly responsive

[3] Available online at: https://economy-finance.ec.europa.eu/economic-research-and-databases/economic-databases/ameco-database_en#explanatory-note

[4] The European Union here refers to all 27 member states.

to changes in cyclical conditions. While the size of the population aged between 15-64 will rise under future scenarios considered by the CSO and Bergin and Egan (2024), its relative share of the total population is set to decrease.

- The top left panel of Figure 3 shows that Irish output growth in the 1995-2023 period has been relatively volatile with the fluctuations due to the recent Covid-19 shock being particularly pronounced. Table 1 shows that Ireland's average output growth of 4.0 per cent was almost twice as high as that of the EU between 2001 and 2007. This period characterised the second half of Ireland's "Celtic Tiger" era. This was followed by a sharp decline during the financial crisis and its aftermath, with output growth falling on average by -1.3 per cent over the 2008-2013 period compared to the -0.3 per cent fall witnessed across the EU as a whole. During the subsequent recovery, between 2014-2019, Irish output grew on average by almost 2 per cent per annum, marginally below its EU counterparts.

- The top right panel of Figure 3 illustrates our estimates of capital stock using the method outlined in Section 3.1 and suggests that Δk grew strongly during the Celtic Tiger era with a growth rate of 6 per cent just prior to the financial crisis. This was followed by a significant decline in the subsequent years. Over the last five years, the growth rate of capital stock has hovered around the 1 and 2 per cent mark.

- As highlighted in the bottom right panel of Figure 3, the growth rate of TFP in the period 1995-2023 was highly volatile. The average growth rate over the entire period of 0.5 per cent is above that reported by the European Union of 0.2 per cent. The assumptions we make around the growth rate of TFP for our simulations will be discussed in detail in the next section.

3.2. Trend TFP Growth in Ireland

As is well known, neoclassical growth models tell us that TFP growth is the key determinant of labour productivity growth over the longer run. Therefore, assumptions about future rates of TFP growth are particularly important in terms of evaluating a country's medium-term output prospects.

However, in general deciding on a future path for TFP growth rates is a non-trivial exercise and one that is particularly difficult for an economy such as Ireland's given its

small and open nature. The situation is further complicated by the measurement issues previously discussed concerning Irish economic performance as TFP is typically calculated as the Solow based residual.

Overall, it is evident that many western economies are experiencing relatively low rates of TFP growth in recent decades. McQuinn and Whelan (2008, 2016, 2018) have discussed this issue in an EU context, while Robert Gordon (2012, 2014) has detailed a number of reasons why productivity growth is likely to be low in the coming years in the US. He points out that, from a very long-term perspective, US productivity growth has been falling since the 1950s and that the current round of innovations in areas such as healthcare and information technology are less transformative than previous waves of innovation.

Therefore, in arriving at our expected future path for Irish TFP we appeal both to the literature and to an evaluation of recent trends. Recently, for example, Kostarkos, McQuinn and Varthalitis (2024), in a detailed examination of the role of intangible capital in an Irish context present revised estimates of TFP for the domestic economy. Their estimates suggest TFP growth rates have been a much more modest contributor to recent Irish growth than what headline indicators would suggest.

Figure 3 presents the growth rate of TFP in the Irish case over the period 1995 to 2023. However, the latter part of this period has seen significant fluctuations due to Covid 19. Consequently, we estimate the average growth rate of TFP over the period 1995 to 2019. This works out as 0.6 per cent per annum. This is somewhat less than what headline estimates would suggest. However, given the findings of Kostarkos, McQuinn and Varthalitis (2024) and the observed decline in TFP rates internationally, we take this estimate as our baseline forecast.

Table 2 presents an alternative accounting breakdown of the growth performance of Ireland and the European Union. Using the following identity:

$$\frac{\dot{Y}_t}{Y_t} - \frac{\dot{L}_t}{L_t} = \frac{\dot{A}_t}{A_t} + \alpha\left(\frac{\dot{K}_t}{K_t} - \frac{\dot{L}_t}{L_t}\right) \tag{4}$$

Labour productivity growth can be characterised as a function of TFP growth and "capital deepening" (growth in capital per unit of labour). For the period 2001 to 2023, for example, our estimates indicate that 0.3 percent of the 0.9 percent average growth

rate of productivity is due to the capital deepening effect.

Ultimately, with a stable investment share of GDP, a certain rate of TFP growth will ultimately also translate into the same rate of capital deepening. The steady-state growth rate of a Solow model economy with the production function employed here is $\frac{g}{1-\alpha}$ where g is the growth rate of TFP. With a value of α of one-third, or $1.5g$, this means that along a steady growth path, one-third of the growth in output per hour is due to capital deepening.

3.3. Factors Determining Labour Input

Turning from productivity growth to the growth of labour input, we focus on the total amount of hours worked as our measure of labour input. We decompose past movements in hours worked based on five different factors: Population, the fraction of population of standard work age (i.e. aged between 15 and 64), the participation rate (by which we mean the labour force divided by the work-age population), the employment rate (employment as a fraction of the labour force) and the average workweek per employee. These factors determine hours worked as follows:

$$\begin{aligned} \text{Total Hours Worked} \;=\; & \text{Population} \\ & \times \left(\frac{\text{Work Age Population}}{\text{Population}}\right) \\ & \times \left(\frac{\text{Labour Force}}{\text{Work Age Population}}\right) \\ & \times \left(\frac{\text{Employment}}{\text{Labour Force}}\right) \\ & \times \text{Average Hours Worked Per Employee} \end{aligned} \tag{5}$$

This equation can be used to decompose the growth rate of total hours worked during any period into the contribution coming from each of these five factors.[5] Table 3 provides a decomposition of this type for the percentage change in total hours worked for Ireland and the European Union.

As highlighted by Bergin and Egan (2024), Ireland has experienced rapid population growth in recent years. This growth is somewhat unusual in a wider EU context. Over the

[5] One small complication with this decomposition is that some people continue to work past 65, so our estimate of the "participation rate'; (the ratio of the labour force to population aged between 15 and 64) is boosted slightly by these people. We use this framework to illustrate historical developments because of the important role that the fraction of population aged between 15 and 64 will play in our projections.

20-year period 2001 to 2021, the population in Ireland grew by 30.3 per cent compared to population growth of just 4.1 per cent in the EU. This translates to annual average population growth of 1.3 per cent per annum compared to 0.2 per cent per annum in the EU27. Relative to other EU countries, population growth in Ireland was the third highest in the EU (after Luxembourg and Malta) over the 2001 to 2021. Over this period, across all individual countries, the population grew by an average of 6 per cent, although ten countries experienced no population growth or declines in their population. This trend in stronger population growth in Ireland has continued and more recently, between 2016 and 2021, the population in Ireland grew by 6 per cent compared to average growth of 1 per cent across EU countries.

Looking to future demographic developments, Ireland is set to become one of the most rapidly ageing Member States in the EU. Ireland's population is set to change significantly over the next twenty-five years with a significant increase in old age dependency ratios. Figure 5 illustrates projections for the total population and population aged between 15 and 64 from Eurostat's EUROPOP2013 forecasts.[6] While strong short to medium-term migration assumptions result in robust population growth, particularly among the working age cohort, over the first few years of the population projections, these trends are assumed to reverse with much slower growth in the working age population in the latter part of the projections. These projections, based on detailed projections for trends in life expectancy, fertility and migration, highlight the significant decline in Ireland's working age population in the medium to long term.

Population projections provided by Bergin and Egan (2024) also highlight the shift in Ireland's demographic makeup over the next twenty years, estimating that the share of the population aged 65 and over is set to rise from 15 per cent in 2022 to 26 per cent in 2050. At the same time they project that the share of the working aged population (15 to 64) will falls from 65 per cent in 2022 to 63 per cent by 2040.

4. Longer-Run Outlook

In this section we outline a version of the Solow growth model to generate long-term forecasts for the Irish economy. We report results from a simulation of a simple supply-side

[6] These forecasts are available at http://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data

model that projects growth using recent trends for TFP, uses the demographic projections just described and also assumes relatively low unemployment and investment rates. Everything up to 2023 is taken from historical data, so 2024 is the first year of the simulation.

4.1. The Model and Underlying Assumptions

The model is described as follows:

$$
\begin{aligned}
Y_{it} &= A_{it} K_{it}^{\alpha} L_{it}^{1-\alpha} && (6)\\
K_{it} &= (1-\delta) K_{t-1} + I_{t-1} && (7)\\
L_{it} &= (1-U_{it})(PART_{it} \times WorkPop_{it}) \times H_{it} && (8)\\
I_{it} &= s_{it} Y_{it} && (9)\\
\Delta \log A_{it} &= g && (10)
\end{aligned}
$$

The evolution of Ireland's capital stock depends on last period's rate of investment which we project as a time-varying ratio of total real GDP. Labour input is modelled as a product of the country's employment rate $(1 - U_{it})$, the participation rate for those in the work-age age population $(PART_{it})$ the working age population $(WorkPop_{it})$ and the average length of the workweek (H_{it}).

The assumptions underlying the simulation are as follows:

- TFP is assumed to continue to grow at 0.6 per cent per annum.
- The ratio of investment to output is projected to remain at 20 per cent over the forecast period.
- Unemployment rates are projected to remain at 4.3 per cent per annum.
- The work-age population is taken from Eurostat's EUROPOP2013 projections as illustrated in Figure 3.
- We assume that participation rates remain unchanged from 2023 onwards.
- We also project that the average workweek of employees remains flat from 2023 onwards.

As discussed, Figure 5 illustrates for both Ireland and the EU how population levels for the key 15 to 64 age cohort is likely to evolve over the coming decades. Also included is the share of the population in the 15 to 64 age category. Figure 6 presents some labour market assumptions for the future, while Figure 7 illustrates how our assumptions translate into aggregate Irish labour market outcomes.

Our projection of the average workweek as remaining flat at 2023 levels could be considered optimistic on the grounds that there is no evidence, as of yet, that the trend decline in the average workweek has ended. However, it is likely that much of the trend decline in the average workweek is due to increased female labour force participation in part-time employment. When this source of increased participation flattens out, the trend decline in the average workweek may also cease. In addition, we consider it unlikely that the rest of the decade would see the introduction of many legal new restrictions on the amount of hours that people can work. But there is a possibility that this assumption is too positive.

Figure 8 illustrates the assumptions for TFP growth and the investment share of output.

5. Baseline Irish Forecasts

As illustrated in McQuinn and Whelan (2008, 2016, 2018), one way of presenting the model's long-run behaviour comes from the following decomposition for output per hour, where the capital-output ratio is defined as

$$X_t = \frac{K_t}{Y_t} \tag{11}$$

Output per hour can now be expressed as

$$\frac{Y_t}{L_t} = A_t^{\frac{1}{1-\alpha}} X_t^{\frac{\alpha}{1-\alpha}} \tag{12}$$

This version of the model has also been illustrated in Hall and Jones (1997). DeLong (2003) shows that the capital-output ratio in this model follows a so-called "error-

correction" equation of the form

$$\Delta X_t = \lambda \left(X^* - X_t \right) \tag{13}$$

where it adjusts towards a long-run or "steady-state" level determined by

$$X^* = \frac{s}{\frac{g}{1-\alpha} + n + \delta}. \tag{14}$$

The adjustment speed is given by the following

$$\lambda = (1-\alpha)(\frac{g}{1-\alpha} + n + \delta). \tag{15}$$

McQuinn and Whelan (2007) use data from the Penn World Tables to show that convergence speeds for the capital-output ratio tend to conform closely to the Solow model's predictions.

Compared with other decompositions of output per hour into TFP and capital-per-hour terms, McQuinn and Whelan (2008, 2016, 2018) note that this decomposition has the important advantage of the long-run capital-output ratio being completely independent of the level of A_t. This is not the case in terms of capital-per-hour.

As a result, the decomposition presented in (12) captures entirely the impact of A_t on long-run output, whereas the other more standard decomposition contains a capital deepening term that depends indirectly on the level of technology.

These calculations show that, over the long-run with constant values for g and n, the capital-output ratio converges to its steady-state. Thus, equation (12) tells us that all growth in output per hour ends up being due to $A_t^{\frac{1}{1-\alpha}}$. This term grows at rate $\frac{g}{1-\alpha}$. Thus, in our example with TFP growth of $g = 0.0077$ per year and a value of $\alpha = \frac{1}{3}$, we end up with a long-run steady-state growth rate of output per hour $\frac{g}{1-\alpha} = 0.01$ or 1.0 per cent per year.

We estimate that the current value of the Irish capital-output ratio is 2.3 while its long-run steady-state estimate, based on a projection of 0.6 percent per year TFP growth and a growth rate of labour input of approximately 1.1 per cent, is about 2.5. This means that the model will generate growth in output per hour that is greater than 1 per cent per annum along a transition path. The pace of convergence, λ, based on a depreciation

rate of six percent per year, is about 5.5 per cent per year.

The dynamics described can be seen in Figure 9 which presents the projected future path of the capital output ratio (left panel) and overall capital stock growth (right panel), both historically and over the forecast period. The right panel of Figure 9 shows that the rising investment over the last number of years lead to a gradual increase in the growth rate of the capital stock from 0.91 percent in 2016 to a peak of 1.58 percent in 2022 before gradually declining again.

Over the forecast period, 2024-2040, the growth rate of capital stock falls from 2.6 per cent in 2023 before reaching 1.8 per cent by the end of the forecast period in 2040, changing by around 0.02 percentage points (pp) per year. The left hand panel of Figure 9 shows that over the same forecast period of 2024-2040 that the capital output ratio increases marginally over time, rising from 2.3 in 2023 to just under 2.4 by the end of the forecast period in 2040.

Table 4 and Figure 10 show the growth rates in output and output per hour generated by the model outlined in Sections 4 and 5. The forecasts generated show output growth that is declining over time, with the Irish economy growing by 2 per cent in the period 2024-2030 before falling to 1.5 per cent and 1 per cent in the 2030-2040 and 2040-2050 forecast windows respectively. Over the same periods, the growth rate of productivity, measured by the annual growth rate in output per hour, increases from 0.8 per cent in 2024-2030 to 1.1 and 1.2 per cent in 2030-2040 and 2040-2050 respectively.

6. Scenario Analysis

In this section we perform a number of scenario analysis by looking at different assumptions relating to both population growth and the rates of investment over the simulation period. Below outlines both the rationale for the alternative paths of population and investment rates as well as the impact the alternative paths have on key variables such as output, output per hour and hours worked. In addition to the scenario analyses for investment and migration, we conduct robustness checks on the assumptions for TFP growth, the unemployment rate and the labour share of income. We also evaluate the choice of the initial level of the capital stock.

6.1. Demographic and Migration

The primary factor influencing changes in Ireland's population is net migration. Because migration movements are highly dependent on economic conditions in both the host and destination country, migration flows are difficult to predict and prone to volatility. With this in mind, we employ two distinct scenarios for migration and, by extension, overall population levels, in addition to the baseline population assumptions used for the results discussed in Section 5.

Figure 11 plots the population assumptions in the baseline along with those related to the high and low migration scenarios. These alternative population scenarios are based on those adopted in Bergin and Egan (2024) and over the longer-period (2050 - 2100) follow those of the European Commission and relate to a higher and lower level of net migration over the simulation period.

Table 5 presents the results of the scenario analysis for both the low and high migration scenarios. The simulations are presented in terms of output, output per hour and hours worked over three simulation windows, namely 2024-2030, 2030-2040 and 2040-2050. The results indicate that there is little or no change to the output per hour worked across the simulation windows in either the low or high migration scenarios. There is a slightly more noticeable impact on the output growth rate across the scenarios.

In the lower migration scenario, the annual average growth rate across all three simulation windows falls by 0.2 per cent per annum. The same magnitude of change of is observed in the high migration scenario, resulting in a 0.2 per cent increase in the growth rate of output. With regard to the growth of labour input, we also observed a noticeable change in the hours worked across both the low and high migration scenarios across all simulation windows.

The scenario analysis shows that in the 2024-2030 period, with lower migration, and by extension a lower population, hours worked fell by 1 per cent from the baseline level. The fall increases to 2.9 and 5.4 per cent in 2030-2040 and 2040-2050 respectively. The increase in the high migration scenario is stronger suggesting a level of asymmetry in the reaction of hours worked to our high and low migration assumptions. The results show that higher migration had an 0.9, 2.7 and 4.7 per cent increase on hours worked across the 2024-2030, 2030-2040 and 2040-2050 simulation windows respectively.

6.2. Investment Scenarios

As discussed in Section 1, in light of the significant fall in investment after the global financial crisis (GFC), infrastructural deficits have been identified as a potential limit vis-á-vis the growth potential of the Irish economy. Furthermore, going forward, these deficits will be exacerbated by future challenges presented by an aging population which will require investment in areas such as health services, long term care and sustainable pension systems to ensure long-term economic stability.

Ireland's underlying investment share has fallen consistently since 2007. Despite the strong recovery in the economy post crisis, the investment rate remains at a level comparable to the pre "Celtic tiger" era at around 20 per cent. Therefore, as a scenario, based on historical rates of investment, we simulate the impact on key headline variables of an increase in the investment rate over a plausible simulation horizon.

In Scenario 1, the investment rate rises gradually from 20 percent in 2023 to 25 per cent in 2030 and remains at that level for the remainder of the simulation period out to 2040. In the higher investment rate scenario, Scenario 2, the rate rises more sharply reaching 30 per cent by 2033 and remains constant until the end of the simulation period in 2040. Both investment rate scenarios along with the baseline are illustrated in Figure 12.

It is interesting to put these scenarios in context given the recent European Commission (2024) report which proposes policies to advance future European competitiveness. The report, contends that a minimum annual additional investment of EUR 750 to 800 billion is needed, based on the latest Commission estimates. This would correspond to 4.4-4.7 per cent of EU GDP in 2023. As a comparison, investment under the Marshall Plan between 1948-51 was equivalent to 1-2 per cent of EU GDP. Delivering this increase would require the EU's investment share to increase from around 22 per cent of GDP today to around 27 per cent. The Commission's report acknowledges that this would necessitate reversing a multi-decade decline across most large EU economies.

Figure 13(a) and (b) illustrate the response of these increased investment rates on both the capital output ratio and the growth rate of the capital stock respectively. The results suggests that the increase in the investment rates from 20 percent to 25 and 30 per cent results in an increase in the capital output ratio of around 0.25 per cent and 0.5 per cent respectively by 2040. The increased investment rates also leads to a significant

increase in the growth rate of the capital stock which by 2040 has risen from just over 2 per cent in the baseline to over 3 percent and 4 per cent in Scenario 1 and 2 respectively.

Table 6 shows the difference in output growth between the investment scenarios over the three simulation windows. In scenario 1, where the investment rate rises from 20 per cent to 25 percent by 2030, the growth rate of output is 0.4, 0.6 and 0.3 per cent per annum higher than in the baseline. From table 7, it can be seen that this corresponds to output growth rates of 2.4, 2.1 and 1.3 per cent in 2024-2023, 2030-2040 and 2040-2050 respectively under the baseline population scenario.

In scenario 2, where investment rates rise from 20 per cent to 30 percent by 2033, under the baseline population scenario, output growth rises by 0.4, 0.9 and 0.5 per cent per annum above the baseline in 2024-2030, 2030-2040 and 2040-2050 respectively. This corresponds to output growth rates of 2.5, 2.4 and 1.6 per cent over the three simulation windows. Under scenario 2, with high rates of migration, output growth would be 2.6, 2.6 and 1.7 per cent over the periods 2024 - 2030, 2030-2040 and 2040-2050 respectively.

7. Robustness Checks

Given the sensitivity of our forecasts to the underlying assumptions, we now conduct a series of robustness checks to gauge the sensitivity of some of our key findings to future uncertainty.

7.1. Total Factor Productivity growth

The baseline assumption underpinning out forecast is that the future growth rate in Total Factor Productivity will equal the average over the period 1995-2019 of 0.6 per cent. Given the assumption of the Solow model, this is a crucial parameter in our forecast exercise. Therefore, we test the sensitivity of the output forecast to this assumption by applying a stochastic model to generate a distribution around our baseline forecast.

In order to do this, we must first specify a model for Irish TFP. Then, using the variances indicated by the estimates of this model, we can generate a distribution around our baseline TFP forecast. We use a simple error correction model to explain the relationship between Irish TFP and an exogenous variable drawn from the National Institute Global Econometric Model which captures global labour-augmenting technology. We then apply

the distribution from the resulting forecast to our baseline assumption. Figure 14(a) plots the 90, 75 and 50 per-cent confidence intervals around the baseline forecast. The figure shows the confidence intervals are quite wide, underlining the variability of Irish TFP growth.

We construct high and low TFP growth scenarios based on the 90 per cent confidence intervals of this distribution. Figure 14 (b) outlines the output path for the baseline along with the high and low TFP growth scenarios and suggests that output is highly sensitive to the TFP growth assumption.

7.2. Unemployment rate

We also conduct a similar exercise for our forecast of the unemployment rate. The baseline forecast for the unemployment rate is that the prevailing rate of 4.2 per cent will continue. We generate a distribution around our baseline forecast for Irish unemployment and test the sensitivity of the output forecast to changes in the unemployment rate.

Historically, the UK unemployment rate has explained much of the variation in the Irish rate (Honohan, 1992). We model the relationship between Irish unemployment and UK unemployment for the period 1995-2023 using an error correction model. We then introduce an exogenous forecast for UK unemployment out to 2050 based on the National Institute Global Econometric Model. We apply the distribution from the resulting forecast for Irish unemployment to the baseline assumption of 4.2 per cent unemployment. Figure 15 (a) presents a fan chart illustrating the confidence intervals associated with this forecast.

We construct high and low unemployment scenarios based on the 90 per cent confidence intervals of this distribution. Output is somewhat sensitive to the unemployment assumption, with a cumulative deviation of ± 2 per cent by 2040. Figure 15 (b) outlines the output forecasts for the baseline scenario along with the high and low unemployment scenarios.

7.3. Initial level of the capital stock

As outlined in Section 5, the capital stock for the period 1996-2023 is generated by a capital accumulation equation based on the perpetual inventory method. This equation requires an initial level of capital to be set for 1995. In the baseline scenario, we assume that capital in 1995 was equal to its steady-state level. We now compare this steady-state

value with an alternative measure of the Irish capital stock, drawn from the ESRI's Core Structural Model (COSMO).

In Figure 16 below, we present the COSMO capital level alongside the baseline assumption as described above. We also present the level of capital in each year that would be consistent with the steady-state level for that year.

This comparison shows that the steady-state capital value in 1995 was almost identical to the value drawn from COSMO. Indeed, the COSMO value and the steady-state value are quite similar over the period 1995-2005. This suggests that not only is the output forecast not sensitive to the choice of initial capital level for 1995, it is not particularly sensitive to the choice of 1995 as a starting point for the capital accumulation equation. In the period since 2006, the capital stock drawn from COSMO increases while the steady-state value decreases. This is attributable to distortions in the national accounts in the case of the former and a fall in investment in the case of the latter.

7.4. Labour share / sensitivity of output to capital

The final sensitivity test we perform is on the assumption for α, the sensitivity of output with respect to capital. In the Cobb-Douglas production function, output is increasing in α provided capital is greater than labour. The capital stock in euro is far larger than the total hours worked. The following derivation describes this process:

$$Y = A \cdot K^{\alpha} \cdot L^{1-\alpha} \tag{16}$$

$$\frac{\partial}{\partial \alpha}[\ln(Y)] = \frac{\partial}{\partial \alpha}[\ln(A) + \alpha \ln(K) + (1-\alpha)\ln(L)] \tag{17}$$

$$\frac{1}{Y}\frac{\partial Y}{\partial \alpha} = \ln(K) - \ln(L) \tag{18}$$

$$\frac{\partial Y}{\partial \alpha} = Y \cdot (\ln(K) - \ln(L)) \tag{19}$$

$$\frac{\partial Y}{\partial \alpha} = A \cdot K^{\alpha} \cdot L^{1-\alpha} \cdot (\ln(K) - \ln(L)) > 0 \tag{20}$$

We draw on a recent estimation of the Irish labour share (O'Shea, 2024) which finds that over the period 1995 - 2023 the average labour share in a peer group of European countries is 0.57, while the average labour share in Ireland is 0.55. Therefore, we evaluate the impact of setting $\alpha = 0.4$ and $\alpha = 0.45$. Figure 17 shows that setting $\alpha =$

0.45 generates a cumulative increase in the output forecast of 2.7 per cent by 2040.

O'Shea (2024) does find that the labour share in the Irish economy has remained particularly consistent over the period 1995 - 2023, when multi-national related distortions are allowed for.

8. Policy Implications

The results presented in this analysis are somewhat sobering as far as the future prospects for the Irish economy are concerned. They appear to suggest that the rapid growth experienced by the economy in the periods 1995 - 2007 and 2012 - 2023 could well be at an end. This is not a profound surprise as economies, typically, do not tend to experience significant growth on a continual basis. However, from a number of perspectives, it is important that the Irish economy continues to grow at a sustainable pace over the coming decades. Therefore, it would appear there are a number of policy challenges which arise if continued growth is to be experienced.

- **Policies which stimulate and increase productivity particularly amongst domestic indigenous firms**. The relatively modest pace of TFP growth assumed in the forecast period of 0.6 per cent per annum has, as demonstrated, significant long-term implications for labour productivity. Therefore, any polices which can stimulate productivity growth, particularly amongst indigenous firms, will be important. Recent work by Papa, Rehill and O'Connor (2021) is of interest in that regard. They highlight that a sizable productivity gap in the Irish economy has emerged between between high productivity firms and those who are lagging behind. Papa, Rehill and O'Connor (2021) point out that as the dispersion is mainly due to differences within specific sectors of the economy, there is greater potential for policy to encourage linkages between the frontier and laggard firms. This could involve activating policies which affect positive contagion between productivity rates in the MNE sector and the domestic indigenous one.

- **Significant and consistent rates of investment in the domestic economy**. The initiation of the recent long-term investment funds by the State is a welcome development in this regard and may help to safeguard domestic investment rates from cyclical

variations in domestic economic fortunes.[7] Unfortunately investment levels in the Irish economy have tended to be chronically pro-cyclical. Increasing investment in this manner would chime with the main proposals outlined in the recent European Commission (2024) report which advances a blueprint for achieving greater growth in the future European economy.

Such increases in investment must of course be accompanied by measures to ensure the effective and efficient provision of infrastructural projects. Previously, in the context of significant capital projects, the Irish economy has witnessed substantial cost overruns in that regard with consequences for the exchequer.

- **Policies aimed at offsetting the implications of "demographic drag"**. Ireland's population is set to change quite significantly over the coming decades and the greater aging which will occur will present substantial challenges on a number of fronts. These challenges are not unique to Ireland and similiar demographic pressures are apparent in Europe (McQuinn and Whelan (2008, 2016, 2018)), Korea (Clemens (2024)), Australia (Clemens and Chand (2023)), the United States (Orrenius et al. (2020)) and many western economies (Poutvaara (2021) and Dao et al. (2021)). In that regard it is imperative that Ireland avails of migration policies in the future to help supplement the domestic labour force. Ireland can learn from economies such as Korea's, where labour migration has been established as a "necessary, sufficient and feasible" policy option to offset demographic drag in that country (Clemens (2024)).

  Of course the relationship between growth rates of TFP and demographic changes is not mutually exclusive. For example, Feyrer (2007) has quantified the link between productivity performance and demographics; he estimates that a 5 per cent increase in the size of the 40 - 49 age cohort can increase productivity across the economy by between 1 to 2 per cent. Therefore, it is imperative that policy makers understand these interlinkages between demography and productivity in assessing the most efficient structuring of policies aimed at addressing these issues.

[7] For more details of the two funds see https://data.oireachtas.ie/ie/oireachtas/libraryResearch/2024/2024-04-08_bill-digest-future-ireland-fund-and-infrastructure-climate-and-nature-fund-bill-2024_en.pdf

9. Conclusions

Ireland has experienced particularly turbulent growth over the period 1995 to 2023. Apart from the disastrous implications of the global financial crisis (GFC) between 2007 and 2012, the economy has expanded considerably. This was mainly facilitated by a sizable growth in population and the participation rate which saw the labour force contributing significantly over the period. Strong demand for that labour came from significant inward multinational investment with other sources of demand coming from certain indigenous sectors of the economy.

However, Ireland's future economic growth is likely to be somewhat different to thath which has prevailed over the period 1995 - 2023. In this paper we use a standard Solow growth model framework, initially, to decompose the past performance of the Irish economy, and then, based on this analysis, we present likely future paths for the economy under a number of plausible scenarios. We have also assessed the implications for the domestic growth trajectory under a number of scenarios concerning different future population growth and certain investment scenarios.

The forecasts generated show that, under the baseline scenario, potential output growth will continue to grow but at a declining pace; the Irish economy is likely to experience annual average growth rates of 2.0 per cent in the period 2024-2030 before falling to 1.5 per cent and 1.1 per cent in the 2030-2040 and 2040-2050 forecast windows respectively.

Our simulations also show that Ireland's output growth is sensitive to both different demographic developments and the rate of investment. The results presented show that alternative migration paths can result in 0.2 per cent per annum deviation from a baseline migration scenario. In addition the paper finds that increasing investment rates, even to rates below those at the peak of the Celtic Tiger era, would result in output growth increasing by as much as 0.9 per cent per annum from the baseline rate.

Given likely future population dynamics and the relatively slow rate of TFP growth evident in the domestic economy it is imperative that policymakers adopt measures which target greater rates of investment in the domestic economy along with policies enabling continued inward migration. Additionally any avenues which enable effective diffusion of technology spillovers between the multinational (MNE) sector in the Irish economy and the more indigenous sector must also be explored.

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Figure 1

Headline and underlying Irish investment rate

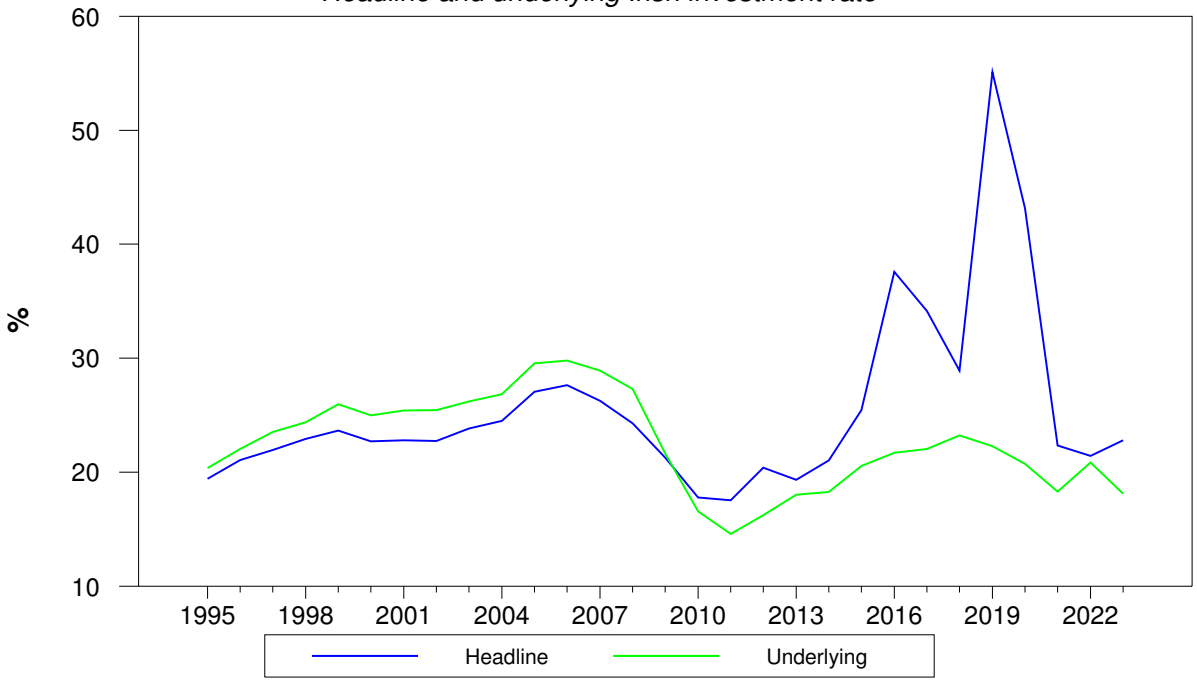

Figure 2

Irish Population Movements

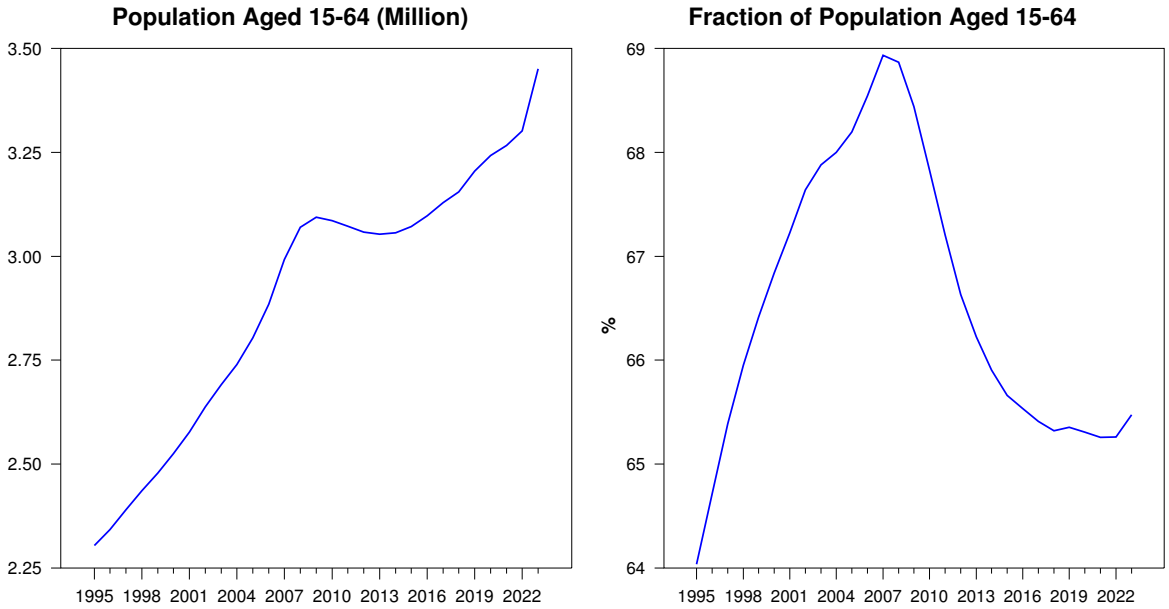

Figure 3

Determinants of Irish Growth

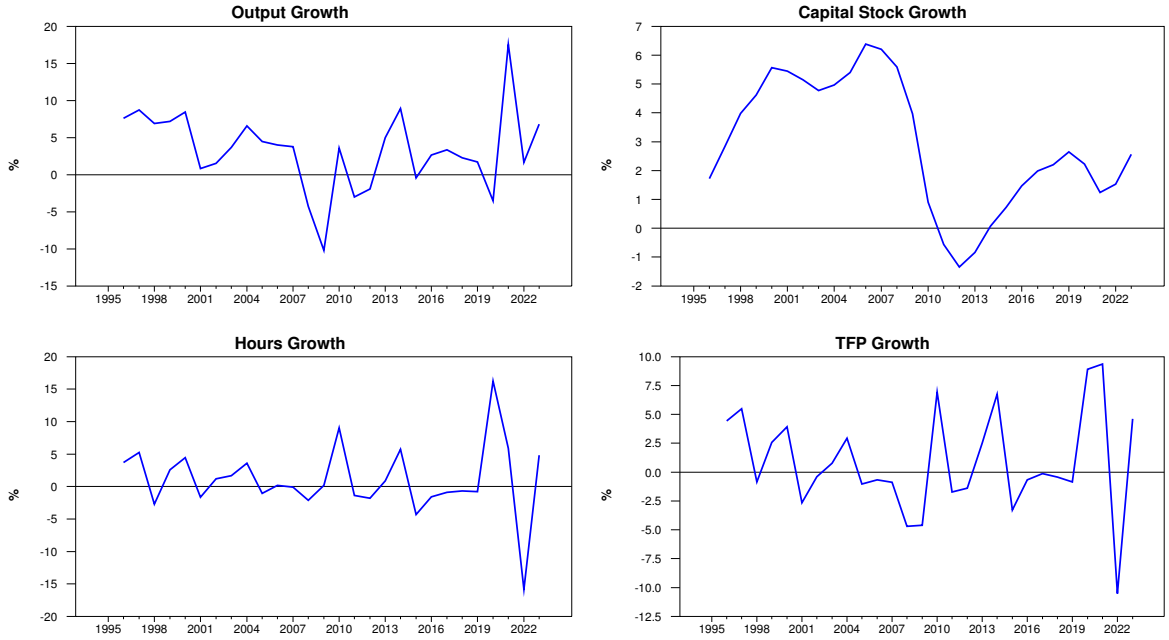

Figure 4

Determinants of Irish Hours Growth

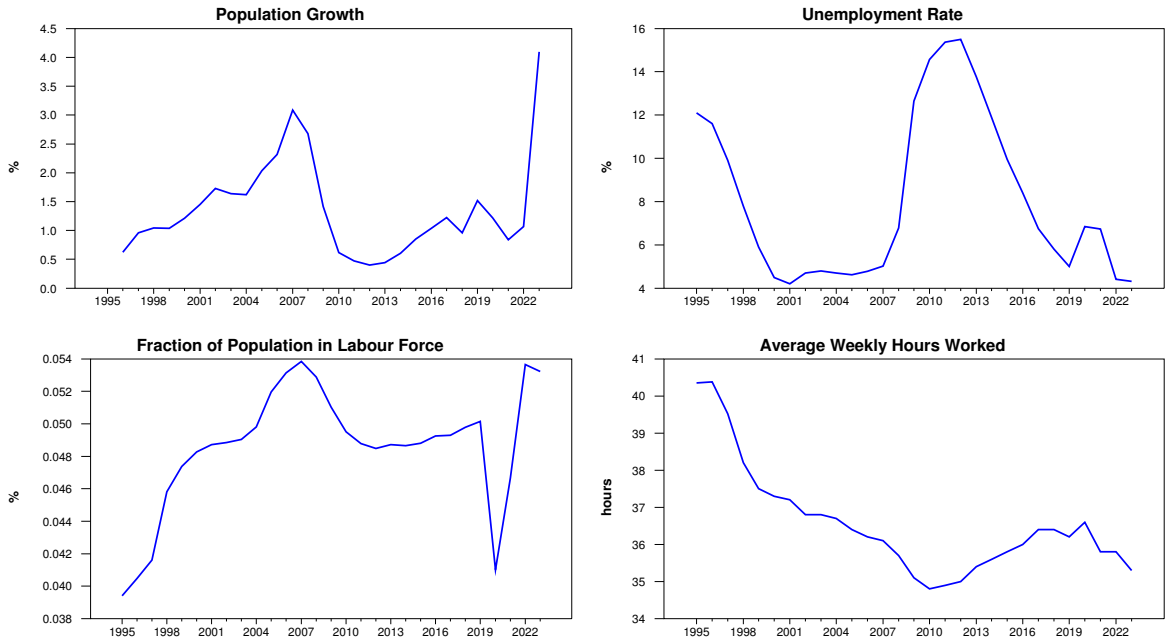

Figure 5

Irish and EU Baseline Demographic Forecasts

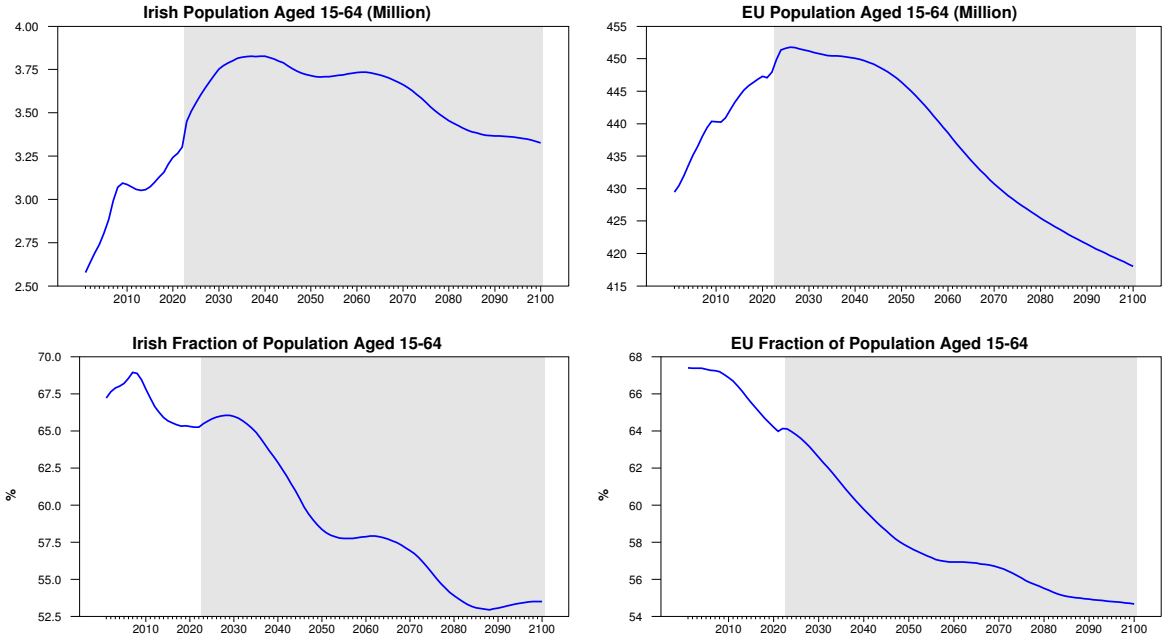

Figure 6

Baseline Labour Market Assumptions

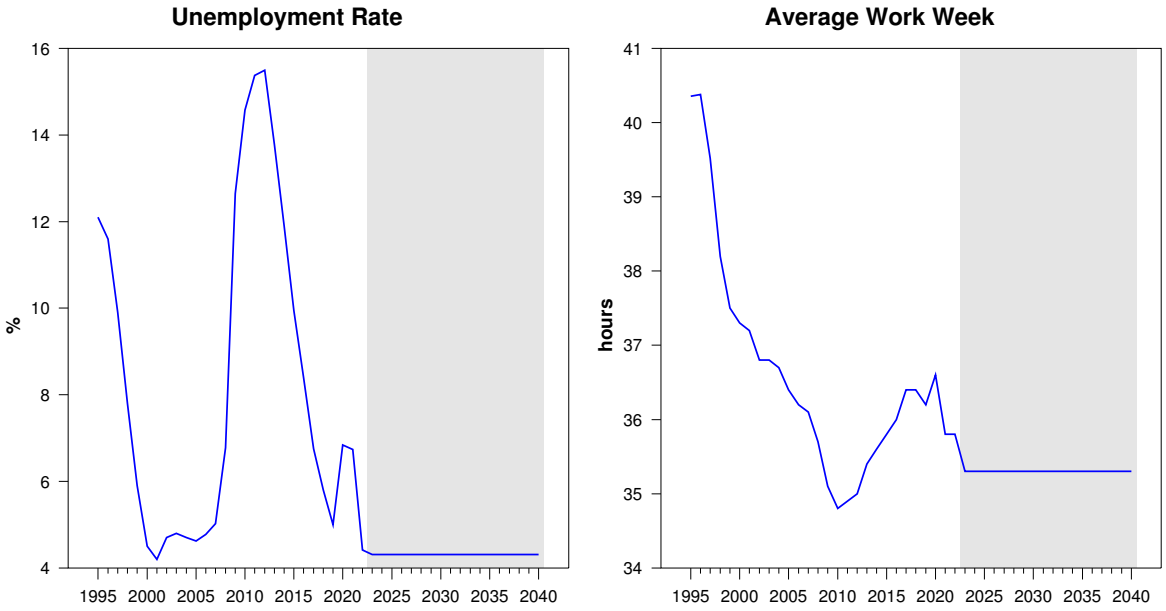

Figure 7

Baseline Labour Supply (Millions)

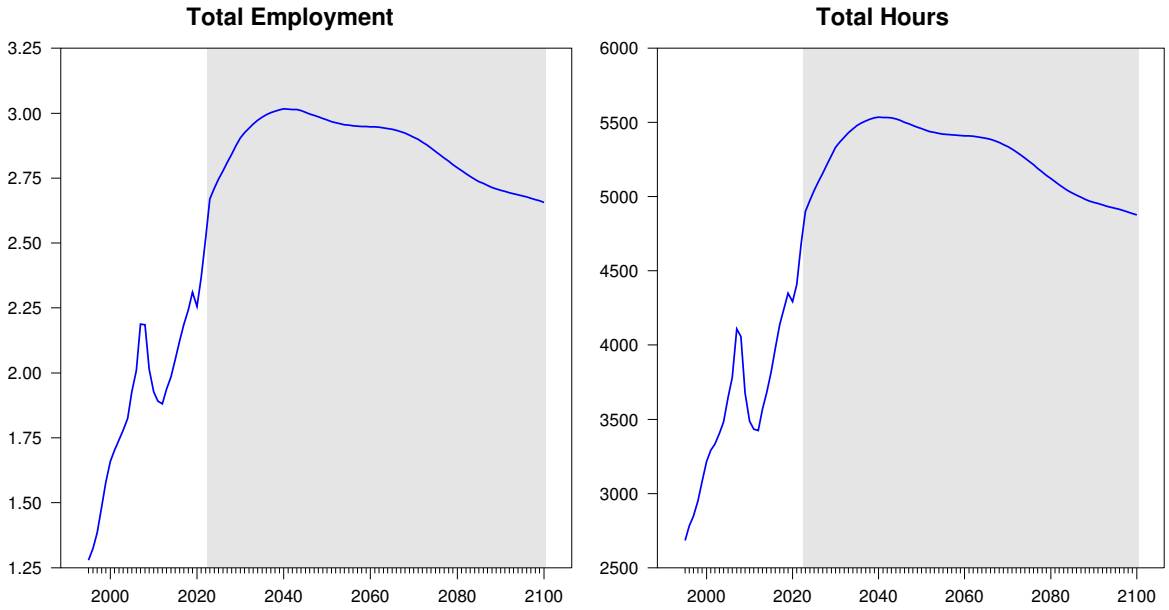

Figure 8

Baseline Investment and TFP Assumptions

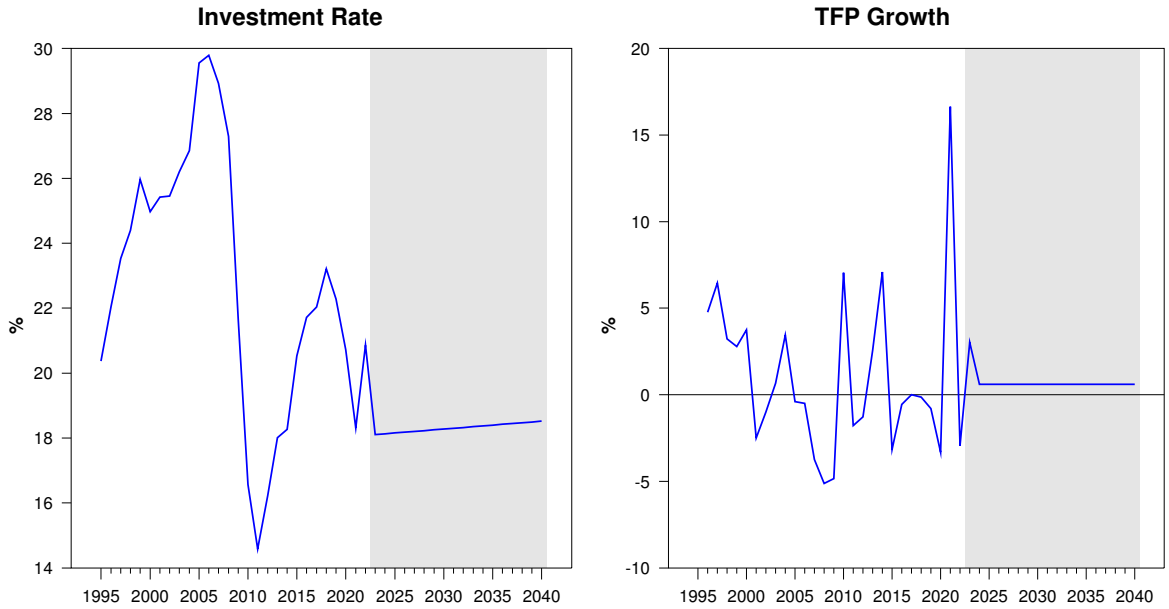

Figure 9

Baseline Capital-Output Convergence

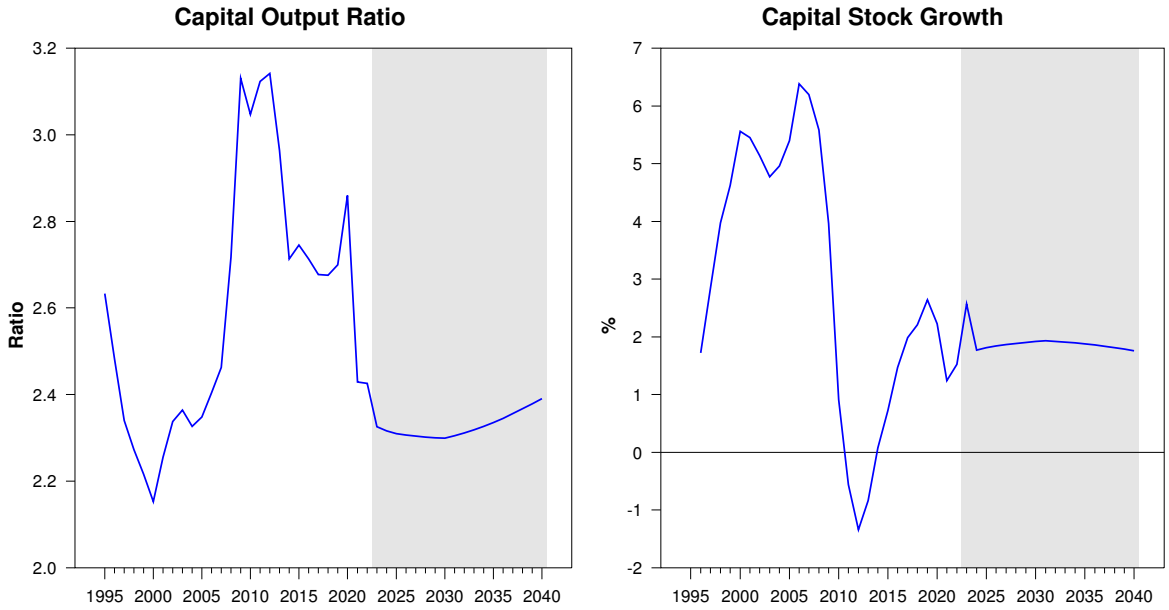

Figure 10

Baseline Output Growth Rates

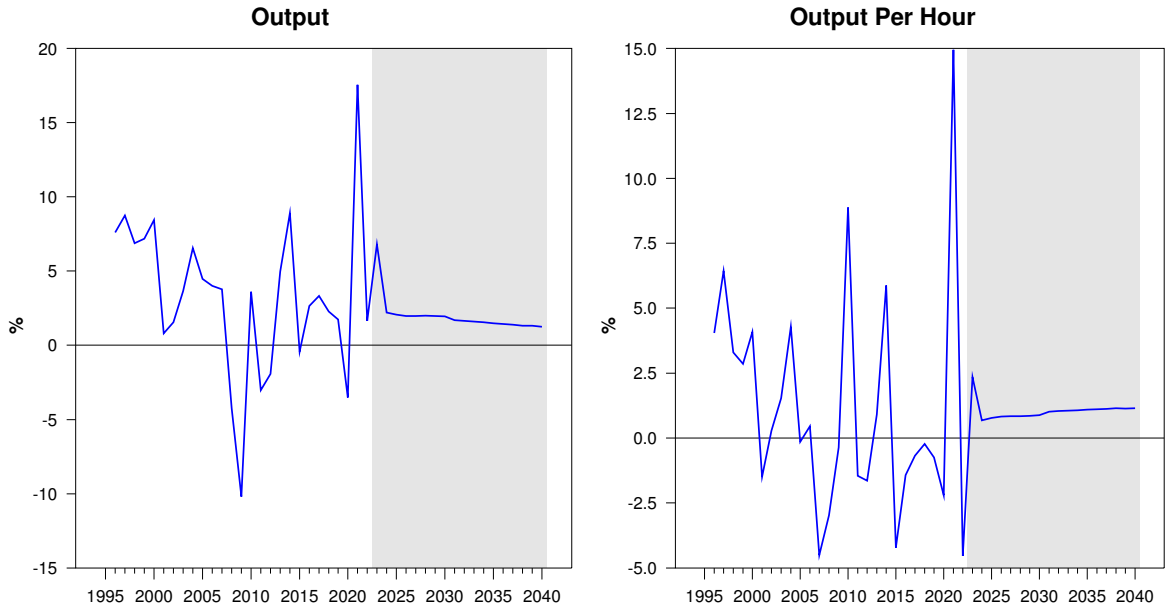

Figure 11

Migration Scenarios

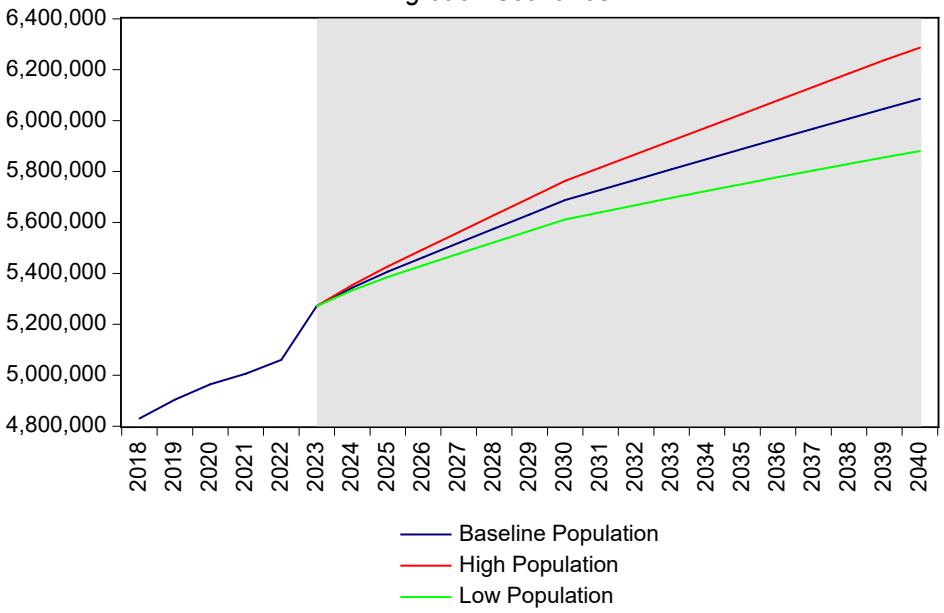

Figure 12

Investment Rate Scenarios

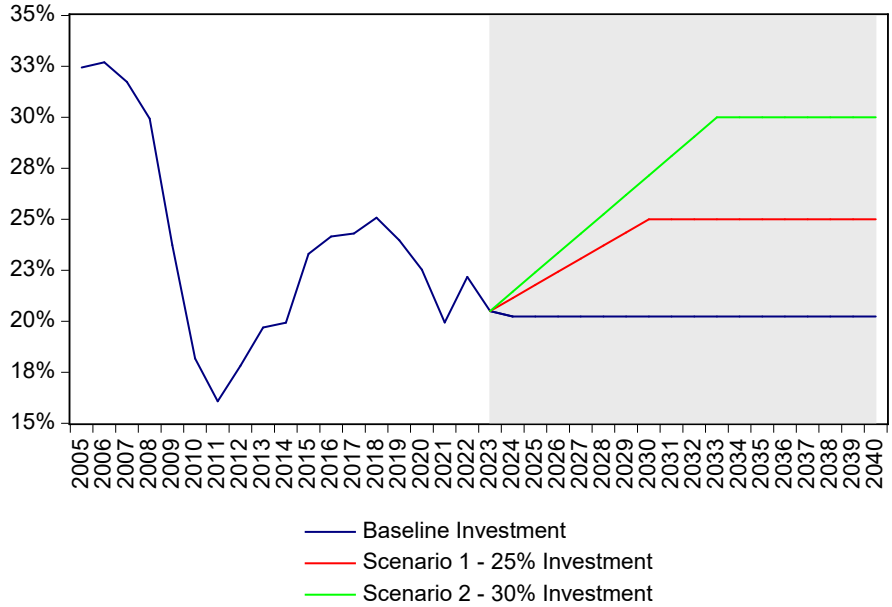

Figure 13 (a)

Capital Output Ratio Under Investment Scenarios

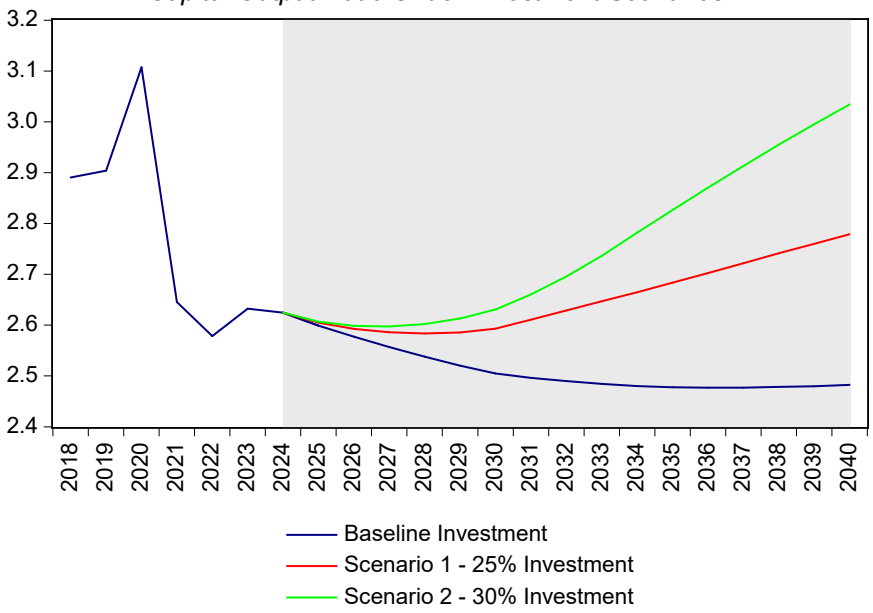

Figure 13 (b)

Capital Stock Growth Under Investment Scenarios

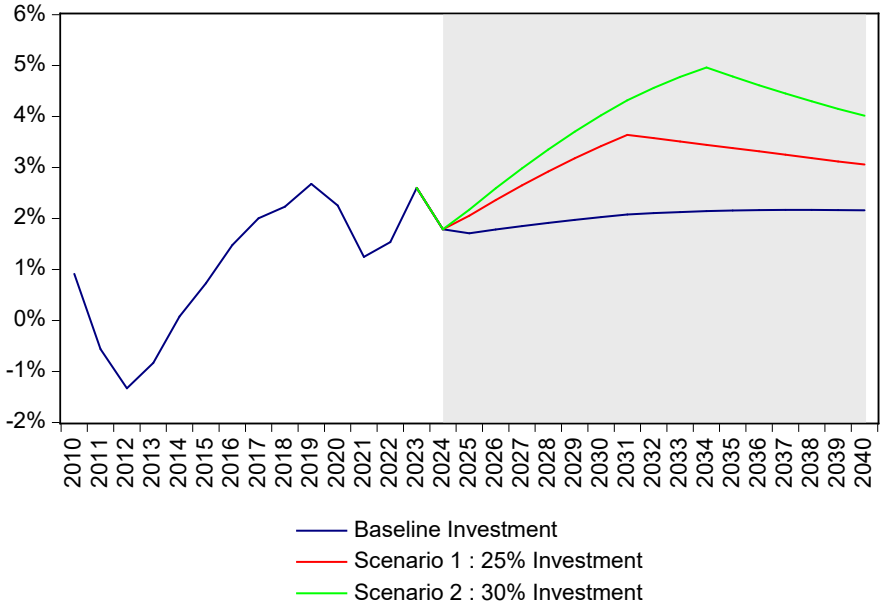

Figure 14 (a)

TFP Growth Paths

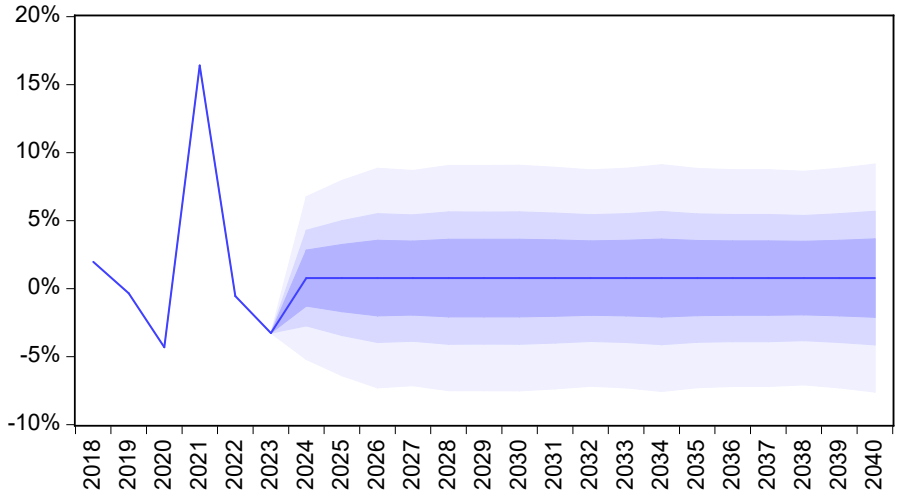

Figure 14 (b)

Output Under Different TFP Growth Paths

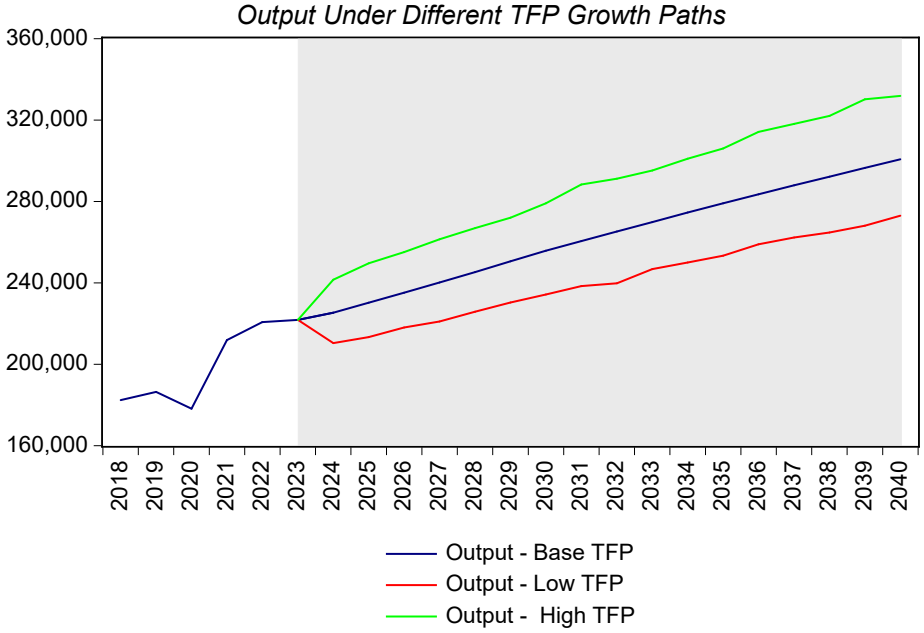

Figure 15 (a)

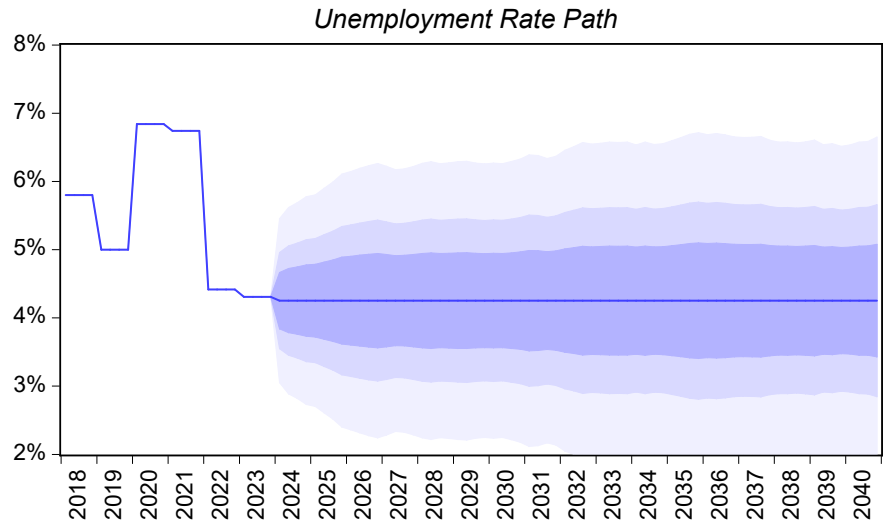

Figure 15 (b)

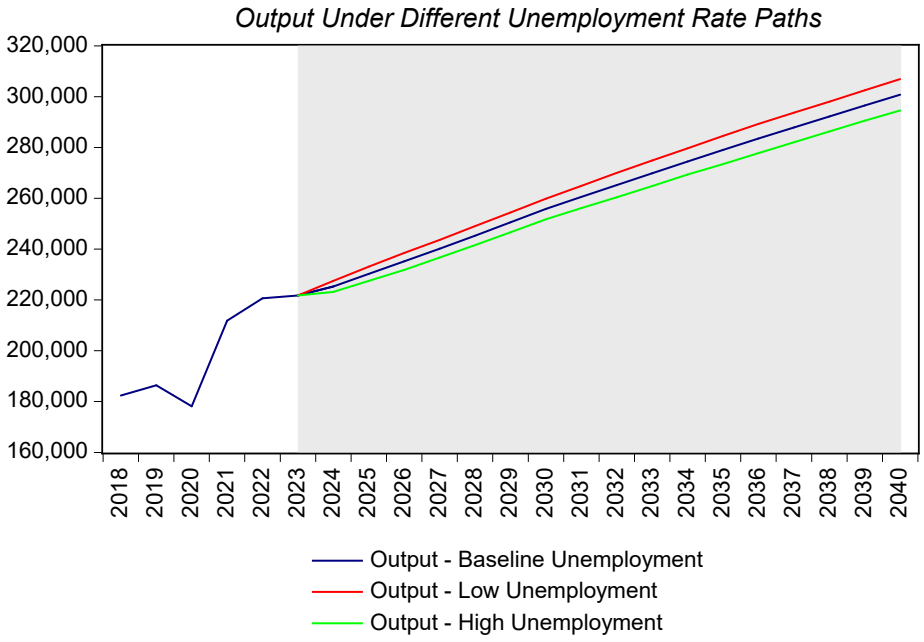

Figure 16

Capital Stock Levels

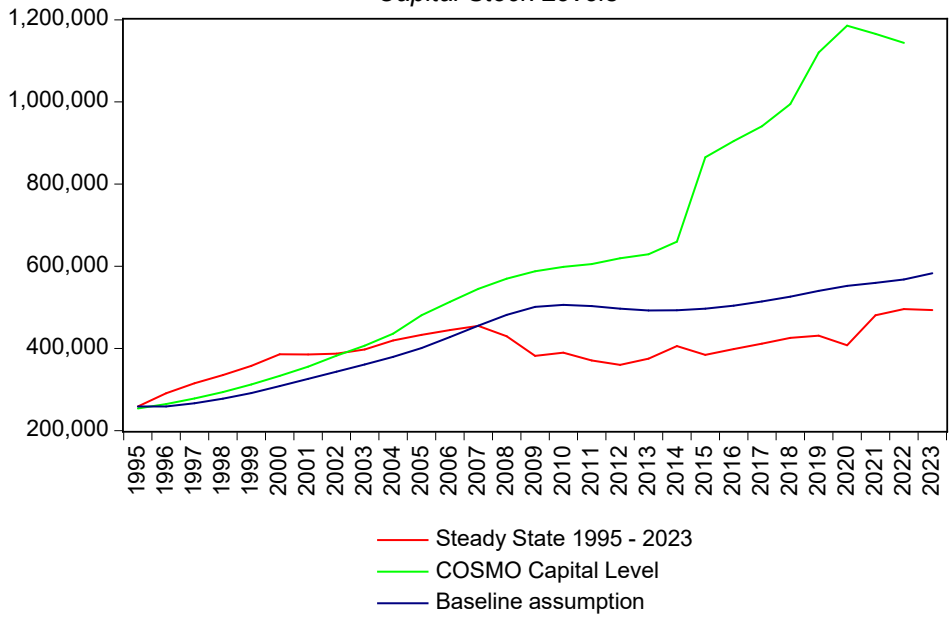

Figure 17

Ouput Under Different Alpha Assumptions

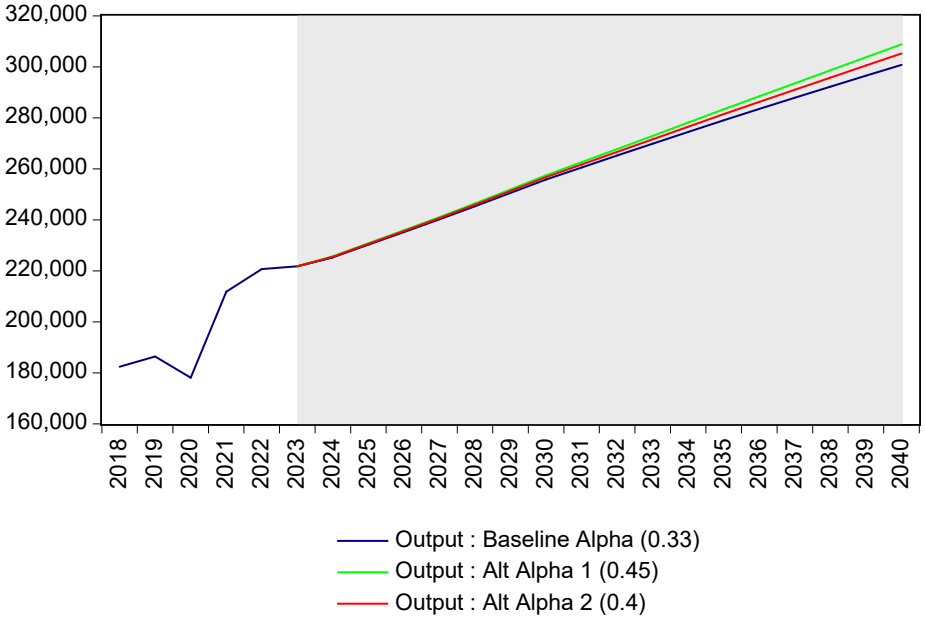

Table 1: Decomposition of Irish and European Union Output Growth Rates (%)

	Ireland				European Union			
Period	$\triangle y$	$\triangle a$	$\triangle k$	$\triangle l$	$\triangle y$	$\triangle a$	$\triangle k$	$\triangle l$
2001 - 2007	4.0	0.1	1.8	2.1	2.1	0.7	1.0	0.4
2008 - 2013	-1.3	0.3	0.14	-1.8	-0.3	-0.2	0.6	-0.7
2014 - 2019	1.9	-1.1	0.6	2.4	2.2	0.8	0.5	0.8
2020 - 2023	7.3	-0.2	0.6	6.9	8.7	1.2	0.6	1.0
2001-2023	2.5	0.5	0.9	1.1	1.3	0.3	0.7	0.3

Note: The table shows the contribution of growth in labour inputs, capital inputs and TFP to total output growth.

Table 2: Decomposition of Irish and European Union Output per Hour Growth Rates (%)

	Ireland			European Union		
Period	$(\triangle y - \triangle l)$	$\triangle a$	$(\triangle k - \triangle l)$	$(\triangle y - \triangle l)$	$\triangle a$	$(\triangle k - \triangle l)$
2001 - 2007	0.9	0.1	0.8	1.5	0.7	0.8
2008 - 2013	1.4	0.4	1.0	0.7	-0.2	1.0
2014 - 2019	-1.7	-1.1	-0.6	0.9	0.8	0.1
2020 - 2023	-1.7	1.2	-2.9	1.8	1.7	0.1
2001 - 2023	0.9	0.5	0.3	0.9	0.4	0.3

Note: The table shows the contribution of capital deepening and TFP to the growth rate of labour productivity.

Table 3: Decomposition of Growth in Hours Worked (%)

	Ireland				
Period	Total	Pop.	P. Rate	Emp. Rate	Workweek
2001 - 2007	3.1	2.1	1.7	-0.1	-0.5
2008 - 2013	-2.7	0.7	-1.6	-1.6	-0.2
2014 - 2019	3.6	1.1	0.6	1.5	0.3
2020 - 2023	10.4	2.0	8.7	0.9	-1.2
2001-2023	1.6	1.4	0.4	0.0	-0.2
	European Union				
Period	Total	Pop.	P. Rate	Emp. Rate	Workweek
2001 - 2007	0.6	0.3	0.4	0.2	-0.3
2008 - 2013	-1.0	0.1	0.2	-1.0	-0.3
2014 - 2019	1.2	0.2	0.2	0.9	-0.1
2020 - 2023	1.4	0.2	0.9	0.5	-0.2
2001-2023	0.4	0.2	0.3	0.1	-0.2

Note: *Pop.* refers to population, *P.* is the participation rate, *Emp.* is employment and $Workweek$ is average hours worked by employees.

Table 4: Baseline Irish Growth Forecasts (%)

	2024-2030	2030-2040	2040-2050
Output	2.0	1.5	1.0
Output Per Hour	0.8	1.1	1.2

Note: Average annual growth rate for the period in question.

Table 5: Change in Output and Hours Worked due to Migration Scenarios (%)

	Low Migration		
	2024-2030	2030-2040	2040-2050
Output	-0.2	-0.2	-0.2
Output Per Hour	0.1	0.0	0.0
Hours worked	-1.0	-2.9	-5.4
	High Migration		
	2024-2030	2030-2040	2040-2050
Output	0.2	0.2	0.2
Output Per Hour	-0.1	0.0	0.0
Hours worked	0.9	2.7	4.7

Note: For output it is the change in the average annual growth rate with respect to the baseline growth rate for the period in question, while for hours worked it is the average annual percentage change in the total hours worked with respect to the baseline level for the period in question.

Table 6: Change in Output Growth Rates due to Investment Scenarios (%)

	2024-2030	2030-2040	2040-2050
Scenario 1	0.4	0.6	0.3
Scenario 2	0.4	0.9	0.5

Note: Change in the average annual growth rate with respect to the baseline growth rate for the period in question.

Table 7: Output Growth Rates under Baseline, Migration and Investment Scenarios (%)

	Baseline Investment		
	Baseline Migration	Low Migration	High Migration
2024 - 2030	2.0	1.9	2.2
2030 - 2040	1.5	1.3	1.7
2040 - 2050	1.1	0.8	1.2
	Investment Scenario 1		
2024 - 2030	2.4	2.2	2.6
2030 - 2040	2.1	1.9	2.3
2040 - 2050	1.3	1.1	1.5
	Investment Scenario 2		
2024 - 2030	2.5	2.3	2.6
2030 - 2040	2.4	2.2	2.6
2040 - 2050	1.6	1.3	1.7

Note: Average annual growth rate for the period in question.