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ARTICLE

Some intergenerational arithmetic to control public debt in the EU

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Abstract
Long-term projections are the bedrock of any analysis looking at the sustainability of public finances. This paper computes the changes in economic growth in individual European Union countries needed for government debt-to-GDP ratios to stay on their baseline trajectories (taken from the European Commission's Debt Sustainability Monitor 2023) under high life expectancy, low-fertility, low-migration, and high-migration scenarios. These scenarios are provided in the Commission's Ageing Report (2024). We find that deviations of migration from the baseline entail the largest effect on the required rate of economic growth. The effects of the low-fertility scenario are most pronounced in the very long run and sometimes exceed those of low migration. Our findings inform policymakers about the potential role of higher productivity growth in alleviating the public finance consequences of demographic shocks. The importance of higher productivity growth is increased by the fact that in some countries demographic projections tend to be optimistic.

Keywords: debt; demography; fertility; GDP; migration

JEL Codes: H5; H6; J11; J13

1. Introduction

Governments of advanced economies, and especially those in the European Union (EU), will be confronted with mounting pressure on the public purse, in particular linked to the green and digital transitions,[1] defense, and the costs of aging. The rising spending pressures cumulate against a

[1]The European Commission (2020) estimates of the cost of the digital transition at €125 billion per year (in 2020 prices). Based on a literature review, Saulnier *et al.,* (2025) estimate that for the EU to maintain its current position as a global competitor, requires annual investments of €652-927 billion, including €108-278 billion per year in public investments up to 2035. The European Commission (2024e) estimates an annual additional investment need of around €480 billion (between 2021 and 2030) for energy supply, energy demand and transport. This is expected to grow to €600–700 billion annually over 2031–2040. The public share in these investments is estimated around 25–50 percent (see Darvas and Wolff, 2022; Nerlich and Köhler-Ulbrich *et al.*, 2024 or Pisani-Ferry and Tagliapietra, 2024). Finally, the European Commission (2024f) estimates additional investment needs for defense of €500 billion over the next 10 years. This is likely a conservative estimate, as other analyses suggest. For instance, Burilkov and Wolff (2025) estimate that the EU needs an extra €250 billion annually to deal with the threat from Russia.

background of shrinking working-age populations. According to the latest demographic projections, the number of people in the EU between 15 and 64 years of age will on average decline by more than 1.2 million every year. These developments must be absorbed by increasing the burden on taxpayers, now or in the future, unless spending reductions elsewhere can be found or GDP growth can be raised substantially and durably.

Demographic shocks are important factors influencing GDP and a government's fiscal situation. They will compound the effect of the burden on taxpayers just described. For some countries, past vintages of population projections turned out to be on the optimistic side, with migration being the most difficult driver to predict (Larch and Busse, 2024). In this paper, we *combine* the information from the European Commission (2024c) Debt Sustainability Monitor 2023 and the European Commission (2024a) Ageing Report to compute the changes in economic growth in individual EU countries needed for government debt-to-GDP ratios to stay on the baseline trajectories in the Debt Sustainability Monitor under alternative demographic scenarios from the Ageing Report: low-fertility, high-life-expectancy, low-migration, and high-migration scenarios. Hence, the purpose of this paper is to lay out the magnitude of the policy burden – in terms of, for example, growth promoting measures, migration measures, and measures to stimulate fertility – on EU governments to keep debt on its baseline trajectory when demographic developments deviate from their original projections. Such deviations are not uncommon, as migration is uncertain (Czaika *et al.*, 2024) and increases in life expectancy are often underestimated.[2]

The Ageing Report is a comprehensive analysis carried out by the Directorate-General for economic and financial affairs of the European Commission and the Economic Policy Committee of the Council. The report examines the long-term economic implications of aging populations within EU member states. It provides projections on public spending in areas such as pensions, health care, and long-term care based on assumptions of demographic trends, labor market developments, and macroeconomic conditions. The main assumptions include fertility rates, life expectancy, migration patterns, and labor market participation, which are critical for understanding the future challenges of public finances in the EU.[3] The Ageing Report is updated every three years.

Building on the long-term projections of the Ageing Report, the Commission publishes every year the Debt Sustainability Monitor, an assessment that evaluates the fiscal sustainability of EU member states by examining their current debt levels and projecting future trajectories. The main purpose is to identify potential vulnerabilities and provide early warnings to ensure that public debt remains at manageable levels across the EU.

We combine information from the Debt Sustainability Monitor and the Ageing Report, because the former contains various sensitivity scenarios, but demographic shocks are missing, while precisely these are central in the latter report, which in turn lacks the effect of the costs of aging on debt ratios.[4] Note that we look at deviations from the demographic baseline scenario, which may entail an increasing debt ratio over the long term, that is, we do not impose any concept of long-term sustainability.

Within total public expenditure only the cost of aging is assumed to be sensitive to the demographic scenario. The additional investment needs mentioned above are not factored in, so they will come on top of the aging-related costs. However, they would affect the baseline and alternative scenarios mostly similarly, hence we would not expect them to have 'first-order' effects on the required extra growth under the alternative scenarios to keep debt ratios on their baseline scenario path.

[2]This underestimation of increases in life expectancy is sometimes due to the use of period life tables instead of cohort life tables when estimating the remaining life expectancy at age 65 (see Dattani, 2023). A more fundamental reason are false assumptions, such as a limit to life expectancy; see Oeppen and Vaupel (2002) for a thorough discussion.

[3]The complete set of assumption underpinning the 2024 Ageing Report are detailed in European Commission (2023).

[4]Here, and in the sequel, by public debt ratios we mean debt-to-GDP ratios. Analogously, for the primary deficit ratio.

We find that until 2060, a deviation of migration from the baseline exerts the largest effect on the required change in economic growth. The degree of labor participation of immigrants and their productivity relative to incumbents matter relatively little for the public finance challenges. Low fertility increases labor supply in the short run due to a higher participation rate as fewer children need to be raised. The main effects of the low-fertility scenario, however, are a smaller active population in the long run. This negative labor supply effect may exert such a strong effect on GDP that the required extra economic growth after 2060 occasionally exceeds that in the low-migration scenario. The effects of the high life expectancy scenario depend to a large extent on whether a country has arrangements in place to (automatically) deal with rises in life expectancy. In those cases, the consequences are relatively mild. An example of such a country is the Netherlands. Hence, the examples set by these countries suggest that it is possible to design arrangements in practice that deal effectively with the consequences of unforeseen increases in life expectancy.

The remainder of this paper is structured as follows. Section 2 discusses the related literature. Section 3 lays out the framework of the analysis, while Section 4 presents the results. Section 5 presents a sensitivity analysis. Section 6 concludes the paper and discusses potential policy implications.

2. Related literature

This paper in particular contributes to the growing body of literature on the fiscal implications of fertility, longevity, and migration as an instrument to deal with these implications. The literature focused on the cost of aging, pensions being the most obvious, but also on the extra cost of health care and potentially lower cost of education. As we will show below, the transmission channels affecting GDP are also relevant. Negative fertility shocks may increase the labor participation of younger adults but lower the total labor force around 30 years later. Here, the 2024 Ageing Report is the most relevant publication for the link between aging and its public finance implications, taking all effects into account. However, also other international policy institutions explore how aging affects fiscal sustainability. OECD (2019) zooms in on the different transmission channels and proposes various policies to mostly curb the cost of aging. The contributions in Kim and Dougherty (2020), especially Chapter 2 by Daniele et al., analyze how aging lowers productivity. They conclude that offsetting this negative shock is particularly difficult since the negative effects are concentrated in urban areas. These are mostly specialized in tradable services, which are particularly difficult to automate. Downward pressure on labor supply and productivity takes central stage in Bodnar and Nerlich (2022). The increase of the labor supply since the early 2000s was driven by improvements in the labor force participation rate. The authors refer to a higher level of education and higher labor participation rates of the older population as factors mitigating the rising cost of aging by raising productivity and GDP. Gruber and Wise (2009) study the fiscal implications of pension reform and Heer *et al.* (2023) demonstrate the need for a group of advanced economies to reform in order to keep their pension systems financially sustainable. Indeed, a number of countries have already embarked on pension reform to address the financial consequences of pension provision (e.g., see Beetsma *et al.*, 2020). An important reform is an increase in the statutory retirement age, which acts as a two-edged sword in that spending on pension benefits is reduced and the labor supply is increased. The results we present below show that countries that explicitly link changes in the retirement age to increases in life expectancy will face a smaller burden in terms of raising GDP growth to keep debt ratios on their baseline path.

Turning to the role of immigration, Auerbach and Oreopoulos (1999) analyze the impact of immigrants over time, highlighting that in the short run additional immigration may alleviate the burden of the pension system, while in the longer run immigrants themselves become beneficiaries, thereby altering the net fiscal effect. Storesletten (2000) emphasizes that selective immigration of medium- and high-skilled immigrants in their early forties can alleviate the fiscal burden of the aging of the baby boom generation. Dustmann and Frattini (2014) explore the fiscal impact of immigration by individuals from the European Economic Area (EEA) as well as from outside the EEA into the UK, concluding that the impact is positive for the former group and negative for the latter group, but overall positive for the period since the turn of the century. In a more recent paper, Bernardino *et al.* (2024) demonstrate that fiscal sustainability in the euro area requires a substantial permanent tax increase, which can be mitigated by raising migration, although the effect of the latter becomes smaller at larger increases. In another recent paper focusing on the United States, Colas and Sachs (2024) show that the indirect fiscal benefit from low-skilled immigration through its effect on wages and labor supply is nonnegligible, potentially offsetting negative direct effects.

3. Framework for the analysis

The European Commission regularly publishes two important reports with long-term projections for all EU countries: (i) the Debt Sustainability Monitor and (ii) the Ageing Report. The former looks at public finances more broadly, while the latter focuses on the age-related expenditures, that is, public spending on pensions, health care, long-term care, education, and unemployment benefits, under a baseline and alternative scenarios. We *combine* information from the two reports to determine how much extra (or less) GDP growth EU economies need under alternative demographic scenarios to keep debt ratios on the trajectory of the baseline scenario set out in the Debt Sustainability Monitor. These trajectories themselves may not lead to stabilization of debt ratios. However, assuming that in unstable cases governments take consolidation measures to raise budget balances to levels that stabilize debt ratios will leave our analysis unchanged under the assumption that such measures do not lead to feedback effects on GDP growth itself. This might be a rather strong assumption for the shorter run, because of the negative short-run demand effects of consolidation measures, but in the longer run, if anything, a stabilization of the debt ratio will impact the economy positively and, hence, the consolidation burden is likely to be smaller than needed to stabilize the debt ratio at a given projected GDP level.[5] Inflation and nominal interest rates are considered to be exogenous in the 2024 Ageing Report; hence, they are the same under the different scenarios, which implies that additional real growth is the only 'instrument' to push the debt path under an alternative scenario toward that of the baseline.[6]

Our calculations are based on the following framework. In each period going forward, we calculate the extra GDP growth needed to keep the debt ratio at its baseline level, assuming that debt ratios up to then have equaled their baseline value. Hence, we implicitly assume that the extra GDP growth has fully materialized up to now.[7] To show how this is concretely implemented, start with the standard debt accumulation identity in nominal terms for a scenario indicated with superscript s, in a country denoted by subscript i. Time is indicated by subscript t:

$$B^{s}_{i,t} = PD^{s}_{i,t} + \left(1 + i_{i,t}\right) B^{s}_{i,t-1}, \tag{1}$$

where $B^{s}_{i,t}$ is debt in nominal terms, $PD^{s}_{i,t}$ the primary deficit in nominal terms, and $i_{i,t}$ the nominal interest rate. Nominal interest rates are exogenous and country-year specific, which reflect differences and fluctuations in perceived default risk and market liquidity. Most importantly, nominal interest rates do not vary between demographic scenarios. Primary deficits are scenario specific, which also makes nominal debt levels scenario specific. The baseline is a scenario like any other scenario, but

[5] For example, see Reinhart and Rogoff (2010), who find that very high debt ratios tend to be associated with lower rates of economic growth.

[6] Exogeneity of inflation is an important assumption. Debt ratios, especially when they are high, are very sensitive to inflation shocks. The medium-term fiscal-structural plans under the EU's revised Stability and Growth Pact set nominal paths of net primary expenditure in advance for the entire duration of the plan. Deviations of inflation rates from their projections, which may lead to cumulating price differences from their projection, could over time cause substantial deviations of public spending ratios from their projections, which in turn could lead to pressures to revise the plans – see Beetsma (2024).

[7] By definition, we start the projection period with a debt ratio equal to its baseline value, hence consistently inserting the required extra growth into the dynamics will keep the debt ratio at its baseline value in each new period when we go forward.

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to highlight its relevance, we will denote the baseline with superscript '0'. Dividing by the scenario-specific real GDP level $y^s_{i,t}$ and the price level $p^s_{i,t}$, we obtain the usual expression for the scenario-specific debt ratio $d^s_{i,t}$:

$$d^s_{i,t} = pd^s_{i,t} + \frac{1 + i_{i,t}}{\left(1 + \pi_{i,t}\right)\left(1 + \gamma^s_{i,t}\right)} d^s_{i,t-1}, \tag{2}$$

where $pd^s_{i,t}$ denotes the primary deficit ratio (of GDP), $\gamma^s_{i,t} \equiv \left(y^s_{i,t}/y^s_{i,t-1}\right) - 1$ the rate of real GDP growth and $\pi_{i,t} \equiv \left(p^s_{i,t}/p^s_{i,t-1}\right) - 1$ inflation. Differences between nominal growth rates in the baseline and the alternative scenarios may in principle come from both inflation and real growth. In the Ageing Report, inflation only differs from the baseline in the so-called 'higher inflation' scenario, which we do not consider here. Because we focus only on the alternative demographic scenarios, differences in nominal growth must come entirely from differences in real growth rates.

To determine the extra required growth, we first calculate the required level of real GDP $\tilde{y}^s_{i,t}$ to attain the same debt ratio $d^0_{i,t}$ as in the baseline:

$$\tilde{y}^s_{i,t} = b^s_{i,t}/d^0_{i,t}. \tag{3}$$

To focus on the required *extra* growth, we must take growth in the specific scenario into account. Let $\hat{y}^s_{i,t}$ indicate the level of real GDP that the economy would have, if all required extra growth in the past, leading to the required level $\tilde{y}^s_{i,t-1}$ in $t-1$, and the latest scenario-specific exogenous growth $(\gamma^s_{i,t})$, would have materialized:

$$\hat{y}^s_{i,t} = \tilde{y}^s_{i,t-1}\left(1 + \gamma^s_{i,t}\right). \tag{4}$$

From this we can calculate the required extra growth $\delta^s_{i,t}$ to reach $\tilde{y}^s_{i,t}$, assuming real GDP reached $\tilde{y}^s_{i,t-1}$ in the previous period:

$$\delta^s_{i,t} = \frac{\tilde{y}^s_{i,t}}{\hat{y}^s_{i,t}} - 1 = \frac{b^s_{i,t}/d^0_{i,t}}{\tilde{y}^s_{i,t-1}\left(1 + \gamma^s_{i,t}\right)} - 1 = \frac{b^s_{i,t}/d^0_{i,t}}{b^s_{i,t-1}/d^0_{i,t-1}} \frac{y^s_{i,t-1}}{y^s_{i,t}} - 1 = \frac{d^0_{i,t-1}}{d^0_{i,t}} \frac{d^s_{i,t}}{d^s_{i,t-1}} - 1. \tag{5}$$

With the required extra growth of GDP realized in the past, the debt ratio in each scenario in the previous period equals that in the baseline, that is, $d^s_{i,t-1} = d^0_{i,t-1}$, and the required extra growth in period t reduces to:

$$\delta^s_{i,t} = \frac{d^s_{i,t}}{d^0_{i,t}} - 1. \tag{6}$$

The Debt Sustainability Report and the Ageing Report, unfortunately, do not contain information on scenario-specific debt ratios. However, we can use the debt accumulation identity to obtain:

$$\delta^s_{i,t} = \frac{1}{d^o_{i,t}}\left(pd^s_{i,t} + \frac{1 + i_{i,t}}{\left(1 + \pi_{i,t}\right)\left(1 + \gamma^s_{i,t}\right)} d^s_{i,t-1} - pd^0_{i,t} - \frac{1 + i_{i,t}}{\left(1 + \pi_{i,t}\right)\left(1 + \gamma^0_{i,t}\right)} d^0_{i,t-1}\right). \tag{7}$$

Assuming once more that policymakers managed to keep the debt ratio at the baseline level in the previous period, that is, $d^s_{i,t-1} = d^0_{i,t-1}$, we have

$$\delta^s_{i,t} = \frac{1}{d^o_{i,t}}\left(pd^s_{i,t} - pd^0_{i,t} + \frac{1 + i_{i,t}}{1 + \pi_{i,t}}\left(\frac{1}{1 + \gamma^s_{i,t}} - \frac{1}{1 + \gamma^0_{i,t}}\right) d^0_{i,t-1}\right). \tag{8}$$

Finally, the Ageing Report assumes that the difference between the primary deficits in different scenarios is driven entirely by differences in the costs of aging $(CoA^s_{i,t})$; hence, $pd^s_{i,t} - pd^0_{i,t} =$

$CoA^s_{i,t} - CoA^0_{i,t}$, and we have:

$$\delta^s_{i,t} = \frac{1}{d^o_{i,t}} \left(CoA^s_{i,t} - CoA^0_{i,t} + \frac{1+i_{i,t}}{1+\pi_{i,t}} \left(\frac{1}{1+\gamma^s_{i,t}} - \frac{1}{1+\gamma^0_{i,t}} \right) d^0_{i,t-1} \right). \tag{9}$$

Applying the appropriate first-order approximations, this becomes:

$$\delta^s_{i,t} = \frac{1}{d^o_{i,t}} \left(CoA^s_{i,t} - CoA^0_{i,t} - \left(1 + i_{i,t} - \pi_{i,t}\right) \left(\gamma^s_{i,t} - \gamma^0_{i,t}\right) d^0_{i,t-1} \right). \tag{10}$$

The required extra growth should compensate for the difference from the baseline scenario in the cost of aging and the real growth rates in period t.

4. Results

The statistical appendices to the Debt Sustainability Monitor 2023 of the European Commission (2024d) contain the debt ratio $d^0_{i,t}$, the (implicit) nominal interest rate $i_{i,t}$, and the inflation rate $\pi_{i,t}$ in the baseline (see 'Annex 8 Country fiches tables and graphs'). Eurostat generously shared with us the real GDP levels in the baseline and alternative scenarios used in the 2024 Ageing Report. From these levels, we calculate the growth rates of GDP ($\gamma^0_{i,t}$ and $\gamma^s_{i,t}$). The statistical annex to the European Commission (2024b) Ageing Report, series 135–143, contains the cost of aging in percent of GDP ($CoA^0_{i,t}$ and $CoA^s_{i,t}$) in the baseline and the alternative scenarios.

The total cost of aging (henceforth referred to as 'cost of aging') is the sum of age-related public spending on pensions, health care, long-term care, and education. The baseline projections are based on a general no-policy-change assumption, that is, reflecting only legislated or credibly announced measures, and assume that policies remain unchanged over the projection period.

A number of macroeconomic assumptions are made for each country. These comprise economic growth and its driving factors, changes in labor productivity (total factor productivity [TFP] and capital deepening), the labor force (participation, employment, and unemployment rates), and interest rates. TFP growth is assumed to steadily rise reversing the trend decline observed in many countries over the past few decades. Nominal interest rates of all euro area countries are assumed to converge to 4 percent in the long run (European Commission, 2024a, p.184). With an average inflation rate of 2 percent aimed at by the European Central Bank, this would imply a real interest rate of 2 percent. As is clear from Equation (10), changes in the nominal interest rate and in the inflation rate have opposite effects on required extra growth in an alternative scenario relative to the baseline. Their effects scale in the growth differential times the debt-to-GDP ratio. It is the real interest rate which eventually matters for the comparison with the baseline scenario. Under the counterfactual assumption that the aging costs are identical under the different scenarios and that the growth rates themselves are unaffected, a higher real interest rate magnifies the required extra growth in absolute terms under the alternative scenarios.

The state of the business cycle at the start is the same for the baseline and the various scenarios. Hence, a correction (conform, e.g., Girouard and André, 2006; Bonin *et al.*, 2014) for the initial state of the business cycle would affect the baseline and the scenarios similarly, hence would have no effect on the comparison between them. Moreover, as is clear from the country fiches, the demographic shocks mostly have long-term effects; their effects on the business cycle are negligible.

Figure 1 depicts economic growth in percentage points for different scenarios *relative* to the baseline taken from the European Commission (2024a) Ageing Report, Figure 2 shows the cost of aging in percentage points of GDP *relative* to the baseline as presented in the European Commission (2024a) Ageing Report, and Figure 3 depicts the extra GDP growth in percentage points needed to keep the debt ratio at its path under the baseline by combining the information in the Ageing Report and Debt Sustainability Monitor. In other words, Figure 3 depicts the required extra GDP growth relative to the baseline. The different scenarios are:

- high life expectancy, captured by a two years higher life expectancy than in the baseline;
- low fertility, captured by a fertility rate 20 percent lower than in the baseline;
- high migration, which assumes 33 percent higher non-EU immigration than in baseline; and
- low migration, where non-EU immigration is 33 percent lower than in the baseline.

In all scenarios, the emigration rate is assumed constant as a fraction of total population.

Figure 1 shows that for most countries the high-life-expectancy scenario has only a moderate effect on economic growth relative to the baseline. This is because economic growth is measured as growth of the economy as a whole, not as per-capita growth. Broadly speaking, if an increase in life expectancy does not lead to an increase in retirement age, growth will remain unaffected, because the number of workers stays unchanged, although growth per capita will fall, as more people have to share the same unchanged level of economic output. To the extent that the retirement age rises with life expectancy, we expect to see an increase in growth compared to the baseline when life expectancy increases. This is indeed confirmed for some countries, notably Greece, Italy, and the Netherlands.[8] In all three countries, this is explained by the fact that the retirement age is indexed to the development of life expectancy. For Greece, as of 2021, the minimum and statutory retirement ages are adjusted in line with changes in life expectancy every three years, while for Italy eligibility requirements for old-age, early retirement, and social assistance pensions are indexed to changes in life expectancy.

The low-fertility scenario starts to weigh on economic growth only in the longer run, because children born now will enter the labor market only about 18–25 years later. In fact, for some countries there is even a small uptick in growth in the shorter run, because a lower number of children to take care of positively impacts labor supply. In the long run, growth falls in all countries relative to the baseline. Lower growth is in the range of 0.3–0.5 percentage points, which is quite substantial relative to the low rates of GDP growth EU countries have become accustomed to over the recent past. This lower growth accumulates over time; in 2070, total GDP in our sample is on average 7.4 percent lower than in the baseline. Because emigration is assumed constant as a fraction of the population and because emigrants tend to be relatively concentrated in the younger cohorts (the age-group 15–44 years), countries with relatively large emigration rates, such as Cyprus, Luxemburg, or Malta, will be hurt less in terms of GDP growth under the low fertility scenario.

A shift in net migration from the baseline to the high-migration scenario has in most cases an almost immediate positive effect on economic growth, as more migrants enter the labor market. Overall, the effects range from about 0 to 0.5 percentage points growth increase relative to the baseline. A few countries stand out. First, Malta strongly depends on migration for its economic growth. In the high-migration scenario, economic growth immediately jumps to 4.3 percent compared to 3.9 percent in the baseline. After some further increase, this difference gradually declines. Economic growth in Cyprus, Ireland, and Slovenia and Spain also depends strongly on migration, but not as much as in Malta. The compounded effect in 2070 is sizeable in these countries; GDP of Malta is 13.9 percent higher than in the baseline, Cyprus 12.4 percent, and Spain 12.5 percent. Opposite effects occur under the low-migration scenario.

Turning to age-related spending in percent of GDP (Figure 2), we observe that relative to the baseline it generally rises over time under the high-life-expectancy scenario, driven by higher costs of retirement benefits, health- and long-term care. Long-run differences relative to the baseline can go up by a full percentage point for a number of countries. In the low-fertility scenario, age-related costs fall after a couple of years relative to the baseline in all countries. Fewer children have a positive effect on the labor supply and raise GDP as highlighted above. However, the biggest effect is that after a few years savings on education spending start to matter. In the long run, the costs of aging as a share of GDP relative to the baseline rise because of an even more inverted population pyramid. The

[8]The country fiches accompanying the Ageing Report contain the most relevant features of the country-specific retirement systems. For the exact details, we refer to the Economic Policy Committee – Ageing Working Group (2025) PENSREF database.

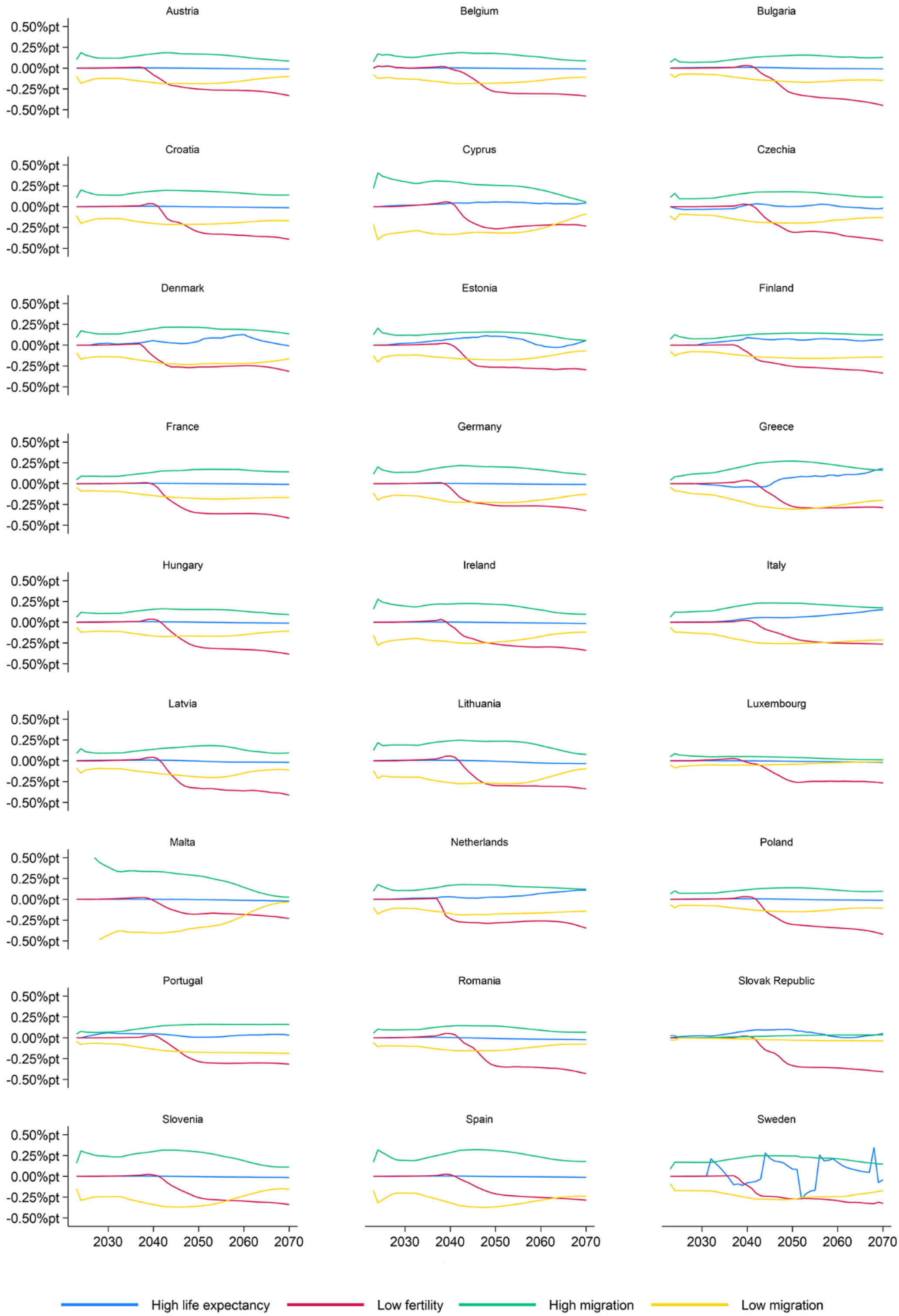

Figure 1. Economic growth in various demographic scenarios compared to the baseline scenario ($\gamma^s_{i,t} - \gamma^0_{i,t}$), 2022–2070.

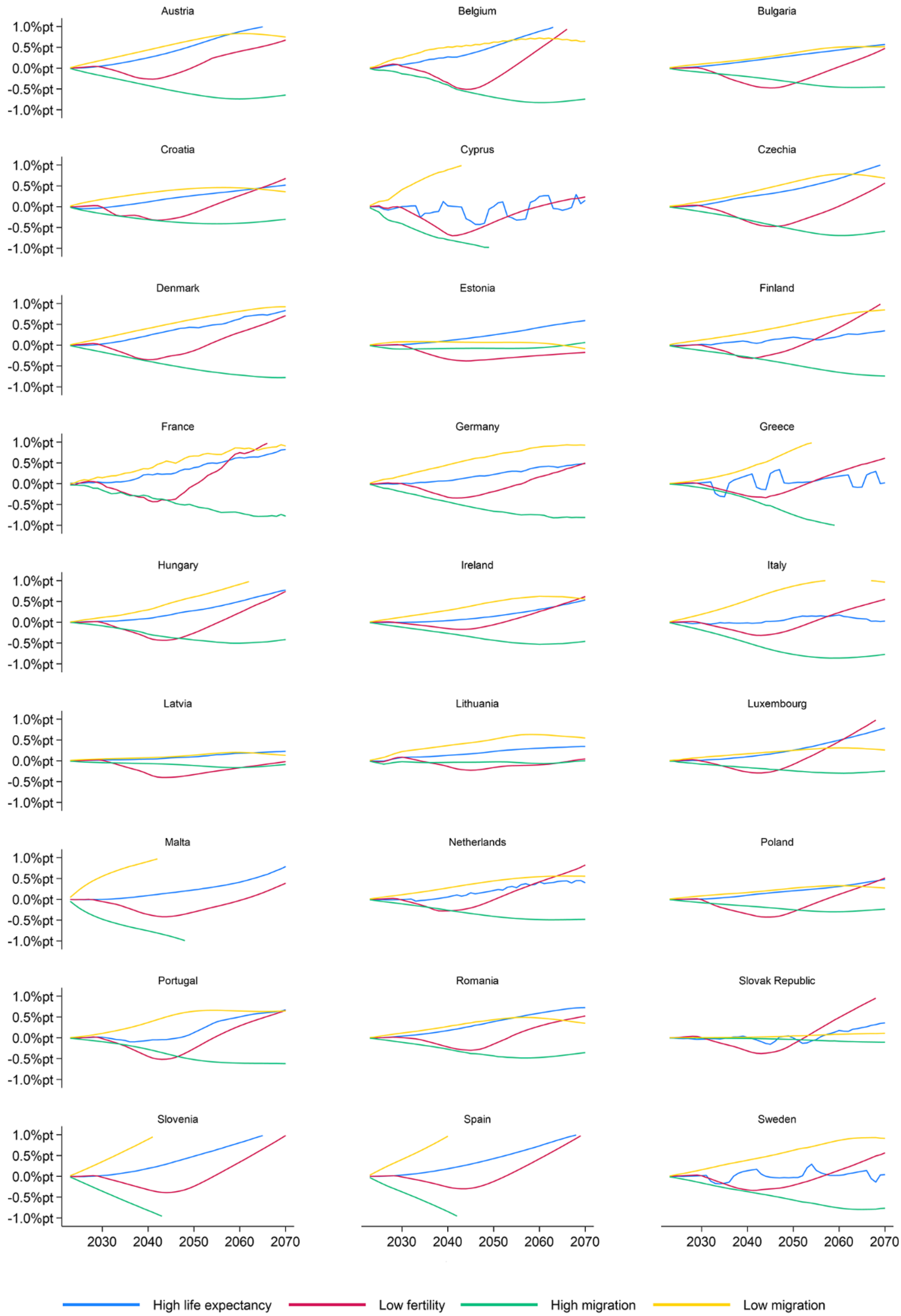

Figure 2. Cost of aging (as a fraction of GDP) in various demographic scenarios compared to the baseline scenario $(CoA^{s}_{i,t} - CoA^{0}_{i,t})$, 2022–2070.

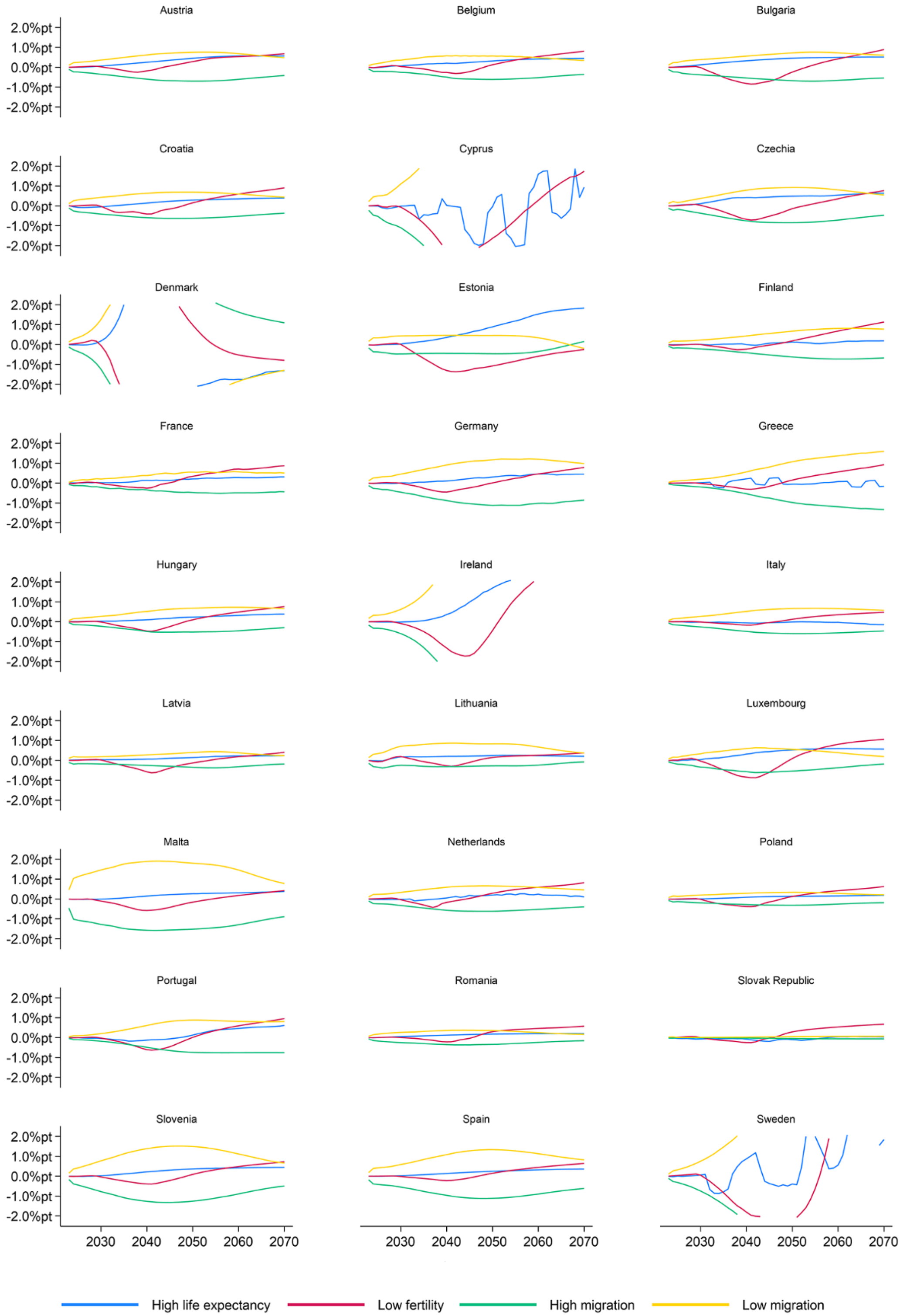

Figure 3. Scenario-specific required extra economic growth to keep debt ratios at the baseline, 2022–2070.

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old-age dependency ratio rises more than in the baseline scenario due to fewer people entering the labor market, hence fewer people are available to shoulder the rising costs of retirement benefits and health care. High migration in almost all countries has a substantial suppressing effect on the cost of aging relative to the baseline, in a number of instances reaching 1 percentage point of GDP in the longer run. Migrants are on average of working age, the group for which age-related public spending is lowest. The low-migration scenario has implications opposite to those under the high-migration scenario. The total cost of aging responds strongly to migration in some countries that depend a lot on migration for their economic growth, especially Malta, Cyprus, and Slovenia, all economies with a small population.

We now turn to the extra economic growth required to keep the debt-to-GDP ratio at the baseline (Figure 3). Because we set a common vertical scale across all figures, some lines are cut off or interrupted for a certain period of time when they move outside this range. The patterns of required extra growth are rather similar in most cases. We discuss the 'regular' patterns first.

The high life-expectancy scenario for most countries requires extra economic growth increases over time relative to baseline growth, because the cost of aging is increasing over time relative to the baseline. The required extra growth can become quite substantial in the long run. For example, for Austria it exceeds 0.5 percentage point relative to the baseline. The high-life-expectancy scenario incorporates the effect of legislated responses to changes in life expectancy. While many countries have not yet made solid arrangements in this regard, some countries have taken measures in anticipation of a trend increase in life expectancy. For example, the Netherlands features an automatic update (with some delay) of the retirement age for a public pension when life expectancy rises. Indeed, we observe that for that country only little extra growth is needed to keep debt ratios on their baseline path.

Low fertility in most cases initially leads to a drop in the required extra growth, because age-related expenditures fall, but in the longer run the required extra growth starts to increase and continues to rise over time. In the low-migration scenario, the required extra growth starts to rise immediately while the opposite is true under the high-migration scenario. Overall, deviations in migration have a particularly substantial effect on the required extra growth to keep the debt ratio on its baseline path. In most instances, the longer-run effects lie between 0.5 and 1 percentage points of lower (in the high-migration scenario) and higher (in the low-migration scenario) required extra growth. Realizing that these are annual differences in required extra growth, compounded over the years the effect on required extra GDP in level will be up to 0.4 percentage points extra growth per year. See Table 1 and below for a more thorough discussion. We observe that in most cases the effect of lower or higher migration on required extra growth starts shrinking again after a couple of decades, presumably the result of the aging of the new entrants of the country.

For completeness, we report the results for all countries. However, for countries with very low and/or rapidly falling debt, strictly economically speaking the results on the required extra growth are only of limited interest. To see this, notice that required extra growth ($\delta^s_{i,t}$) can be split into two parts, namely (i) different costs of aging between the alternative and the baseline scenario, and (ii) different growth rates between these two scenarios, as a slight rewrite of Equation (10) shows:

$$\delta^s_{i,t} = \frac{CoA^s_{i,t} - CoA^0_{i,t}}{d^o_{i,t}} - \left(1 + i_{i,t} - \pi_{i,t}\right)\left(\gamma^s_{i,t} - \gamma^0_{i,t}\right)\frac{d^o_{i,t-1}}{d^0_{i,t}}. \tag{11}$$

This expression shows that a low initial debt ratio $d^o_{i,t}$ blows up differences in the cost of aging due to the denominator effect in the first term on the right-hand side. Moreover, a rapidly declining debt ratio magnifies the effect of growth rate differences between the scenarios through the ratio $d^o_{i,t-1}/d^0_{i,t}$ (substantially) exceeding unity in the second term. Take, as an example, a country with cost of aging 1 percentage point higher under the alternative than under the baseline scenario and a debt ratio of 1 percent of GDP. Equation (11) shows that, to stay at the baseline debt ratio, this requires 100 percent extra growth.

Table 1. Scenario-specific cumulative required extra economic growth to keep debt ratios at the baseline, until 2070

	High life expectancy	Low fertility	High migration	Low migration
Austria	0.18	0.11	−0.22	0.31
Belgium	0.13	0.09	−0.19	0.24
Bulgaria	0.18	−0.03	−0.23	0.32
Cyprus	−0.11	−0.24	−0.92	19.19
Czechia	0.21	−0.01	−0.26	0.38
Germany	0.12	0.04	−0.33	0.54
Denmark	0.09	−2.70	−3.79	0.46
Estonia	0.46	−0.27	−0.16	0.18
Greece	0.00	0.09	−0.31	0.50
Spain	0.10	0.07	−0.33	0.59
Finland	0.03	0.13	−0.21	0.30
France	0.08	0.13	−0.17	0.22
Croatia	0.10	0.08	−0.21	0.30
Hungary	0.09	0.05	−0.17	0.30
Ireland	0.72	0.19	−0.76	3.66
Italy	−0.02	0.06	−0.20	0.28
Lithuania	0.09	0.04	−0.12	0.39
Luxembourg	0.20	0.05	−0.18	0.22
Latvia	0.06	−0.03	−0.12	0.15
Malta	0.10	−0.04	−0.47	1.05
Netherlands	0.05	0.11	−0.21	0.28
Poland	0.05	0.04	−0.11	0.13
Portugal	0.08	0.05	−0.23	0.34
Romania	0.07	0.09	−0.12	0.14
Slovenia	0.14	0.05	−0.37	0.68
Slovak Republic	−0.02	0.10	−0.02	0.02
Sweden	0.31	2.09	−1.00	174.04

Notes: Numbers are in fractions of annual GDP. For example, the first number, 0.18, corresponds to 18% of GDP or approximately 0.3 percentage points extra growth per year over the sample period.

Indeed, the required extra growth of Cyprus, Denmark, Ireland, and Sweden exhibits a strong increase or decrease under some scenarios. This is explained by Equation (11). Consider Denmark, for example. Denmark starts with a low debt ratio which is also rapidly declining along the baseline scenario (and expected to become even negative in 2038), which implies substantial extra required growth in a high life expectancy and a low-migration scenario, and the opposite in a high-migration scenario. Both terms on the right-hand side of Equation (11) contribute to the strong dynamics of required extra growth. However, taking a broader policy perspective, there is no reason for Denmark to try and stay on the baseline debt path. Denmark does not face any danger of an uncontrollable rise in its debt ratio and, hence, within reasonable bounds it can afford to deviate from its baseline debt trajectory. Obviously, measures that raise potential growth are welcome. More important, however, is that the dynamics allow policymakers to shift to using the fiscal space offered by the low and falling debt ratio to raise expenditures, for example, to finance the energy and digital transitions. A mechanism similar to that for Denmark explains the large increase or decrease in required extra growth of Cyprus, Ireland and Sweden. Hence, also these countries may use their fiscal room to finance the extra investment needs identified by Draghi (2024) and the additional defense spending agreed upon in the NATO (for those who are NATO member).

Further, the required extra growth of Cyprus, Greece, and Sweden under the high life-expectancy scenario appears to fluctuate in cycles. These fluctuations are driven by the effects of life-expectancy rising faster than under the baseline (hence, we do not see these fluctuations under the other alternative scenarios) and the fact that adjustments of the retirement age do not take place continuously, but rather when certain threshold indicators are exceeded and system parameters are reset. The pattern the required extra Swedish growth relative to the baseline is driven by the so-called 'indicative age' (see Sweden Country Fiche in Economic Policy Committee - Ageing Working Group, 2023). In the

Ageing Report, from 2026 and onwards exit ages into retirement will be indexed to a new 'indicative age', which is set to rise in line with the remaining lifetime at the age of 65. The indicative age is calculated every year based on the unisex life expectancy at 65. When it reaches a threshold, then a change is triggered. The Eurostat population projection foresees a further increase in the indicative and all related eligibility ages again in 2035, 2051, and 2069, raising the earliest age for an old-age pension to 67 in 2035 and the earliest age for the pension to 70 in 2069. Under the high life expectancy scenario these discrete changes to the indicative age – and hence the effective retirement age – happen in different years compared to the baseline scenario. Combined with relatively high participation rates (20.3 in 2022, increasing to 29.7 in 2070) for the relevant age-group (65–74), changing the effective retirement age at different dates generates large effects in the required extra growth. A similar effect can be observed – to a lesser extent because of smaller adjustment steps – for the Netherlands.

While for Greece, the difference in growth rates with the baseline does not exhibit an irregular pattern, the difference in the cost of aging does. This is due to a sustainability clause (Greece Country Fiche, p.6, in Economic Policy Committee - Ageing Working Group, 2023), which stipulates that if long-term projections show a rise in public pension expenditure of over 2.5 percentage points of GDP relative to 2009 expenditure, then relevant parameters of the pension system are changed to bring the increase in expenditure to below its targeted threshold. In addition, the retirement age in Greece is linked to life expectancy at 65 (Greece Country Fiche, p.16, in Economic Policy Committee - Ageing Working Group, 2023). Legislation stipulates a mechanism to adjust the retirement age in line with life expectancy every three years as of 2021. This change of the retirement age only leads to limited changes of economic growth compared to the baseline. This is mostly because the labor force participation rate of the relevant group (65–74) is relatively low – it is projected to increase from 9.3 percent in 2022 to 24.3 percent in 2070 (Table 3, p.22, of the Greece Country Fiche in Economic Policy Committee - Ageing Working Group, 2023). We also see that the effects of an unforeseen increase in life expectancy are limited by the fact that, as a result of the eurozone debt crisis, Greece went through a macroeconomic adjustment program aimed at making the public finances sustainable again. A similar pattern can be observed in Cyprus. Also in Cyprus, the retirement age is linked to life expectancy at 65 with relatively low participation rates in the very old cohort.

Finally, required extra growth of the Slovak Republic requires some attention. Its growth rates seem mostly insensitive to migration shocks. This is due to low overall migration rates (AR, Slovak Republic Country Fiche, p.39, in Economic Policy Committee - Ageing Working Group, 2023) in combination with migration shocks proportional to baseline migration. The small effect of the high life expectancy scenario is in line with most other countries. In the Slovak Republic, the retirement age is linked to life expectancy, but participation rates of elderly (65–74) are low (7.0% in 2022); hence, a change in the retirement age will only have a small effect on the total active labor force.

Table 1 reports the *cumulative* required extra GDP growth to keep debt ratios at the baseline until 2070. If we ignore the countries with exceptionally low debt ratios, such as Cyprus, Denmark, Ireland, Estonia, and Sweden, then the following results stand out. For the high life expectancy case, the numbers are modest. The largest is an additional cumulative increase for Czechia of 0.21 or 21 percent extra GDP over our sample of 48 years, which corresponds to 0.4 percentage points extra growth per year. The low-fertility scenario has even smaller effects. Figures are substantially larger in absolute terms for the two migration scenarios. Malta for example, is a country with large migration flows. Under the high-migration scenario they require 47 percent less GDP by 2070, or 1.3 percentage points lower growth per year. Under the low-migration scenario, they require 1.5 percentage points extra growth per year. Spain also is very sensitive to migration fluctuations; under the low-migration scenario Spain requires 59 percent extra GDP, so extra growth of 1.0 percentage points per year. For the low-migration scenario, the mean extra required growth for all countries – excluding the five with very low debt ratios – is 0.63 percentage points per year. Hence, these countries may need to stimulate immigration or to cut spending and raise taxes.

It is important to bear in mind that reported numbers for required extra growth are subject to substantial uncertainty. The reason is that the demographic projections are inherently uncertain and change over time. To give an idea of the order of magnitude of the consequences of demographic uncertainty, we can use Table I.5.6. in the Ageing Report of 2024 (European Commission, 2024a), which reports the revisions in the cost of aging relative to the Ageing Report of 2021. The EU average cost of aging has been revised up by 0.1 percentage point of GDP and that for the euro area up by 0.5 percentage points of GDP. Assuming a debt ratio of, say, 100 percent and using Equation (10), this would translate into required extra growth of 0.1 and 0.5 percentage points on an annual basis. The aging cost revisions of individual countries are in a number of cases substantially larger, implying substantially larger changes in the required extra growth. In this paper, we naturally base ourselves on the latest available information embedded in the estimates in the Ageing Report of 2024.

5. Sensitivity analysis: lower labor market participation of immigrants

This section explores the consequences of the high-migration scenario when labor market participation and/or productivity of first-generation migrants is lower than of the incumbent population. This is a plausible situation since immigrants are less familiar with the labor market of their new country of residence and at least part of the immigrant group originates from non-Western countries where the skill level does not entirely match the needs of a Western knowledge-intensive economy. To calculate the resulting levels of GDP and cost of aging is beyond the scope of this paper. But we can determine the scenario-specific required extra economic growth to keep debt ratios at their baseline provided we assume the costs of aging do not depend on the labor force participation rates. We can calculate this because we only need the growth rate of real GDP compared to the baseline scenario, $\gamma_{i,t}^s - \gamma_{i,t}^0$.

If we assume that technology and capital growth are comparable in each scenario to the baseline, then a simple growth decomposition exercise shows that $\gamma_{i,t}^s - \gamma_{i,t}^0$ is completely determined by the growth of labor input in the specific scenario compared to the baseline (multiplied by the output elasticity of labor α):

$$\gamma_{i,t}^s - \gamma_{i,t}^0 = \alpha \left(\frac{L_t^s - L_{t-1}^s}{L_{t-1}^s} - \frac{L_t^0 - L_{t-1}^0}{L_{t-1}^0} \right) \approx \alpha \left(\frac{(L_t^s - L_{t-1}^s) - (L_t^0 - L_{t-1}^0)}{L_t^0} \right), \tag{12}$$

where L measures labor input. In principle, we do not know what drives the growth of labor input in the baseline or any other scenario, but we can assume that the difference in the migration scenarios compared to the baseline is mostly due to migration. That implies that, if labor participation measured in efficiency units of first-generation migrants is a fraction $0 < \lambda < 1$ of that of the incumbent population,[9] then the difference in growth rates is the same fraction. If we assume that the cost of aging in a low-participation-high-migration scenario is comparable to that in the 'pure' high-migration scenario discussed in Section 3, but the growth rate difference is a fraction λ, then the required extra growth in the low-participation-high-migration scenario is:

$$\delta_{i,t}^{LPHM} = \frac{1}{d_{i,t}^o} \left(CoA_{i,t}^{HM} - CoA_{i,t}^0 - (1 + i_{i,t} - \pi_{i,t}) \lambda \left(\gamma_{i,t}^{HM} - \gamma_{i,t}^0 \right) d_{i,t-1}^0 \right), \tag{13}$$

where superscript 'HM' denotes the high-migration scenario (for any participation rate of the immigrants) and the superscript 'LPHM' the low-participation-high-migration scenario. Figure 4 depicts this for $\lambda = 50\%$. We observe that the difference in required extra growth resulting from the lower participation rate relative to the normal participation rate is small. The reason is that the cost of aging is the main driver of the effect on required growth and we have made the assumption that lower participation does not affect the cost of aging in the future. In practice, most pension systems are at least partly of the defined-contribution type, hence lower participation would lead to a lower contribution

[9]Because labor participation is expressed in efficiency units, $\lambda < 1$ captures a lower number of hours worked and/or lower average productivity per immigrating person. For convenience we use 'lower participation rate' to refer to both these possibilities.

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now and lower expenditures in the future. This would shrink the first term $CoA^{HM}_{i,t} - CoA^{0}_{i,t}$ in the formula for $\delta^{LPHM}_{i,t}$, and the red line would be pushed even further toward the blue line in Figure 4. Hence, the required extra growth may fall even further.

In other words, the degree of labor participation of immigrants and their productivity relative to that of the native population matter only little for the public finance challenges that EU governments face.

6. Concluding remarks

This paper has combined information from the European Commission's most recent Debt Sustainability Monitor and Ageing Report to compute the changes in economic growth in EU countries needed for government debt ratios to stay on their baseline trajectories as set out in the Debt Sustainability Monitor under different scenarios. We considered a high life-expectancy, low-fertility, low-migration, and high-migration scenario. Among public expenditures, only the cost of aging is assumed to be sensitive to the demographic scenarios.

We observe that the different scenarios can lead to substantial required extra growth compared to the baseline. As shown in Table 1, compounded over the years, the effect of different scenarios on GDP may be substantial and, hence, the demand in terms of required extra productivity of the labor force may be substantial. The different migration scenarios have the largest effect. Increased immigration, especially of high-skilled workers can substantially alleviate the required extra growth under faster-than-anticipated increases in life expectancy and the associated extra aging costs. Over the very long run, these benefits from higher immigration shrink due to the aging of the new entrants in the work force. Interestingly, the participation rate of migrants and their productivity relative to that of the native population matter only little for the public finance challenges confronting the EU governments. Overall, the policy message is that of a need for extra measures – by stimulating growth, migration and/or fertility – on the side of EU governments when populations age faster than originally projected, as happens quite commonly, because increases in life expectancy are often underestimated (see Oeppen and Vaupel, 2002). In addition, having mechanisms in place that react automatically to increases in life expectancy can help countries in dealing with the financial consequences of aging. Some countries, such as the Netherlands, already have such mechanisms in place, and other countries could follow these examples in designing their own mechanisms.

The analysis has been conducted under a number of assumptions underlying the Debt Sustainability Monitor and Ageing Report. One assumption is that migration only operates through its effect on the size of a cohort GDP, because all migrants have characteristics similar to the incumbent population, so similar productivity and labor force participation. To the extent that immigrants end up in less well-paid jobs, which is more likely for immigrants from non-Western countries, the high-migration scenario will be less favourable and the low-migration scenario will be less unfavourable in terms of growth. If the EU manages to attract high-skilled migrants, the positive net fiscal effects in the high-migration scenario will be strengthened. The analysis of these, and other, effects of the different migration scenarios are beyond the scope of this paper. Their analysis could draw on the work by Colas and Sachs (2024), who study the indirect fiscal benefits of low-skilled immigration, and Storesletten (2001), who explores the benefits of high-skilled migration. Further, from a historical perspective the projected long-term real interest rate of 2 percent seems to be on the high side. With a lower real interest rate, a given increase in immigration is likely to have a larger positive effect on growth (or required extra growth will be smaller to keep debt on its baseline path), because it is easier for firms to make the investment to put the new labor inflow to work. The high-life expectancy scenario and the low-fertility scenario will also be milder in that investment will be easier to complement those who work longer, respectively to replace those who disappear from the labor force. The required additional growth would be easier to attain. Finally, the public investment challenges for the green climate and digital transitions identified by Draghi (2024) will affect public debt

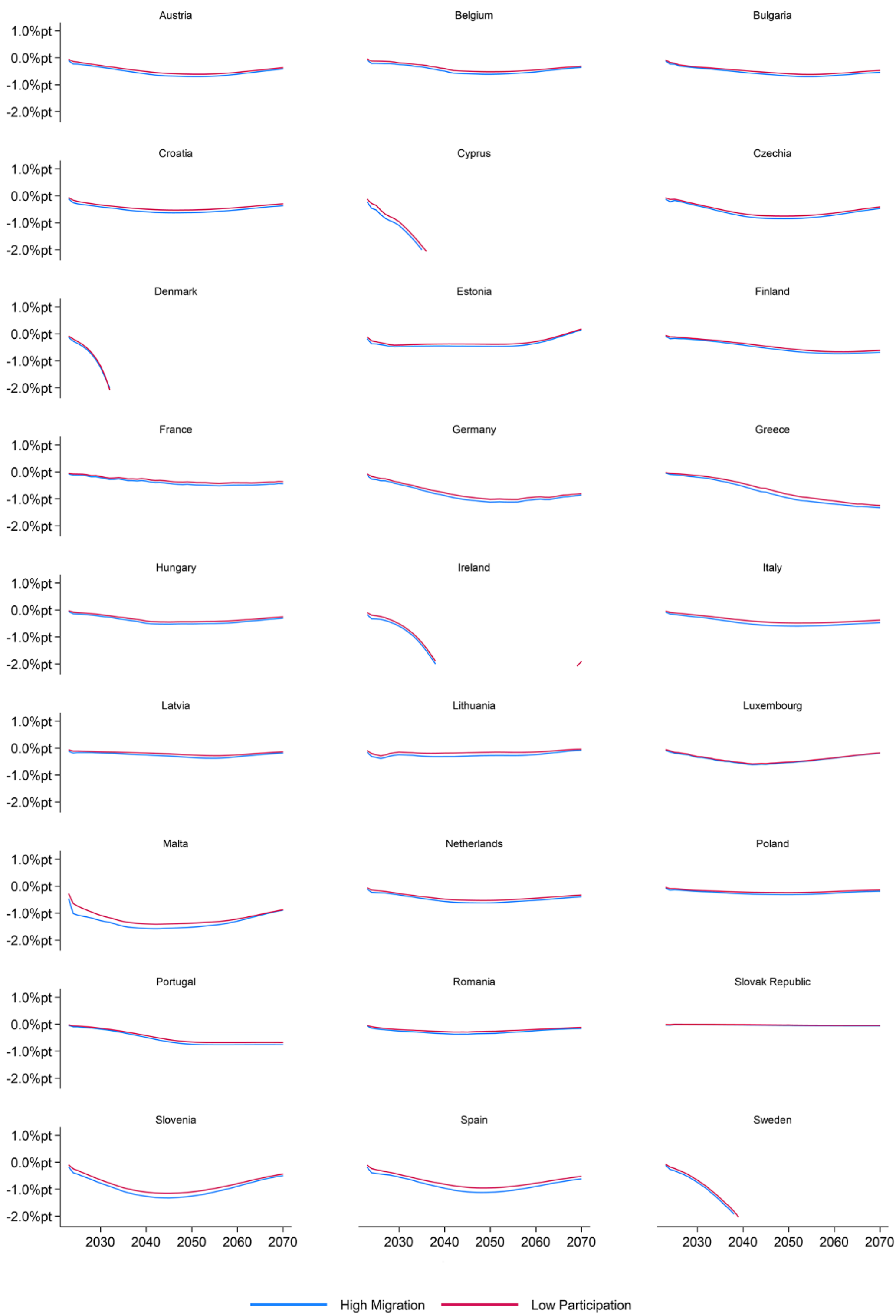

Figure 4. Comparison of required extra GDP growth to keep debt ratios at the baseline, 2023–2070, for high migration with normal (blue) versus 50% lower participation (red).

trajectories, unless they are self-financing by raising growth. However, since our analysis focuses on a comparison of demographic scenarios, we would not expect any 'first-order' effects on the required extra growth *relative to* the baseline scenario. Obviously, some effect can be expected if, for example, the adoption of new digital technologies depends to a substantially extent on the demographic composition of the population. However, investigating this would be beyond the scope of the present paper.

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