The Costs of Building Walls: Immigration and the Fiscal Burden of Aging in Europe*

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Abstract

In low-fertility societies with working-age immigration, reducing inflows disproportionately raises dependency ratios. This creates a convex policy frontier: restricting immigration raises fiscal burdens at an increasing rate. We quantify this mechanism using a demographic model and novel estimates of immigrants' fiscal contributions in the euro area. Eliminating immigration raises the tax increase required to finance aging-induced spending by 16%, while doubling inflows reduces it by only 9%. Differences across countries are substantial, reflecting their positions on the frontier as well as heterogeneity in immigrants' ages and national tax-benefit systems. Immigration improves fiscal balances even when migrants are low-skilled, as long as their lifetime contributions exceed those of newborn natives. Higher native fertility offers no comparable relief.

JEL codes: E62; F22; H55; J11

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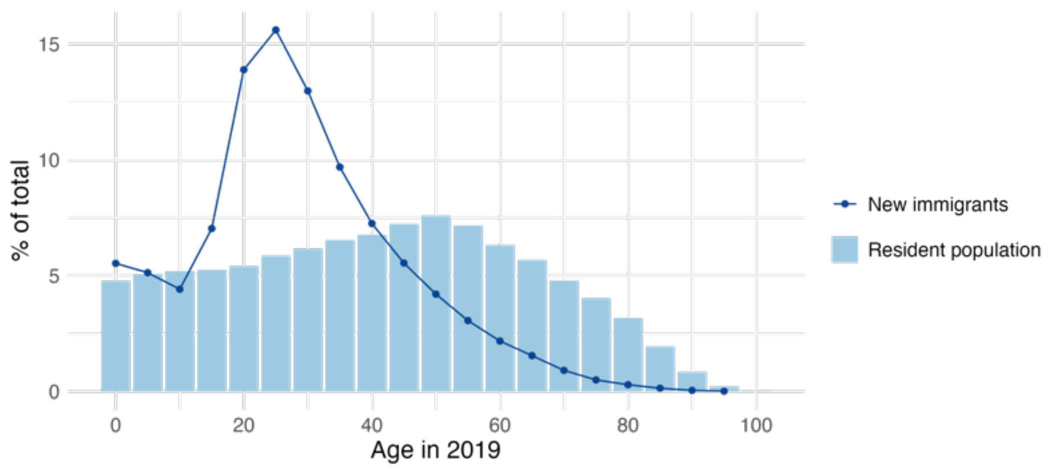
1 Introduction

Population aging is a major challenge for public finances in advanced countries. Leading to higher spending on old-age-related benefits, it will demand higher net contributions from taxpayers to maintain fiscal sustainability.[1] Immigration is often discussed in public debate as a remedy for the fiscal burden of aging. In the European Union (EU), as Figure 1 shows, individuals immigrating from outside the EU in 2019 were much younger than the resident population. Specifically, current immigration flows (the solid line in the chart) are concentrated in the young working ages, between 20 and 40, unlike the older resident population (the bars in the same chart). This contrast suggests immigrants can slow population aging and ease the pressure on public finances.

Figure 1: Age Distribution of the Population Stock and the Immigration Flow to the EU in 2019



Note: Each bar represents the percentage of the resident population in the EU belonging to a specific age group in 2019. The solid line represents the percentage of immigrants arriving in the EU from outside the union in 2019, also segmented by age group.

The picture is similar in the United States and in other advanced economies. Yet, despite these potential benefits of immigration, political platforms that portray migration as a problem have been gaining traction. Currently, EU countries are discussing policies to contain or even cut down immigration from the developing world. In other countries, such as the USA or the UK, such policies are already in place.

In this paper, we ask what are the fiscal costs of building walls. Our focus is on how immigration affects public finances through its role in the demographic composition of societies marked by low fertility. We demonstrate the existence of a negative, convex relationship between the intensity of immigration flows and the fiscal balance, under mild assumptions that hold in most advanced economies. This relationship arises directly from demographic dynamics and, crucially, is independent of assumptions about immigrants' productivity or labor complementarities, which may

[1] In Europe, the old-age-dependency ratio (the ratio of 65-plus to 20- to 64-year-old population) is projected to increase by more than 20 percentage points, from 34.8 percent in 2019 to 56.7 percent in 2050 (Eurostat, 2020). According to the UN World Population Prospects, the old-age-dependency ratio is also projected to sharply increase in Australia, Canada, Japan, Korea, the UK or the USA.

be hard to validate empirically. We formalize the mechanism and quantify its importance for each country of the Euro Area (EA), using new estimates of immigrants' contributions to government budgets in each country. Due to their role in demographic dynamics, as long as migration flows are not interrupted, extra-EU migrants will relieve the fiscal burden of aging by around 850 euros per year for the average native 30-year-old taxpayer. The key insight is that this benefit comes in spite of migrants making lower and, in fact, negative individual net contributions to the budget when considering their full lifecycle.

To explain this result, and the circumstances in which it applies, we first examine the properties of the cohort-component model with constant immigration flows—the standard framework used by statistical offices for their population projections, as well as in the literature. We show that, at any finite horizon, restricting immigration flows leads to higher dependency ratios at an increasing rate. In low-fertility societies, native populations are on a path to extinction, featuring large dependency ratios. Working-age immigration avoids this path, ensuring a sustainable population and lower dependency ratios in the long run. At any finite horizon, larger immigration flows raise the share of immigrants (and descendants) in the population, shifting the age distribution toward the younger age profile of the immigrants' group. But this convergence is bounded, giving rise to the convexity: each additional increment to immigration has a smaller marginal effect on dependency ratios, as these move closer to the transition path of a population composed only of migrants.

To examine the implications of these results, we build population projections for each EA country, featuring constant net migration inflows, allowing the level of these inflows to vary in different scenarios.[2] We take from the data the age and education composition of migration flows. They are concentrated in working ages at the EA aggregate level, albeit with significant heterogeneity across countries. In our baseline, migration remains at the current level of 0.4 percent of the population (1.33 million people) per year. This leads to a stark increase in the share of non-EU-born population and their descendants. By 2050, the share of non-EU-born population and their descendants will be 25 percent. By 2100, it will be at 50 percent. If migration inflows are cut in half, this share falls closer to 25 percent in 2100, and the inactive population would exceed the working-age group by around 27% instead of 20%. A complete shut-down of new inflows pushes this share to 40%.

We then quantify how restricting or expanding immigration affects the fiscal burden of aging by combining the population projections with detailed evidence on immigrants' fiscal contributions across the EA. Drawing on multiple survey sources, we estimate age profiles of taxes and benefits for immigrants and natives separately, conditional on gender and education level, using a quasi-saturated regression model. These estimates allow us to decompose the net fiscal contribution of each demographic group, namely including novel estimates of the contributions of immigrants in each EA country. Merging this data with our alternative population projections, we construct counterfactual government budget paths under varying migration scenarios. We then measure accumulated fiscal imbalances in each scenario, summarizing them by the minimum tax increase

[2] A constant net migration flow is the standard assumption in population projections. External factors, linked to conditions in origin countries, are the most important drivers of this inflow and are hard to predict. All our results hold qualitatively regardless of fluctuations in immigration flows, as long as net migration remains positive.

required to ensure long-run fiscal sustainability. This "rebalancing tax increase" translates population dynamics into a comparable economic measure of the fiscal costs of aging, and the effects of changes in migration flows.

Our headline result is that current immigration flows in the EA reduce the rebalancing tax increase from 16.3% to 14.0% (corresponding to a 16% reduction). In other words, shutting down migration would impose an additional tax burden on resident taxpayers worth 1 percent of GDP to adapt to demographic change, or adjusting spending policies equivalently.[3] These numbers rely on sustaining the net migration inflow of 2019 in the future, both in its overall size and age-education structure, which is mostly composed of younger and lower-qualified individuals. Increasing migration further would help reduce the fiscal gap, but with decreasing returns. Doubling the size of the net migration flow would result in a smaller rebalancing tax increase by 1.4 percentage points (corresponding to a 9% reduction). As fiscal costs closely follow dependency ratios in most countries, a convex policy frontier arises: restricting migration flows raises future dependency ratios at an increasing rate and, therefore, future deficits, summarized by the rebalancing tax increase.

Crucially, our result does not rely on immigrants being high-skilled. In most countries in our data, immigrants' net fiscal contribution is negative and lower than that of natives over a full life cycle. Yet, because most immigrants arrive as young adults—after childhood, i.e. without the associated public expenditures—their remaining lifetime contribution is typically higher than a native newborn's. By enlarging the working-age tax base relative to dependents, immigration lowers the *per-capita average* adjustment to taxes and transfers that would otherwise be required to restore fiscal balance. This effect only disappears when migrants' expected lifetime contributions are so negative that a new migrant contributes less, in present-value terms, than a native newborn. In such cases, migrants cannot be described as "working-age taxpayers," whether because they arrive at later ages or because the host country's tax–benefit system implies very low net payments even during working years. Unlike previous studies, where the fiscal benefits of immigration depended on skill composition (e.g., Storesletten, 2000) or complementarities in production (Colas and Sachs, 2024), our mechanism operates through a simpler and more general channel. Immigration improves the fiscal position whenever immigrants' lifetime net contributions exceed those of newborn natives—regardless of skill—highlighting a direct demographic link between migration inflows and the sustainability of public finances in aging societies.

To complement our analysis, we unpack our results and analyze the rebalancing tax increase in each country of the EA, finding substantial heterogeneity. We draw, for each country, the policy frontier between net migration intensity and the country-specific rebalancing tax increase. The convexity that we highlight contributes to large cross-country differences. The fiscal costs of restricting migration vary substantially, both due to starting levels of immigration (the position on the convex frontier), but also the age structure of migration inflows in each country and differences in tax-benefit policies. Overall, immigrants relieve the fiscal burden of aging even if their expected

[3] Many countries in the EA have enacted retirement age increases, for example, that will lead future spending associated with old age to decline. Such policies have the same effect of a tax hike in the sense that they increase the net fiscal contribution of current workers over their full life cycle.

net contributions over their stay in the country are negative—as long as they are above those of natives over a full life cycle. This is the case in most countries, including France, Germany, Italy, and Spain, leading to our aggregate result. In a few cases, it does not apply, leading to negative effects of immigration on the budget. From a fiscal sustainability perspective, a uniform EU migration policy is not optimal and some countries would benefit more from larger migration inflows than others.

This demographic mechanism helps to explain why, as we show in our framework, boosting native fertility is not a viable alternative to migration in averting population aging and its fiscal consequences, contrary to popular belief. If we start from a scenario with zero migration, and increase native fertility to the replacement rate – a highly optimistic scenario –, the rebalancing tax increase slightly reduces by 0.7 percentage points. This contrasts with the 2.3 percentage points reduction obtained by maintaining the migration levels of 2019, compared to the same zero migration scenario. Incoming working-age migrants pay taxes, and only collect net benefits later in life, whereas newborns add a spending stage before entering the workforce. As such, the short-run costs of a higher share of children outweigh the long-run benefits of a larger working-age population, which only come much later.

Our main findings are robust to alternative assumptions regarding immigrant fertility, educational composition, real productivity growth, and interest rates. The nonlinearity we highlight arises from demographic dynamics that apply broadly whenever native fertility falls below replacement while there is a sustained inflow of working-age migrants. As such, the mechanism we identify is not specific to Europe but extends to other low-fertility economies, including Australia, Canada, Japan, Korea, the United Kingdom, and the United States. Specifically, the United States has seen large inflows of young, mostly low-qualified immigrant workers which, are similar to those who have recently immigrated into the EU in similarly large numbers.[4] Moreover, the convexity we identify implies that the fiscal impact of expanding immigration would potentially be larger in countries such as Japan and Korea, where immigration flows remain small relative to their resident population and native fertility is particularly low.

Related Literature and Contribution We contribute to the literature that studies the fiscal effects of immigration in advanced economies. Early work emphasized the importance of measuring lifetime net contributions (Auerbach and Oreopoulos, 1999, Lee and Miller, 2000, Storesletten, 2003 — see Rowthorn, 2008 for a review), as we do.[5] This includes life-cycle accounting methods and overlapping-generations models. We contribute to this strand of the literature by showing a negative and convex relationship between net migration flows and the fiscal burden of aging, a result

[4] The United States are also characterized by large internal migration flows. This does not affect the applicability of our results as we focus on migration into the EU from developing countries.

[5] Two recent policy-oriented papers (Christl et al., 2022 and Fiorio et al., 2023) also provide an accounting of recent data on immigrants in Europe showing short-run positive dividends from immigration.

that applies to both frameworks.[6]

Crucially, our result does not require high-skilled immigration. In most EA countries, immigrants have lower lifetime fiscal contributions than natives but still relieve fiscal burdens because they enter at working ages rather than birth. This demographic mechanism operates whenever immigration flows are concentrated at working ages and does not rely on immigrants' skill composition, contrasting with prior work. We argue this channel deserves focus for three reasons.

First, it operates independently of hard-to-estimate parameters like skill-specific substitution elasticities, which underlie important contributions in overlapping-generations model settings. Storesletten (2000) showed that, in the US, immigration could alleviate the fiscal burden of aging, but only if inflows were young and skilled. However, at the time native fertility was expected to remain above replacement. We show that working-age immigrants can relieve the fiscal burden on native workers in low-fertility societies, even when they are relatively unskilled. The key insight is that immigrants contribute more over their remaining lifetimes than newborn natives, reducing the *per capita average* adjustment needed from resident tax payers to cover future deficits. More recent studies, in applications to European countries, yield mixed results. Hansen et al. (2017) found that non-Western immigrants have negative fiscal impacts in Denmark's welfare state, while Busch et al. (2020) show small positive aggregate welfare effects from Germany's 2015-16 refugee wave, with gains for skilled natives offsetting losses for low-skilled natives. These contrasting findings reflect country-specific economic assumptions and calibrations.

Second, our demographic mechanism operates as long as the lifetime net contributions of immigrants at the age of arrival are larger than the lifetime net contributions of native newborns. It is independent of indirect effects of migration that recently have been highlighted in the literature. Colas and Sachs (2024) show that skill complementarities between low-skilled immigrants and high-skilled natives raise native wages and labor supply, generating indirect fiscal gains through higher tax revenues that can be as large as immigrants' direct fiscal contributions. Clemens (2022) shows that immigration induces capital accumulation (as firms invest to maintain capital-labor ratios), which generates another indirect fiscal gain through increases in the capital tax revenues.

Third, our work directly addresses the policy-relevant question of how do fiscal outcomes vary with immigration intensity, rather than its composition, which is arguably harder to adjust. This demographic channel was hinted at empirically by D'Albis et al. (2019), who use OECD panel data to show an association between fiscal balances and immigration intensity, through dependency ratios. We formalize the theoretical mechanism underlying those and many other findings in the literature, and show its implications using harmonized microdata across all Euro Area countries.

More broadly, our paper also contributes to the demographic economics literature focusing on the consequences of low fertility. An extensive body of papers focuses on the stationary-through-immigration (SI) population. Papers such as Espenshade et al. (1982) or Schmertmann (1992) showed that constant immigration flows can sustain below-replacement fertility populations. We

[6] There is also a part of this literature that measures the "static" contributions at a given point in time (e.g., Dustmann and Frattini, 2014; see Preston, 2014 for a review). We also provide new estimates of them.

extend this by proving that dependency ratios are strictly decreasing and convex in immigration intensity at all finite horizons. Another part of the demographic economics literature (Weil, 1999, 2023) studies the role of fertility rates for fiscal sustainability. We show that increases in native or immigrant fertility have little impact on fiscal sustainability even if fertility was pushed up to replacement, which is an unrealistic prospect.[7]

We then demonstrate the quantitative importance of the mechanism through a large-scale accounting exercise, that uses harmonized microdata across all Euro Area countries on the characteristics of immigration from outside the EU, essentially composed of incoming migrants from the developing world. Our application shows a substantial heterogeneity across EU countries. In some cases, our model does not apply, and immigrants indeed have a negative contribution to fiscal burdens. Even where it does, countries sit at different points along the convex frontier depending on their native population decline rates and current immigration levels. This suggests that, as aging pressures rise, a common migration policy could become increasingly contentious: restrictions impose disproportionately larger fiscal costs on member states located on the steep part of the frontier, precisely where aging pressures are most acute.[8]

Organization The rest of the paper is organized as follows. Section 2 describes the population projections and some theoretical results of this class of models. Section 3 presents how we estimate the demographic profiles of different budget items and the current net contributions to the government budget of each demographic group. Section 4 describes the results on the role of migration for long-run European public finances. Section 5 shows the cross-country heterogeneity results. Section 6 concludes.

2 Immigration in Low-Fertility Populations: Theoretical Insights and Projections for Europe

In this section, we start by developing a simplified three-generation model, to characterize how working-age migration affects the age structure of populations with low fertility. We later extend the simple framework to a full cohort-component model to project the population of each country of the Euro Area. This class models are used by different statistical offices worldwide, such as Census Bureau or Eurostat, in their official population projections, meaning the following insights apply generally to population projections used by policymakers around the world.

[7] The case of fertility above replacement, where the population has explosive dynamics, may be different but we do not study it given it is not a realistic prospect.

[8] Our paper also relates to the political economy literature on immigration. See Alesina and Tabellini (2024) for an overview of this topic. Specifically, several studies show that the fiscal effects of immigration are a first-order driver of anti-immigration sentiment in European countries (Dustmann and Preston, 2007; Hanson et al., 2007; Alesina et al., 2018). Mayda et al. (2022) show the impact of immigration on voting.

2.1 A Three-Generation Population Model

Population is composed by three generations: the young generation, the working-age generation, and the old generation. There are two birth groups: natives and foreigners. The number of persons alive at date t of generation $a \in \{y, w, o\}$ and birth group $i \in \{N, F\}$ is defined as $P_t^{a,i}$. For simplicity, there is a single gender.

There is an exogenous immigration flow, which may vary over time. Immigrants only enter the population at the beginning of the working age. This simple assumption captures the feature of the data that immigration flows from the developing world into advanced countries are mostly composed of younger working-age adults, as shown in Figure 1.

Across all groups, each period, children achieve working age with probability π_w, adults retire with probability π_o, and the old face mortality risk π_m. Moreover, only the working-age generation can have children with a fertility rate f. This Markov chain structure captures the life cycle: time spent in youth before becoming productive and fertile, adulthood followed by retirement, and old age with a positive death probability. With constant parameters, this is equivalent to spending fixed duration in each stage. We assume these parameters are time-invariant. Note that in this simple model, within each birth-group, replacement fertility is simply given by π_o.

In summary, the population stock of each group evolves over time t according to the following system of difference equations:

$$\begin{aligned}
P_t^{O,i} &= (1-\pi_m)P_{t-1}^{O,i} + \pi_o P_{t-1}^{W,i} \\
P_t^{W,i} &= (1-\pi_o)P_{t-1}^{W,i} + \pi_w P_{t-1}^{W,i} + M_t^i \\
P_t^{Y,i} &= (1-\pi_w)P_{t-1}^{Y,i} + f P_{t-1}^{W,i},
\end{aligned} \tag{1}$$

with $M_t^i = 0$ for $i \neq F$. Variables where i is omitted represent the sum across birth-groups, i.e., $P_t^i = \sum_i P_t^{a,i}$.

Our analysis focuses on the dependency ratio, i.e. the ratio of non-working (young and old) to working-age population, as the key demographic outcome, defined as

$$D_t \equiv \frac{P_t^Y + P_t^O}{P_t^W}.$$

Under a balanced budget, the dependency ratio is a sufficient statistic for the net tax burden. This holds as long as tax and benefit systems maintain the feature that taxes are mainly paid by working-age taxpayers while social benefits and government provided services (such as education and healthcare) are disproportionately enjoyed by children and the elderly. This is the case across all advanced economies. As the dependency ratio rises, maintaining fiscal balance requires either raising tax rates on the working-age population, reducing benefits and spending for dependents, or some combination of both.

With this in mind, we study the properties of the dependency ratio under different paths for migration flows. First, we establish some properties regarding population stationarity, following standard results in demography. All proofs are in Appendix A.1.

Lemma 1. *(Extinction path) Under zero migration ($M_s = 0 \ \forall s$), the population shrinks to extinction. Along the extinction path, the dependency ratio converges, $D_t^{ext} \to_t D_\infty^{ext}$.*

When the native fertility is below the replacement rate and there are no migration flows, population growth is negative. In the limit, the total population is zero, i.e., it becomes extinct. However, Lemma 1 points out that, on the path to extinction, the dependency ratio converges to a well-defined level.[9]

Population extinction can be avoided with a persistent migration flow. Lemma 2 describes the key properties of such a population, called stationary-through-immigration (SI) in demography studies.

Lemma 2. *(SI population) A constant positive inflow of working-age migrants ($\forall s: \ M_s = M > 0$) allows the population to converge to a stationary-through-immigration (SI) state (Espenshade et al., 1982). The limiting dependency ratio D_∞^{SI} is independent of the scale of migration flows M.*

A constant positive migration flow avoids population extinction even if fertility rates are below replacement for both natives and immigrants. This leads to a stationary population, where population growth rate is zero in the limit and age structure is stable.[10] The SI population is composed exclusively by immigrants and their descendants, as the native group still becomes extinct. This is the empirically relevant case of advanced countries today. We now consider the behavior of the dependency ratio along the transition to a SI state.

Proposition 1. *(Effect of migration on dependency ratios) Consider constant working-age inflows $M \geq 0$ and the associated total population dependency ratios $D_t(M)$. For any finite horizon $t \geq 1$, $D_t(M)$ is strictly decreasing and convex in M.*

At any point, the dependency ratio is strictly decreasing in M. Intuitively, migrants enter the population at the working age, and although they eventually become older, this takes time. Under constant inflows, in the same period new working-age immigrants are necessarily more than new old-age persons originating in the preceding immigrant cohorts, as $\pi_O < 1$.

The convexity results from the fact that the dependency ratio of the total population will be a "weighted average" of the dependency ratio of the two groups, each converging smoothly to their respective steady-states. This implies the decreasing effect of M on the population dependency ratio, as it is bounded by the immigrant group's specific ratio.

[9] Populations are modeled here as continuous stocks, a standard approach in demography. In practice, this continuous approximation would eventually break down once numbers became very small, since integer indivisibilities would matter and D_t would become undefined when the working-age group vanished. As population headcounts are typically in the millions, the continuous formulation provides tractability while still accurately describing demographic dynamics..

[10] Note that this is the case even with fertility above replacement for immigrants. Espenshade et al. (1982) show that it suffices that immigrants' descendants have fertility below replacement starting in some n-th generation of successors for zero population growth to be obtained in the limit.

In reality, it is implausible that immigration inflows could continue indefinitely. It is easy to imagine scenarios where immigration flows cease, either for political reasons in host countries, or in a future where current origin countries achieve higher living standards and lower fertility rates. As it turns out, the key results above also apply in such scenarios, where immigration flows are interrupted at some date in the future.

Corollary 1. *(Temporary migration) Suppose inflows are constant at $M > 0$ until date T^*, and zero thereafter. Then:*

1. *For all $t < T^*$, the results of Proposition 1 apply.*
2. *For all $t \geq T^*$, the population reverts to an extinction path as per Lemma 1. For any finite t, D_t is still strictly decreasing and convex in M, even though the effect attenuates over time.*

In the long run, without new migrants the dependency ratio still explodes, but at any finite horizon before extinction, dependency ratios are still lower compared to a no-migrants scenario. The same conclusions hold if inflows decay smoothly to zero.

These results are powerful in establishing that in any aging population with below-replacement fertility, migration has positive but diminishing effects on dependency ratios. The tight link between dependency ratios and fiscal balances creates a convex policy frontier: reducing migration involves increasing the net fiscal burdens on resident taxpayers, i.e. mainly natives along with pre-existing migrants.

All of this analysis hinges on the key assumption that native fertility remains below replacement. Many developed countries, including the Euro area and the United States, have now experienced below-replacement fertility for several decades, and several middle-income countries are following the trend. This is not a temporary phenomenon and there is no indication in the data that there is likely to be a reversal of these trends in the near future (Weil, 2023; Fernández-Villaverde, 2025). Several reasons have been pointed out in the literature for that such as changes in contraceptive use, delays in childbearing or shifting of preferences/priorities. See Kearney et al. (2022) for an overview.

Note that these dynamics are present in any population model with this structure. Therefore, the results of most preceding papers on the fiscal effects of immigration, which use such models, also depend on this effect. These dynamics had not been explained before in the literature, to the best of our knowledge, but should be taken into account in interpreting such results. In Appendix A, we complement this analysis with numerical simulations to illustrate these dynamics.

The paper proceeds with a quantification of the convex relationship between immigration and fiscal balances for the Euro area. For that we build extensive population projections and estimate the demographic profile of the government budget. By combining both, and varying the size of migration flows, we quantify the role of immigration to mitigate the fiscal burden of aging.

2.2 A Full Demographic Projection Model

We now extend the model above to a more realistic setting with genders, year-of-birth generations, and time-varying fertility and mortality rates, corresponding to the same framework used in population projections. The goal is to quantify the relevance of the effects shown above for the link between migration and dependency ratios – and therefore public finances – for countries today, focusing on the case of Europe.

We extend the model above from ages 0 to 100, where $a = 100$ also includes individuals above 100. We also consider two genders, male and female, and two country of birth groups: "natives", people born in the EU and their descendants, and "migrants", people born outside the EU and their descendants (which in the data come mostly from developing countries). The number of individuals alive in period t with age a, gender g and country of birth group c, given by $P^c_{t,a,g}$, evolves according to

$$P^c_{t+1,a+1,g} = (1 - m_{t,a,g,c})P^c_{t,a,g} + \overline{M}^c_{t,a,g}, \tag{2}$$

where $m_{t,a,g,c}$ is the mortality rate and $\bar{M}_{t,a,g,c}$ is the net migration of age a, gender g and country of birth group c. Newborns are given by

$$P^c_{t,0,g} = \sum_{a,g,c} P^c_{t-1,a,g} f^c_{t-1,a,g} \lambda + \bar{M}^c_{t,0,g}, \tag{3}$$

where $f^c_{t,a,g}$ corresponds to the fertility rate at time t of the population with characteristics a, g and c. λ is the gender breakdown of newborns, assumed constant. This is referred in the literature as the cohort-component model and it is the standard method used by different statistical offices worldwide, such as Census Bureau or Eurostat, in their official population projections.

2.3 Data Sources and Assumptions

We project the population for each country of the Euro area separately, taking 2019 as the starting year.[11] This avoids the effects of the pandemic, that temporarily increased old-age population mortality. We run our population projection model until 2100. After that year, we impose population size and distribution to be constant in all dimensions.[12]

Fertility rates differ by age and country of birth group and vary over time. We take values for each EA country from the EUROPOP2019 central projection forecasts (Eurostat, 2020). The total fertility rate of natives starts off slightly over 1.4 and slowly increases over time, though still remaining well below the replacement rate of 2.1 children per woman, reaching around 1.6 by 2100 (see Appendix B.3). First-generation migrants born outside the EU have fertility rates above replacement, which

[11] We do not include Malta and Cyprus in our exercise as they have a large non-resident population in the working force that does not appear in the migration numbers but are relevant for public finances purposes.

[12] Interrupting the population transition at a later year does not affect our results.

we take from Eurostat data for 2019, where their total fertility rate is 2.4. We assume this converges to 2.1 by 2100 (our results are robust to this assumption, as shown in Appendix D.3). We assume that their descendants exhibit the same fertility as natives (this assumption does not also have meaningful effects on any of our results; see Appendix D.2).

Mortality rates are also taken from Eurostat data and their EUROPOP2019 assumptions. Life expectancy at birth was around 81 years old on average in 2019, and is assumed to rise (and converge between countries) to around 88 years old by 2100. Mortality rates differ only by age and gender, and therefore are common across country of birth groups and education levels.[13]

After projecting the population by age, gender, and country of birth, each cohort is further split by education level. We consider three education categories: primary, secondary and tertiary education.[14] The population is split by education and country of birth groups using available data from Eurostat. This is crucial for an accurate measurement of the immigrants' contribution to the budget. As to the future path of education levels, we build it based on a conservative invariance assumption. Specifically, we assume that each young and unborn cohort attains the same education levels as the cohort aged 25 in 2019, and that after the age of 25 the education composition of each cohort remains constant. We take the evolution of education up to 25 years old, and of cohorts older than 25 in 2019, from the aforementioned Eurostat dataset. This invariance assumption still implies that the overall education level of the projected population will increase over time as older cohorts, who generally have lower education, are replaced by younger, more educated ones.

As in the three-generations model, the net migration flow does not change over time. This assumption is consistent with official demographic projections, such as those routinely performed by Eurostat or the Census Bureau. These projections account for ongoing shocks that affect net migration inflows, but for the medium- and long-run they assume a constant net migration flow. Forecasting future migration shocks is challenging as they depend, for example, on wars or natural disasters that are generally unpredictable.

Across migration scenarios, we vary the net migration flow of those born outside the EU, keeping the net migration flow of those born in the EU constant. We keep the age, gender and education distribution of the flow constant. So, in the different scenarios for migration that we run, we vary the size of the net migration inflow, but keep the age and education distribution of new immigrants fixed. Note that in all scenarios we test, total net migration is positive, although for some demographic groups it may be negative. Appendix B.3 describes more details about these population projections.

[13] Data on mortality rates by education level are only available for a few EA countries. We could expect projected dependency ratios to be slightly higher if we incorporated such differences, as individuals with higher education levels tend to live longer.

[14] Primary education corresponds to ISCED 2 or below in the International Standard Classification of Education (ISCED), secondary corresponds to ISCED 3 and 4, and tertiary corresponds to ISCED 5 and above.

2.4 Population Projection Results

In 2019, the starting point of our projection, about 342 million people lived in the Euro Area. Table 1 compares the population composition by country of birth in terms of age and education in 2019. Panel (a) of the Table shows the age composition. Non-EU-born population is heavily concentrated in working ages with more than two-thirds with ages between 25 and 65 years old. Contrarily, the EU-born population is almost split in half between dependent groups (young and old) and the working-age group.

Table 1: Composition of Population by Country of Birth in 2019

Age in 2019	2019 Population stock	
	EU-born	non-EU-born
0–25 years old	27.7%	17.5%
26–65 years old	52.0%	71.1%
>65 years old	20.3%	11.5%

(a) Age (full population)

Level of education attained	EU-born	non-EU-born
Primary	28.8%	41.1%
Secondary	42.3%	33.8%
Tertiary	28.9%	25.1%

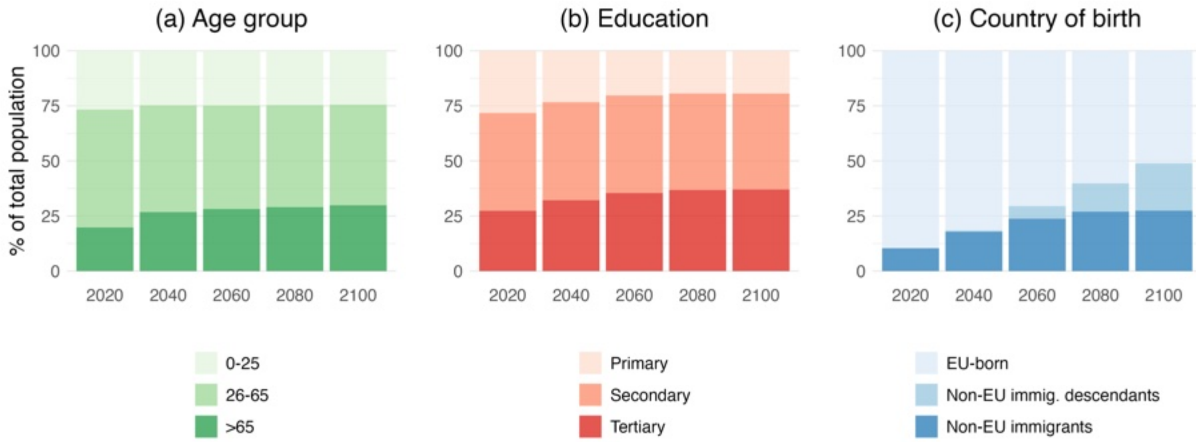
(b) Education Level (population above 25 y.o.)

Note: The tables above describe the composition of the resident population in the EA in 2019 by age and education, looking separately at groups based on country of birth. Panel (a) shows the age composition of each group, while panel (b) shows the composition in terms of attained education, considering only residents above 25 years old. Primary education corresponds to below high school attainment (ISCED 0–2), secondary education corresponds to completed high school education (ISCED 3–4), and tertiary education corresponds to a university degree (ISCED 5–8).

Panel (b) of Table 1 shows the education composition of the population above 25 years old by country of birth in 2019. For both country of births, the largest group attained secondary education, which corresponds to completed high school. The native population is, however, more educated with more than 30% of the population above 25 years old having tertiary education (a university degree), comparing with only 25% among non-EU-born population.

Using the population projection model described by Equations (2) and (3), we forecast, for each country of the EA, the population stock until 2100. After that year, we assume a constant population. By 2100, we project that 330 million people will live in the EA. Figure 2 plots, for selected years of the projection, the implied EA age, gender, education level, and country of birth distribution.

Figure 2: Demographic Distributions Implied by the Population Projections



Note: The figure shows the percentage of people with given demographic characteristics for selected years of the projection. Panel (a) displays the age distribution by age group (young, working-age, and old-age). Panel (b) presents the education level distribution as a percentage of the adult population (primary corresponds to below high school attainment, secondary corresponds to completed high school education, tertiary corresponds to a university degree). Panel (c) depicts the distribution of country of birth as a percentage of the adult population. The group of non-EU immigrant descendants includes only those born from 2019 onward, with preexisting descendants included in the EU-born group. Finally, the gender distribution is not plotted but it remains constant around 50% throughout the projection.

In our baseline projection, the population ages significantly. The dependency ratio (the ratio of the young and old populations to the working-age population) increases from 0.89 in 2020 to 1.13 by 2100, in line with Eurostat projections. Panel (a) shows that the share of the working-age population decreases, while the share of the old population increases. The share of the young population first decreases, due to the low fertility rates, but then slowly recovers to its initial value as fertility slowly rises. At the same time, as life expectancy continues to rise, the share of the population with more than 65 years old increases by more than 10 percentage points. over the projection time span. The gender distribution, not plotted, is projected to remain constant, with the female population making up slightly half of the total population, as female life expectancy is slightly larger than male life expectancy.

Our demographic forecasts also imply the education levels distribution of the adult population will change, as panel (b) illustrates. As described above, we assume that the education distribution verified at age 25 in 2019 is the distribution that new cohorts attained once they reach the same age. This implies that the percentage of population attaining secondary and, especially, tertiary education will increase over time. In fact, the share of adult population with the highest education level is expected to increase by 12 percentage points, whereas the lowest will fall by about 10 percentage points, between 2020 and 2100.

Last, panel (c) shows that the share of non-EU immigrants is projected to rise 15 percentage points, and the children of this part of the population are projected to represent 25 percent of the adult population in 2100. Non-EU-born population are characterized by having a higher fertility rate than the native population and our projections encompass a yearly constant flow of immigrants. At the same time, native fertility is below replacement which means that the native group is shrinking.

Consequently, the population projections imply that the share of non-EU born and their descendants increase over time, representing around 50% of the population by 2100.[15]

3 Fiscal Burden of Aging in Europe and the Contributions of Natives and Migrants

In this section, we describe how we map the different budget aggregates into the demographic groups considered, by building the demographic profile of the government budget for each country of the EA. We then combine this profile with the population projections to measure the fiscal burden of aging. Our overall methodology is based on the generational accounts of Auerbach et al. (1991), who propose it an alternative to standard public accounts that consider how demography affects public finances.

3.1 Fiscal Contributions of Different Demographic Groups and the Rebalancing Tax Increase

We divide the population in demographic groups by age, gender, education level and country of birth, the same groups that we consider in the population projection model. For each of these groups, we want to estimate its net contribution to the government budget. For that we need to compute how much they pay of each tax item (e.g. personal income tax) and how much they receive and benefit from each expenditure item (e.g. healthcare). Let $\tau^i_{t,x}$ be the average per capita government revenue of category i that is attributed to an individual of demographic group x in the year t, and $g^i_{t,x}$ is the average per capita government expenditure of category i attributed to a person of demographic group x in year t.

The sets $\left\{\tau^i_{t,x}\right\}$ and $\left\{g^i_{t,x}\right\}$allow us to build the demographic profile of the government budget in year t. We estimate these profiles for the base year $\bar{t} = 2019$ and assume that they grow at the rate of labor productivity, γ, plus the inflation rate, π:[16]

$$\tau^i_{t,x} = \tau^i_{\bar{t},x} \prod_{j=\bar{t}+1}^{t} \left(1+\gamma_j\right)\left(1+\pi_j\right), \text{ for } t > \bar{t}, \tag{4}$$

and similarly for government expenditure items. We next derive a metric for the fiscal burden of aging. It is important to note that we do not aim to accurately forecast the different budget aggregates, whose future paths certainly depend on many factors beyond demographics, including policy changes. Our goal is to quantify the fiscal imbalances induced by aging trends under different demographic scenarios.

[15] Our data does not allow to break down the resident population in 2019 by the country of birth of parents. Estimates by Eurostat on Labour Force Survey data place the share of the working-age population that is a descendant of at least one foreign-born person (including both intra-EU and extra-EU) at 7.3% for the whole EU in 2023.

[16] 2019 is a good year to estimate the demographic profiles as it does not suffer from any contamination from the 2020-2021 health crisis and subsequent 2022-2023 cost-of-living crisis.

Following the GA literature, we define public finances to be balanced if the present discounted value of current and future revenues is equal to the present discounted value of current and future expenditures plus current debt, that is if the intertemporal government budget constraint (IGBC) holds:[17]

$$\sum_{s=0}^{\infty} \prod_{j=1}^{s} \frac{T_{\bar{t}+s}}{(1+i_{\bar{t}+j})} = B_{\bar{t}-1} + \sum_{s=0}^{\infty} \prod_{j=1}^{s} \frac{G_{\bar{t}+s}}{(1+i_{\bar{t}+j})}. \tag{5}$$

Total government revenues are the sum of all revenue items, and each revenue item is the sum across demographic groups of the product between the population stock and the demographic profile of that group, i.e. $T_t = \sum_i \sum_x \tau^i_{t,x} P_{t,x}$, and similarly for government expenditures. We introduce a wedge $(1+\theta_\tau)$ in the above equation, which corresponds to a proportional adjustment factor to revenues necessary to the IGBC to hold. Given a set of demographic profiles at $\bar{t}$, future paths for the population of each group x, and a starting value for public debt $B_{\bar{t}-1}$, this adjustment factor is implicitly given by:

$$\sum_{s=0}^{\infty} \sum_{i} \sum_{x \in X} D^s \left[g^i_{\bar{t},x} - (1+\theta_\tau)\tau^i_{\bar{t},x} \right] P_{\bar{t}+s,x} + B_{\bar{t}-1} = 0, \tag{6}$$

with $D_t \equiv \frac{(1+\gamma_t)(1+\pi_t)}{1+i_t}$, which represents the growth/discount factor.[18] The adjustment factor θ_τ represents the *minimum* permanent tax increase, across all revenue categories, and groups, necessary to ensure intertemporal fiscal balance, keeping the same demographic structure of the budget. We refer to θ_τ as the *rebalancing tax increase*.

θ_τ is the minimum tax increase necessary in the sense that given fixed demographic profiles, delaying adjustment means increasing revenues only later, which is less valuable in present value terms, thereby widening the tax increase that would then be required in future periods to respect the IGBC.[19] In practice, this often means a practically unreasonable public debt trajectory, such as sustaining large surpluses for an extended period of time (while dependency ratios remain low). In this case, the government would accumulate substantial assets, that would be then depleted in the future to sustain small primary deficits. In none of our exercises do we specify a path for the public debt trajectory, but by this argument this would, in any case, result in larger adjustments. (The advantage is to be able to compare different cases/countries with different timing of demographic change in a consistent way) As such, our results all represent lower bounds for the necessary adjustments θ_τ as a lower-bound indicator in this sense. Note also that the focus on tax increases is simply for interpretability, as the same exercise could be performed by instead introducing an adjustment factor on government expenditure, which would represent the permanent change required in all expenditure categories to ensure the IBC holds. The results of doing so are essentially symmetric and therefore, for presentation purposes, we focus only on the rebalancing

[17] To be precise, the IGBC should also include the term $\lim_{s\to\infty} \prod_{j=1}^{s} \frac{B_{\bar{t}+s}}{(1+i_{\bar{t}+j})}$. Public finance sustainability implies that the government is solvable and hence Ponzi schemes cannot happen.

[18] For simplicity, we assume that the productivity growth rate, the inflation rate and the interest rate are constant and equal to the long-run average.

[19] Note that the IGBC equalises the present value of all future revenues to corresponding expenses.

tax increase.[20]

Since we are estimating the profiles for a given base year and then projecting them, we could also be projecting year-specific effects. Specifically, $\bar{t}$ was associated with a given business cycle position which has effects on the budget, such as higher unemployment benefits due to $\bar{t}$ being a recession year, or higher income taxes because in that year the economy was expanding. To clean fro these effects, we use cyclical adjustments to fiscal aggregates, following the approach of Bonin et al. (2014) who apply the cyclically-neutral budget adjustments of Girouard and André (2006) to a GA exercise. In Appendix B.1.1, we describe this adjustment in detail.

Furthermore, our framework assumes prices do not adjust, which implies that immigration, that leads to an increase in employment, must be met by additional capital. This generates more capital income, and consequently higher tax revenue. In our case, this bias can be particularly relevant since immigration is mostly concentrated in working ages. Clemens (2022) proposes a simple adjustment that accounts for this omission, which we adopt here as well. In Appendix B.1.2, we describe this second correction in detail.

Note that θ_τ is positive when the discounted sum of the contributions to the budget is smaller than the benefits paid by the government, meaning that restoring fiscal balance requires a tax increase. As we can see in Equation (6), since the demographic profiles grow uniformly for all demographic groups, the value of θ_τ is larger if the demographic groups for whom $\sum_i g^i_{\bar{t},x} > \sum_i \tau^i_{\bar{t},x}$ grow more over time, and smaller in the opposite case. As we shall see in the data, young and retired groups are net beneficiaries from the budget and the working-age group is a net contributor. Therefore, the value of θ_τ follows the evolution of the dependency ratio, and hence the results of Section2 also apply for public finances. Following Proposition 1, for all periods of the projection, the dependency ratio decreases with the net migration flow size and so it does θ_τ.

3.2 Data Sources and Methodology

In this subsection, we explain the data and methodology used to estimate the demographic profiles, $\{\tau^i_{t,x}\}$ and $\{g^i_{t,x}\}$. As for the population projections, we obtain data for all countries that were part of the EA in 2019, except for Malta and Cyprus.

Data. To estimate the demographic profiles we use two types of data. First, we use individual micro-level data with the demographic characteristics of individuals, their payments of each tax, and their benefits from each social subsidy and public service. Second, as we want our exercise to be consistent with the national accounts, we use the macro-aggregate values of the different budget items.

Individual microdata on taxes and benefits come mostly from the EU Statistics on Income and Living Conditions (EU-SILC) survey. This data set offers timely and comparable cross-sectional and longitudinal data on income, poverty, social exclusion, and living conditions. For our purpose

[20] Blanchard (1990) argues why an indicator such as θ_τ is the most appropriate measure of long-run fiscal sustainability.

we only use the cross-sectional dimension of the data set. We use individual data on labor income, income and property taxes, and social transfers, including pensions. This allows us to estimate the demographic profile of personal income tax, social security contributions, property tax, old-age pension, survival pension, disability pension, unemployment benefits, and sickness allowance.

To achieve a more complete coverage of the government budget, we use two additional microdata sources. We obtain household-level data on consumption from the Household Budget Survey (HBS), in order to derive the demographic profile of consumption, which we use to allocate value-added tax to each group x. We also use the European Central Bank's Household Finance and Consumption Survey (HFCS) data on household business wealth holdings, which we take as a proxy measure for the incidence of corporate income tax.[21]

For healthcare spending, we obtain an age-gender profile of government health expenditure reported directly by the European Ageing Working Group (European Commission, 2018). For education expenditure, we use data from Eurostat that report expenditures by level of studies.[22]

Macro-aggregates on taxes and benefits come from the Eurostat. We also use data on productivity growth rate, the inflation rate and the interest rate to compute the discount factor, as well as public debt. Appendix C contains the list of variables used from the different data sources.

Methodology. To estimate the demographic profiles we proceed in two steps. First, we estimate a quasi-saturated regression model of country and demographic groups for each tax/benefit item:

$$\begin{aligned}
\tau_{\bar{t},j} = {} & \alpha + \beta^{\text{country}} \cdot \text{country}_j \\
& + \gamma^{\text{age}\times\text{country}} \cdot (\text{age}_j \times \text{country}_j) + \phi^{\text{gender}\times\text{country}} \cdot (\text{gender}_j \times \text{country}_j) \\
& + \delta^{\text{educ}\times\text{country}} \cdot (\text{educ}_j \times \text{country}_j) + \varkappa^{\text{CoB}\times\text{country}} \cdot (CoB_j \times \text{country}_j) \\
& + \eta^{\text{gender}\times\text{educ}\times\text{country}} \cdot (\text{gender}_j \times \text{educ}_j \times \text{country}_j) \\
& + \psi^{\text{age}\times\text{gender}\times\text{country}} \cdot (\text{age}_j \times \text{gender}_j \times \text{country}_j) \\
& + \theta^{\text{educ}\times\text{CoB}\times\text{country}} \cdot (\text{educ}_j \times \text{CoB}_j \times \text{country}_j) \\
& + \lambda^{\text{CoB}\times\text{age}} \cdot (CoB_j \times \text{age}_j) + \mu^{\text{CoB}\times\text{gender}} \cdot (CoB_j \times \text{gender}_j) + \varepsilon_j
\end{aligned} \tag{7}$$

where $\tau_{\bar{t},j}$ denotes the value paid or received by individual j of a given budget item, $country_j$ is the vector of the EA country dummies, age_j indicates the individual's age bracket (groups of 5 ages), $educ_j$ denotes the education level group (primary, secondary and tertiary), $gender_j$ is a gender indicator (male and female), and CoB_j is the individual's country of birth group (EU and non-EU). With this specification, we estimate country-specific age, gender, education and country of birth

[21] Corporate income tax is paid by firms on their profits. However, ultimately, firms belong to households and hence we use the households' business wealth holdings distribution as a measure of the incidence of this tax on individuals.

[22] We allocate primary education (ISCED 0-1) expenditures to ages 2 to 11, secondary (ISCED 2-4) to ages 12 to 18, and tertiary or higher education (ISCED 5-7) to the population aged between 19 and 25 who completed at least secondary education. This represents a typical situation in European countries, as described in Motiejunaite-Schulmeister et al. (2022).

profiles. The interaction terms allow for country-specific gender-education differences, gender-age differences, and education-country of births differences profiles. Furthermore, our specification also allows for country-of-birth-specific age and gender profiles. This specification enables us to make effective use of a relatively limited dataset. Since the data come from surveys, the number of observations is restricted. By exploiting the large cross-country dimension, the specification allows us to estimate systematic gaps by country of birth, namely the age and gender gaps.

In a second step, using the estimated coefficients, we predict for each country, age bracket, gender, skill level and country of birth, how much, on average, an individual contributes to each revenue item and receives from each benefit item. For the items estimated using the HFCS data, we do not distinguish by gender, as the unit of observation is the household.

In total, we estimate the demographic profile of 12 different budget items, that cover about two-thirds of the budget. The remainder of the budget cannot be mapped to a demographic group, due to data limitations or conceptual reasons. Benefits from government activities such as defense, justice, or regulation cannot easily be distinguished between individuals. For the revenues of these budget items, we uniformly distribute them to all individuals older than 18 years, and for the expenditures, we distribute them uniformly, independent of any demographic characteristic.[23] Appendix B.4 has additional estimation details of these profiles and Appendix E.5 reports the profiles for the budget items.

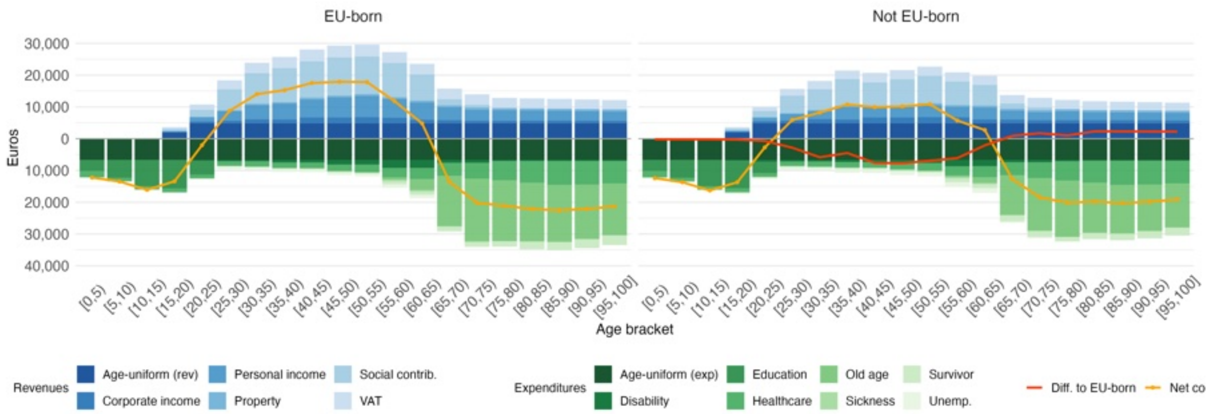
3.3 Demographic Profile of Revenues and Expenditures for Natives and Migrants

Figure 3 plots the EA mean age profile of revenues and expenditures per capita, estimated using the microdata sources described above, for individuals born in the EU and outside the EU, respectively in the left and right-hand-side charts. The top blue bars show, for each age group, the average payment in 2019 that an individual makes to the government by revenue category. Similarly, the bottom green bars show, for each age, the average amount received from the government by expenditure category. The yellow line gives the sum of all revenues minus the sum of all expenditures for each age and country of birth group. This corresponds to the per capita net contribution. The red line in the right panel gives the difference between migrants' and natives net contributions by age.[24]

[23] This distinction is mostly for presentation purposes and does not materially affect the results. In any case, the rationale is that children, while unable to earn any income and thus not bearing the burden of taxation until they reach working age, can and do benefit from public services since birth.

[24] In Appendix E.5, we show for each country and each budget item the demographic profile estimated. We also show the mean age profile for each country separately.

Figure 3: Mean Age Profile of Revenues and Expenditures Per Capita



Note: The figure shows estimates of mean per capita amounts for the different revenue and expenditure components of the government budget, for the euro area average (weighted by GDP). The orange solid line shows the net contribution by age, which the sum of revenues minus the sum of expenditures. In Appendix E.5 we show the same plot but for each country.

For both natives and migrants, the figure shows the expected life-cycle pattern, where three distinct age groups emerge. The first are the young age groups (0–24 years old), who are net receivers from the budget, benefiting from education and healthcare and paying very little in taxes. Per capita spending on education and healthcare is the same between migrants and natives by assumption, and estimated differences in revenues are small, so in this age group there is essentially no difference between migrants and natives.

The second group are the individuals in the working ages (25–64 years old). These groups are net contributors to the budget as they pay more in taxes (personal income tax, VAT and social contributions are the largest items) than what they receive in benefits and public services. Differences between migrants and natives are the largest here, as working-age migrants provide substantially less revenue in per capita terms, around 5,000 Euros less on average, whereas spending is similar. Most of the difference comes from social contributions and personal income taxes, reflecting migrants' lower average education levels and wages.

The third segment of the population is the older age groups (65+ years old), who are net receivers from the government budget. Although they still provide some revenue in income and consumption taxes (but not on social contributions), they receive substantially more, mostly in the form of pensions and healthcare services. The average migrant receives significantly less than natives at these ages, as their pensions are lower, and while they also contribute less in revenues, the difference much smaller. As a result, their net contribution is over 2,000 Euros larger than natives'.

These tax and benefit profiles result of a combination of groups with different education levels among both natives and migrants. Individuals with lower education (primary education attainment) have smaller income which implies they pay less taxes during the working ages, but receive benefits at closer levels to the highly educated. On the other hand, more educated individuals (secondary and tertiary education attainment), as they receive a higher income, they tend to pay more taxes, and are net contributors to the budget. In Appendix E.6, we show these mean age profiles by education group.

In Table 2 we show the net contribution by country of birth (EU-born and non-EU-born) and age group (0–25, 26–65 and >65 years old, the three relevant groups). Column (1) shows the net contribution per capita, which is the sum of the values on the yellow line in Figure 3 over age brackets in each group.

Table 2: 2019 Primary Budget Decomposition

Country of Birth	Age Group	(1) Net Contrib. (€, per capita)	(2) Pop. (Million)	(3) Contrib. to the Balance (1×2) (Billion €)	(% EA pot. GDP)
EU-born	0–25	-10,635	85.9	-858.4	-7.37
	26–65	13,125	161.0	1,927.3	16.55
	>65	-19,546	63.0	-1,141.1	-9.80
	total	–	311.0	-72.3	-0.62
Non-EU-born	0–25	-8,279	5.3	-40.1	-0.34
	26–65	8,158	21.5	165.0	1.42
	>65	-17,219	3.5	-58.9	-0.51
	total	–	30.3	66.0	0.57
Total		–	342.0	-6.3	-0.05

Note: The table shows, by country of birth and age group, the per capita net contribution in column (1), the population stock of that group in column (2) and the total contribution to the balance in billion Euros and in percentage of the potential GDP in column (3), for the EA.

Column (2) of the same table contains the population of each group and column (3) corresponds the respective total contribution to the budget, which is the product of column (1) and column (2). The same life-cycle pattern of the per capita net contribution emerges here, for both country of birth groups. The current total net contribution of the EU-born population is negative, whereas the total net contribution of the non-EU-born group is positive, which leads to an essentially balanced budget (a small deficit of 6.3 billion euros which corresponds to 0.05% of the EA potential GDP). In other words, without the contributions of the non-EU-born population group, the EA budget would be in a unbalanced position.

These results relate with the literature that has computed the so-called "static" net contribution of immigrants to the budgets of governments in advanced countries. In particular, they are in line with the results of Fiorio et al. (2023), who also look at data for the EU, finding that between 2014 and 2018, the per capita net fiscal contribution of migrants in the EU was substantially higher than natives due to their age composition. Before, Mackie and Blau (2017) looked into the US, finding a similar life-cycle pattern for the net contribution, and showed that immigrants, in particular second-generation immigrants, have a positive net fiscal impact once they become independent adults. Dustmann and Frattini (2014) found that in the UK, between 1995 and 2011, immigrants from the EU had positive net contributions, while non-EU immigrants and natives made negative net contributions.

In the next section, we will introduce population dynamics to study the fiscal burden of aging and the potential of immigration to attenuate it. The exercise is to compute the counterfactual government budget balance implied by the population projections. Essentially, we keep the demographic profiles of the budget (that imply the values in column (1) of Table 2) fixed, only letting them grow at a constant rate, and use the population dynamics produced by the model of Section 2 to compute net contributions (what we have in column (2) of Table 2) over time.

4 Immigration and the Fiscal Burden of Aging in Europe

In this section, we study the role of immigration for the long-run public finance sustainability. We start by extending the analysis in the previous section and compute the lifetime expected net contribution of different demographic groups. Second, we look into the balance budget evolution implied by those contributions. Then, we present the main results on the impact of changing the net migration flow on public finances. We conclude this section comparing the impact of higher fertility with higher immigration.

Immigration flows are mostly concentrated between the ages of 20 and 40 years old (Figure 1). At these ages, they do not benefit from the education services. Instead, they come at an age where they mostly contribute to the government budget by paying taxes and social contributions. Due to their age composition, their average net contribution is better than the average net contribution of the natives, even though the per capita contributions are smaller, as Table 2 shows.

In Table 3, we show the expected lifetime net contributions in 2019 at birth and at age 30 by country of birth. For a person aged a_e in 2019, this is given by:

$$\sum_{a=a_e}^{100} \sum_{i} D^{a-a_e} \left[\tau^i_{\bar{t},a,x'} - g^i_{\bar{t},a,x'}\right] \left(1 - \pi^X_{a,x'}\right) \left(1 - m_{a,x'}\right),$$

where D, τ^i and g^i are defined as before, π^X is the probability of out-migration, m the mortality rate, all of which are defined by age a and by other demographic characteristics than age, which are constant and denoted by x' . This accounts for the projected taxes and benefits that will be paid over an individual's life cycle within our projection framework. The numbers in the table are the yearly annuity corresponding to the present value of this lifetime net contribution.

The expected lifetime net contribution at birth differs substantially by country of birth. On average, EU-born individuals contribute €–5,051 per year over their lifetime, compared to €–9,757 per year for non-EU-born individuals. This gap is similar across other ages.

Since immigration is concentrated at working ages (see Table 1), the key comparison is between the net contribution of EU-born population at age 0 and the net contribution of non-EU-born population at age 30. The table shows that a new immigrant to the EA makes a less negative lifetime net contribution than a native newborn. This difference stems from the education costs borne by

Table 3: Expected lifetime per capita net contributions in 2019

Country of Birth	Net Contribution		Tax payments	
	At age 0	At age 30	At age 0	At age 30
EU-born	-5,051	2,160	37,117	37,123
Non-EU-born	-9,757	-2,697	29,837	29,369

Note: Annuity values, in Euros per year. The table shows, for a person at birth and at the age of 30 in 2019, by country of birth group, the average projected lifetime net contribution and tax payments.

European governments before age 25 and highlights the potential of immigration to alleviate the fiscal burden of aging, although not completely eliminating.

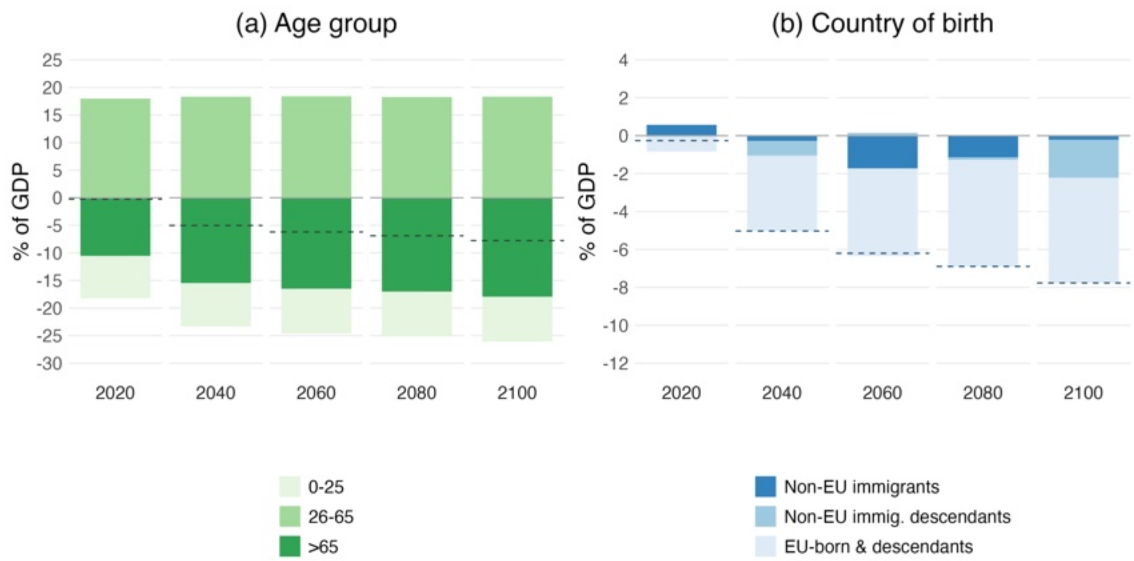
4.1 The Fiscal Burden of Aging in the Baseline Projection

Building on the framework described in Section 3, we quantify the fiscal burden of aging in Europe. We begin by computing the lifetime net contributions, which we then aggregate to calculate the primary balance and the rebalancing tax increase necessary to achieve public finance sustainability.

As shown in Section 2, the population of the EA will age over the coming decades, with the dependency ratio increasing substantially. This trend will strain public finances, as the share of net contributors in the population declines. To measure this fiscal burden of aging, we build the counterfactual government budget implied by our population projections, keeping fixed the demographic profiles of revenue and spending items, as estimated in Section 3.

Figure 4, presents the resulting primary balances for selected years of the projection. The initial deficit, 0.2 percent of 2019 potential GDP, widens over time. By 2040, the primary deficit would be 4.7 percent, and by 2100, it would be almost 9 percent of potential GDP. Although with varying intensity and speed, we can observe the same trend across the EA countries. See Appendix E.4 for the projected primary balances at the country level.

Figure 4: Counterfactual Primary Balance Implied by the Population Projections Decomposed by Age Group and Country of Birth



Note: The figure shows the net contribution to the EA primary balance for selected years of the projection of each age group – panel (a) – and of each country of birth group – panel (b). The dashed lines in the figure represent the primary balance. All values are shown as a percentage of the potential GDP.

Panel (a) of Figure 4 also shows, for selected years, the decomposition of the primary balance by age group. As the population share of older age groups increases, so does their negative effect on the budget balance, increasing from around 10 percent of the potential GDP in 2019 to almost 20 percent of the potential GDP in 2100. The young generations' negative contribution is relatively stable throughout the projection period. Similarly, the positive contribution from the working-age population is close to 18 percent in 2020 and remains stable for most of the projection.

Panel (b) of Figure 4 decomposes the projected primary balance between EU-born "natives" and immigrants from outside the EU.[25] The negative net contribution from "natives" is projected to widen as this group quickly ages. In the last decades of the century, even though "native" groups compose only about half of the population, they are responsible for three quarters of the projected deficit.

While the immigrant group initially has a positive net contribution, it also becomes a net recipient after 2040. This is due to life-cycle effects that immigrants also experience: when these individuals immigrate, they are mostly at working age and hence contributing positively to the government budget. Eventually, they will also retire, becoming net beneficiaries. As a whole, the immigrant group will also be aging, and this is not compensated by the relatively younger new immigration flow, nor by return migration of non-EU-born individuals at older ages. The descendants of non-EU immigrants have a negative contribution throughout the projection period, except for some years around 2060 where they have a positive although negligible net contribution.

[25]For completeness, in Appendix E.6 we also show the decomposition of the primary balance by gender and education level.

We summarize the fiscal burden of aging by measuring the rebalancing tax increase, θ_τ, defined previously in Equation (6). This indicator tells how much would governments need to increase taxes to rebalance public finances, under the counterfactual budget. For presentation purposes, we compute the EA average weighted by the 2019 potential GDP of the metric. The average rebalancing tax increase is 14 percent, for everyone and permanently. This means an additional 5.9% of GDP in revenues each year, compared with the current 42% of GDP collected in taxes and social contributions. If the tax increase affected only generations born after 2019, it would need to be 28.3 percent.

Next, we analyze the extent to which migration can help mitigate this burden, if it were to increase, or how much heavier the burden would become in the absence of immigration – the fiscal costs of building walls.

4.2 The Effects of Reducing or Expanding Immigration Flows into Europe

We now use our framework to predict how different intensities of the net migration flows impact fiscal balances over time.

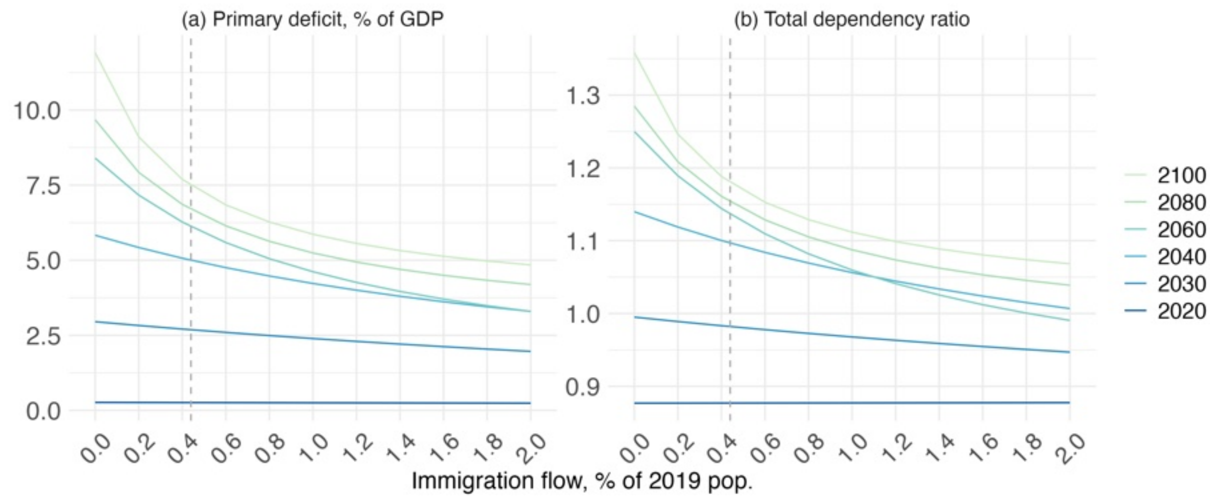
4.2.1 The Effects of Immigration on Future Primary Deficits

Our baseline projection assumes a constant yearly net migration flow from non-EU countries at the level observed in 2019, around 0.4 percent of the EA population in that year. We then explore scenarios where we change the intensity of net migration flows. The age/gender/education distribution of incoming net migration is kept equal to that observed in 2019, with only the scale of net migration flows changing across scenarios.[26]

Figure 5 shows the results of this exercise, plotting for selected points in the projection horizon different variables along the migration scenarios. Panel (a) shows the primary deficit in percentage of the potential GDP and panel (b) shows the total age dependency ratio.

[26] This net migration flow includes return migration, that is, the population returning to their origin countries.

Figure 5: Primary Deficit and Demographic Dynamics under Different Net Migration Scenarios



Note: Panel (a) shows the projected primary deficit as a percentage of the potential GDP for the different net migration scenarios. Panel (b) plots the age-dependency ratio (computed as the sum of the young and old populations divided by the working-age population) for these same net migration scenarios. Panel (c) shows the share of non-EU born and descendants in the population stock for the same net migration scenarios. The dashed line in all three panels indicates the size of migration flows in the baseline scenario.

Panel (a) shows that, regardless of the level of migration, the current small primary deficit will increase over time. These projected deficits are essentially driven by the dependency ratio, as suggested by comparison with panel (b). Young and old individuals are net receivers of the government budget, whereas working-age individuals are net contributors, as previously shown in Figure 3. With aging, the share of net contributors in the population decreases, as evidenced by the rise in the dependency ratio, leading to an increase in the deficit over time. We remark that even in this rich projection exercise, which considers several dimensions (age, education, country of birth and gender), the dynamics of the deficit are always tightly linked to the dependency ratio.

The Figure also compares different scenarios for the net migration flow, ranging from zero to 2 percent of the 2019 total population. These are depicted along the horizontal axis of the figures. The results show a positive relation between net migration and fiscal sustainability. A smaller migration inflow leads to larger primary deficits, while larger flows result in smaller deficits. This is mainly due to the age structure of net migration flows being more concentrated in the working ages compared to the resident population as shown in Table 1. For this reason, a more intense migration inflow leads to lower dependency ratios, and therefore smaller fiscal deficits.

The relationship between net migration flows and primary deficits is not linear. As panel (a) also shows, the effect of intensifying immigration flows on the deficits is positive, but diminishing, while constraining migration has increasing effects: the fiscal costs of "building walls" increase with the size of the restriction. By 2100, a smaller immigration flow by 0.4 p.p. (i.e., a shut down of the net migration flow) would lead to a deficit larger by about 4.1 p.p., while a larger immigration flow by 0.4 p.p. (i.e., doubling the net migration flow) would only reduce the 2100 deficit by 1.5 p.p. This non-linearity is rooted in population dynamics, as explained in Section 2.

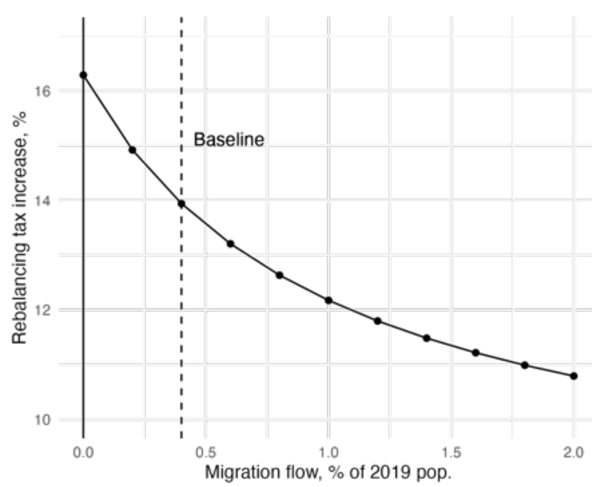
4.2.2 Implications for the Fiscal Burden of Aging: a Convex Policy Frontier

The interpretation of these dynamics is clear. As fertility is below replacement, the population of Europe is undergoing a transition towards a "stationary through immigration" population, i.e. one which is only sustained by a regular inflow of migrants. Increasing the immigrant flow accelerates that transition, but there is a limit to that acceleration. This is why immigration alone cannot solve the fiscal burden of aging and, conversely, why the "costs of building walls" are increasing. As the immigrant population share increases over time, this subpopulation's age structure plays a greater role in driving the overall primary deficit. Since the immigrant population exhibits lower dependency ratios, they contribute to shrink the deficit. As a result, stronger net migration inflows lead to smaller deficits, but each additional increment to the inflow has a decreasing impact on the deficits, due to the convergence result discussed in Section 2.

This mechanism explains why many previous studies reached the conclusion that immigration cannot fully solve the public finance sustainability issues faced by developed economies (see Preston, 2014, for a review). Such studies, following the standard procedure in official demographic projections, also assumed a constant immigration inflow.

We now look at the rebalancing tax increase, θ_τ, under the different scenarios for net migration. Figure 6 draws the frontier between the net migration flow and θ_τ. As presented above, in the baseline scenario where the net migration flow is equal to 0.4% of the 2019 population, the rebalancing tax increase is 14 percent. The necessary tax adjustment to restore sustainability becomes more severe with a restriction to immigration flows, due to its effects on future primary deficits as shown in Figure 5.

Figure 6: Frontier between the Level of Net Migration and the Rebalancing Tax Increase, θ_τ



Note: The figure shows the rebalancing tax increase, θ_τ, for the different net migration scenarios. This metric corresponds to the weighted average of the country-specific rebalancing tax increase metrics across the EA countries, using the 2019 potential GDP as weights. The dashed line indicates the size of migration flows in the baseline scenario.

The chart also shows that the relationship between net migration and the fiscal burden of aging is nonlinear and convex. The gains from expanding migration flows are highest at low levels, and then decline – in this sense, increasing migration has diminishing returns for public finances. If we consider a scenario where migration flows are totally shut down, moving from here to our baseline with 2019 levels of migration, we obtain a reduction from 16.3% to 14%, which corresponds to a 14% reduction in the fiscal burden of aging. However, if future immigration flows doubled in size (from the current 0.4% to 0.8% of the 2019 population), the rebalancing tax adjustment would be smaller, from 14% to 12.3, corresponding to a 9% reduction. Table 4 shows the rebalancing tax increase for three net migration scenarios.

Table 4: Imbalance Metrics in Different Migration Scenarios

Size of net migration flow	θ_τ	Diff.	in pct.	in % pot. GDP
0.0% of 2019 pop. (shut-down)	16.3%	–	–	–
0.4% of 2019 pop. (baseline)	14.0%	-2.3 p.p.	-14%	-1.0
0.8% of 2019 pop. (doubling)	12.6%	-1.4 p.p.	-9%	-0.7

Note: The value of θ_τ reported corresponds to the weighted average of the rebalancing tax increase of each country computed according to Equation (6), weighted by the potential GDP of 2019 of each EA country. The table reports the metric for three net migration scenarios: shut-down of migration flows (0%), baseline migration flows (0.4%), and doubling of migration flows (0.8%).

The key takeaway is that maintaining immigration flows can be an important aid to Europe in dealing with the fiscal burden of aging. Shutting down the net migration flows means an additional permanent tax increase equivalent to 1% of the EA potential GDP, every year, on top of the 5.9% of the baseline, to restore fiscal sustainability. Table 5 shows, from an individual perspective, this tax increase.[27] It corresponds to an annualized value of €6,048 per year for the average native 30-year-old worker, compared to €5,203 per year with baseline immigration. For a non-EU-born taxpayer, the difference is slightly smaller: €4,785 with a zero net migration flow which compares with €4,116 with the baseline net migration flow.

Table 5: Expected yearly lifetime contributions and tax increase for taxpayers aged 30 in 2019

Country of Birth	Net Contribution	Tax payments	Tax increase by θ_τ baseline	Tax increase by θ_τ no migration	Diff.
EU-born	2,160	37,123	5,203	6,048	-845
Non-EU-born	-2,697	29,369	4,116	4,785	-669

Note: Annuity values, in Euros per year. The table shows, for taxpayers aged 30 in 2019, by country of birth group, the average projected lifetime net contribution and tax payments, and, for the baseline and no-migration scenario, the additional payments corresponding to the rebalancing tax increase, along with their difference.

[27] Figures at the country level are reported in the Appendix, in Table 12.

A potential caveat in our results concerns the general equilibrium effects of immigration. Immigration expands the labor force, which tends to lower wages and raise interest rates due to an increased labor-to-capital ratio. These dynamics can increase the cost of servicing public debt and reduce labor tax revenues. However, Colas and Sachs (2024) argue that such effects may be mitigated in the presence of complementarity between low- and high-skill workers. Since most immigrants are low-skilled, their presence can boost the productivity of high-skilled natives and due to the progressivity of the tax system the wages and tax contributions, partially offsetting the negative general equilibrium impacts. Indeed, the authors show that these indirect fiscal gains may outweigh the direct fiscal costs.

Similarly, Busch et al. (2020) find that the general equilibrium effects of immigration can be modest in a similar setting. Analyzing the large influx of refugee migration to Germany, they report small net welfare gains that grow over time: 0.5% welfare increase in 2020 and 1% welfare increase by 2060. These gains persist despite the downward pressure on wages, suggesting that the main channels operate through demographic change: the influx of migrants increases the working age population, which in turn contributes to a smaller dependency ratio and fiscal cost-to-benefit ratio, which alleviates the tax burden on native workers.

Another potential source of general equilibrium effects is the positive response of immigration flows to better fiscal conditions in the destination country that could downward bias the effects of immigration. While this could be possible in theory, our analysis treats migration flows as exogenous. Moreover, long-term fiscal conditions in host countries are unlikely to be a primary determinant of migration decisions, especially when compared to more immediate factors such as current levels of taxes or socio-economic conditions in the origin country, linguistic ties, and geographic proximity (Mayda, 2010; Grogger and Hanson, 2011).

That said, looking again at Figure 6, we see that immigration cannot per se eliminate the fiscal burden of aging. Even after increasing net migration flows to 2%, an unrealistically large number, fiscal sustainability would still require an 10.8 percent rebalancing tax increase.

4.3 Is Fertility an Alternative to Migration?

Policies promoting fertility are often seen as an alternative to migration to deal with the fiscal burden of aging. We consider this option in our framework, in an exercise where we change native fertility levels, shown in Table 6. We take as a starting point the zero net migration scenario, which features the observed levels of native fertility, at around 1.6 children per woman (Scenario A in the table). We then compare this with two alternatives: first, a higher fertility rate scenario, where we set it at the replacement level, 2.1 children per woman, and keep net migration at zero (Scenario B);[28] second, we keep fertility at around 1.6 children per woman, and set net migration flows at their 2019 levels (Scenario C, also our baseline in the main results above).

[28]Note that this is a highly optimistic scenario regarding the potential of policies to increase fertility. Even if policies were successful, fertility is a slow moving variable.

In the first alternative considered (B), when native fertility is higher, the rebalancing tax increase is almost unchanged, only decreasing by 0.65 percentage points. In contrast, when we increase the net migration flow to 2019 levels (Scenario C), the rebalancing tax increase falls by 2.28 percentage points compared to Scenario A (as previously shown in Figure 6). The high fertility scenario generates higher dependency ratios and, therefore, projected primary deficits, compared to the scenario with no migration, during the first 40 years of the projection. This effect is compensated by a lower long-run primary deficit.

Table 6: Imbalance Metrics in High Native Fertility Scenario

Scenario	Native fertility	Net migration flow	θ_τ
A	Baseline (1.6 in 2020+)	0.0% of 2019 pop.	16.3%
B	High (2.1 in 2020+)	0.0% of 2019 pop.	15.6%
C	Baseline (1.6 in 2020+)	0.4% of 2019 pop. (baseline)	14.0%

Note: The value of θ_τ reported corresponds to the weighted average of the rebalancing tax increase of each country computed according to Equation (6), weighted by the potential GDP of 2019 of each EA country. The table reports the metric for a scenario with high fertility (B) and a scenario with positive net migration flow (C) that compare with scenario A where fertility and migration are low.

Intuitively, in the short run, higher fertility only increases the population share of children, who have a negative net contribution to the budget. This increase would come at the same time as the share of old-age population is growing due to the large "baby boomer" cohort entering retirement. The benefits of higher fertility, in terms of a larger share of working-age population, only come far later.[29] For these reasons, fertility is not an alternative to migration as an instrument to moderate the increase in the dependency ratio and, therefore, the fiscal burden of aging.

4.4 Robustness Exercises

Interest Rate and Productivity Growth Rate. In our baseline exercise, we set the productivity growth rate, γ, the nominal interest rate, i, and the inflation rate, π, equal to the historical average of these variables between 1995 and 2021 i.e. 0.7%, 3.8%, and 1.68%, respectively. This implies a discount factor, D, equal to 0.986. Given that our main results rely on projected values, we tested if the nonlinearity between migration flow size and the rebalancing tax increase depends on the assumption for D. In Appendix D.1, we compute the rebalancing tax increase for different values of D, and plot the frontier between θ_τ and the level of migration in each case. We show that the convexity holds for the different cases considered.

Fertility Rate of Immigrants. All the results shown so far rely on the same assumption for the fertility rate of first-generation immigrants, taken from the data to be 2.35 (on average across countries and ages) in 2019 and assumed to slowly decline, converging towards 2.1 children per woman

[29] This is why, unlike our preferred metric, the θ_τ^{AGK} result improves with higher native fertility, as it places a larger weight on more distant periods. The full projected time path for the primary deficit (analogous to Figure 5) is available in Appendix E.1.

by 2100. This assumption could have an impact on the measured fiscal benefits of migration. In Appendix D.3, we test for that by computing the rebalancing tax increase with different assumptions for the immigrant fertility rate,[30] as well as the frontier between θ_τ and the level of migration. The convexity is observed across these different scenarios.

Immigrants' Offspring Fertility. In the baseline exercise, the second and later generation of immigrants follow the same demographic behaviors as the native population group. An alternative modeling choice is to set the immigrant offspring fertility equal to the first generation of immigrants. In Appendix D.2, we show the results of an alternative exercise where second-generation immigrants have the same fertility as their immigrant parents. Fiscal balances are slightly worse with this higher fertility, for any level of immigration flows, but differences are subdued. We also observe that the nonlinear relationship between the rebalancing tax increase and the net migration inflow level remains.

Education Composition of Immigrants. Our baseline exercise uses the hypothesis that the education composition of new immigration is the same as the one observed in 2019. Differences in education composition change the total net benefits on immigration. In Appendix D.4, we show, however, that the rebalancing tax increase still exhibits decreasing returns with respect to the net immigration flows, when the all immigrants have completed tertiary education or all immigration have only completed primary education.

5 Heterogeneity across Euro Area Countries

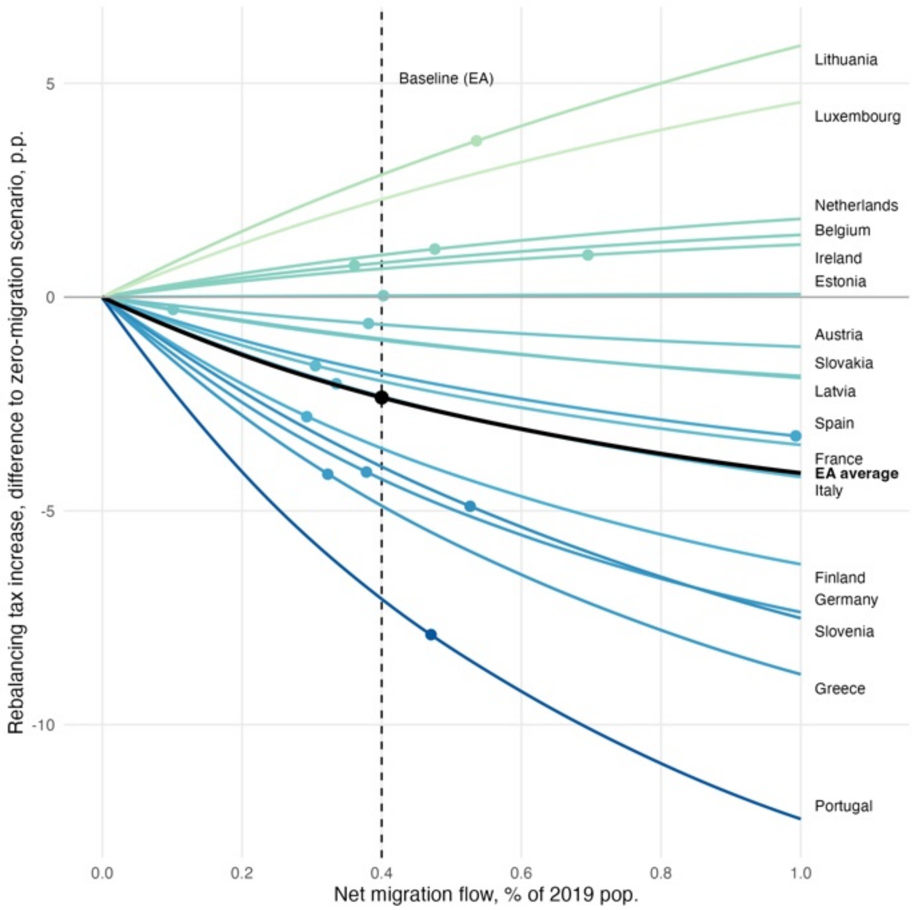
Up until this point, all the results reported referred to the Euro area aggregate. But its member states differ in various key dimensions for the fiscal effects of immigration: aggregate fiscal conditions, tax-benefit policies, and the characteristics of immigration. In this Section, we consider how these affect the role of immigration in the public finances of each country. Beyond unveiling policy-relevant cross-country differences, the exercise sheds light on how our model framework, and main conclusions, apply to specific country cases.

Figure 7 shows the convex policy frontiers between migration flows and the rebalancing tax increase faced by each country. We plot how much θ_τ changes in comparison to a closed-borders scenario for each country (gradient of colors) and for the EA average (black line).[31] The dots on each frontier mark the net migration level of each country observed in 2019, which is kept in the baseline scenario.

[30] Across these scenarios we keep the assumption that 2nd-generation immigrants have the same fertility as natives.

[31] Note this is slightly different from the preceding Figure 6, with the EA-level frontier, which showed θ_τ directly for each level of migration. The change is intended to facilitate comparison given that the baseline fiscal conditions in each country are quite different. See Appendix E.2.

Figure 7: Rebalancing Tax Increase, Difference to Zero-Migration Scenario for each EA Country



Note: The figure shows, for different scenarios of net migration, the difference in the rebalancing tax increase, θ_τ, compared to the zero-migration case, in the different countries of the EA. The dots on each frontier point to the baseline scenario in each country, which are based on the net migration flows observed in 2019. The baseline case for the EA aggregate is further marked by a vertical dashed line. The baseline flow for Luxembourg is not plotted as it was close to 2% of the 2019 population.

Immigration relieves the fiscal burden of aging in most countries. Higher net migration flows reduce the rebalancing tax increase, including in the "big 4" France, Germany, Italy and Spain, driving the results for the EA aggregate. This is not based on extreme immigration flows. With the notable exception of Spain, most countries range between 0.3 and 0.5% of total population, around the cross-country average. In general, in these countries, immigrants from outside the EU arrive between ages 20 and 30, and out-migration is relatively muted. The conditions in our model apply and, like for the EA average, they reduce the tax increase required from all taxpayers despite the fact that they make smaller per capita contributions. The cross-country comparison allows to see clearly that the key comparison is of immigrants' lifetime net contribution from the age of entry, with the lifetime net contribution of natives at birth. Figure 17 in the Appendix shows the former is larger in most countries, where immigrants alleviate – though not eliminating – the fiscal burden of aging for all.

However, for a small set of countries, larger net migration flows *increase* the required rebalancing tax increase. This can happen for two reasons. In some countries, immigrants make substantially lower contributions than natives, including in the working ages. In these cases, even if they enter at ages 20-30, they make a larger negative net contribution over their lifetimes than natives starting from birth. This is the case in the Benelux countries (Belgium, Netherlands and Luxembourg) and Ireland. In other words, in these countries working-age immigrants entering the population have a similar, if not worse, effect than newborns on fiscal sustainability given current tax-benefit policies, and as such the demographic mechanism does not apply. In a couple of other countries, there is also a negative relationship between immigration and fiscal balances, but for a more straightforward reason. In Lithuania and Estonia, the arrival age of most immigrants is later than 30, so they miss some years of positive net contributions. Our model is based on the common case that immigrants arrive at the *early* working ages. The case of these two countries illustrates how the sign of the fiscal effects of immigration may change when this does not apply.

Additionally, the Figure also shows that for countries where net migration is beneficial, increasing the inflows has different impacts on the rebalancing tax increase. These differences are a consequence of the diminishing returns of migration that we uncover in this paper. Countries face different costs and benefits of immigration depending on where they sit on the convex frontier. Spain, which has a high migration flow, has little to gain from increasing it further, and could actually let it retreat with little impact on the fiscal burden of aging. Finland, Greece or Germany, instead, would stand to face significantly higher per-capita fiscal costs if they were to cut back immigration. Portugal would lose even more, as it is an outlier – the only country in our data where immigrants are estimated to make larger net contributions than natives. Countries like Austria or Slovakia are on the opposite end, where immigrants make significantly lower net contributions than natives, and only provide a small relief to the fiscal burden of aging. These results highlight how challenging is to set a common migration policy within the European Union. Restricting immigration flows, as currently under discussion in many countries, will have very heterogeneous impacts on public finances across countries. Our results are also relevant when thinking about refugee allocation programs, since some countries could benefit, from the fiscal perspective, receiving more migrants.

While this is beyond the scope of our paper, our framework also sheds light in understanding which countries' public finances are more vulnerable to aging. Figure 16 in Appendix E.2 decomposes the overall sources of the rebalancing tax increase in each country, in the baseline scenario. This decomposition shows, for instance, that although the baseline rebalancing tax increases in Germany and France are very similar, France is mostly due to current aggregate imbalances (high debt and a large primary deficit), whereas Germany is mostly due to demographic reasons with a budget structure that is vulnerable to demographic change in the country.

6 Conclusion

In this study, based on detailed data on taxes, benefits, and demographic dynamics, we revisited the question of how immigration can help relieve the fiscal burden of aging, focusing on the case of Europe. Increasing net migration flows to Europe from non-EU countries, composed mainly of working-age individuals, moderates the rise in the dependency ratio and, therefore, of fiscal imbalances. The relation between immigration and fiscal balances is convex: boosting migration has diminishing benefits, while restricting migration would have increasing costs for public finances – these are the costs of building walls. This conclusion is underpinned by a novel theoretical analysis of the stable population and transition properties of population models featuring constant immigration flows, along with our empirical application to European data.

Specifically, we show that cutting migration flows down to zero increases the fiscal burden of aging, measured by the necessary rebalancing tax increase, by 2.3 percentage points compared to our baseline of 14%. This means that shutting down migration would require Euro area countries to, on average, impose an additional tax burden increase of 1 percent of the GDP, every year, to deal with the fiscal burden of aging.

We also show that boosting fertility is not an alternative to immigration, as the short-run costs of such a policy – due to a higher population share of infants – exceed the long-run potential benefits of a larger work force.

Furthermore, the rebalancing tax increases vary significantly across countries, due to differing demographic factors and initial fiscal conditions. Net migration alleviates the fiscal burden of aging in some countries, while its impact is minimal or even negative in others. These findings suggest additional challenges to finding an agreement between countries for a EU-wide migration policy.

Future work can use this framework to measure the importance of this mechanism, and refresh ideas about the potential of migration to reduce the fiscal burden of aging in other advanced countries, such as the US, where migration policy has been under heated discussion, or Japan and South Korea, with especially low native fertility rates. Together with this paper, we leave a fully reproducible coding infrastructure that can allow other researchers and policy-makers to easily run population projections with our model and computing counterfactual budget series, given demographic profiles of taxes and benefits.

Our analysis uncovers novel facts informing current policy discussions. Migration policy has taken center stage in Europe: as many European countries experience an increase in political polarization, some proposals are pushing towards curbing immigration. Our findings make it clear that restrictions on immigration flows from developing countries may significantly increase the net tax burden on natives. This is due to the strong effects of immigration on demographic dynamics in aging societies and, consequently, on the fiscal burden of aging.

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The Costs of Building Walls: Immigration and the Fiscal Burden of Aging in Europe

Online Appendix

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A Population Projection Model

A.1 Model Proofs

The model described in subsection 2.1 is a linear differences model, which we can write as:

$$\mathbf{P}_t^i = A\mathbf{P}_{t-1}^i + B, \ i = \{N, F\} \tag{8}$$

where $\mathbf{P}_t^i = \begin{bmatrix} P_t^{O,i} & P_t^{W,i} & P_t^{Y,i} \end{bmatrix}'$, $B = \begin{bmatrix} 0 & M & 0 \end{bmatrix}'$, with $M = 0$ for $i = N$. The transition matrix A is given by

$$A = \begin{bmatrix} 1-\pi_m & \pi_o & 0 \\ 0 & 1-\pi_o & \pi_w \\ 0 & f & 1-\pi_w \end{bmatrix},$$

where π_m is the probability of death, π_o is the probability of entering retirement, π_w is the probability of entering working age, and f is the fertility rate.

Define total population vectors $x_t = (P_t^O, P_t^W, P_t^Y)'$, where $P_t^W \equiv P_t^{a,N} + P_t^{a,F}$. Let $u = (1, 0, 1)'$ be an auxiliary vector that selects old and young populations and $v = (0, 1, 0)'$ a vector that selects the working-age population. The dependency ratio is

$$D_t = \frac{u'x_t}{v'x_t} = \frac{P_t^O + P_t^Y}{P_t^W}.$$

Write immigrant inflows as $m_t = (0, M_t, 0)' = M_t v$.

A.1.1 Proof of Lemma 1 (Extinction path, precise version).

Note that A is block upper triangular:

$$A = \begin{bmatrix} 1-\pi_m & \pi_o & 0 \\ 0 & 1-\pi_o & \pi_w \\ 0 & f & 1-\pi_w \end{bmatrix} = \begin{bmatrix} 1-\pi_m & A^* \\ 0 & B \end{bmatrix},$$

with $A^* = \begin{bmatrix} \pi_o & 0 \end{bmatrix}$ and

$$B = \begin{bmatrix} 1-\pi_o & \pi_w \\ f & 1-\pi_w \end{bmatrix}.$$

The spectral radius of A is therefore

$$\rho(A) = \max\{\, 1-\pi_m,\ \rho(B)\,\},$$

where

$$\rho(B) = \tfrac{1}{2}\left(\operatorname{tr} B + \sqrt{(\operatorname{tr} B)^2 - 4\det B}\right), \quad \operatorname{tr} B = 2 - \pi_o - \pi_w, \quad \det B = (1-\pi_o)(1-\pi_w) - f\,\pi_w.$$

Under admissible parameters $\pi_w > 0$, $f > 0$, $\pi_o < 1$, $\pi_w < 1$, the block B is positive and hence primitive. By the Perron–Frobenius theorem, $\rho(B)$ is simple and B admits strictly positive right and left eigenvectors. We then have:

1. If $\rho(B) > 1 - \pi_m$, then $\rho(A) = \rho(B) < 1$ and the dynamics are governed by the Perron eigenvector $r \gg 0$ of A. In this case

$$D_t^{\text{ext}} \longrightarrow D_\infty^{\text{ext}} = \frac{u'r}{v'r}.$$

2. If $\rho(B) \le 1 - \pi_m$, then the old-age block dominates and $D_t^{\text{ext}} \to \infty$.

A convenient sufficient condition for (i) is

$$\min\{(1-\pi_o) + \pi_w,\ f + (1-\pi_w)\} > 1 - \pi_m,$$

since for non-negative matrices the Perron root lies between the minimum and maximum row sums. Intuitively, persistence in the (W, Y) block must exceed old-age survivorship $(1-\pi_m)$; otherwise the worker base vanishes faster and the dependency ratio diverges. This inequality is satisfied under any empirically reasonable parameterization. □

□

In the case $M_t = 0$ we have $x_t = A^t x_0$. Under sub-replacement fertility $f < \pi_o$, the characteristic equation of A yields a Perron root $\rho \in (0,1)$. By the Perron–Frobenius theorem, A has a unique strictly positive eigenvector $r \gg 0$ such that $Ar = \rho r$.

It follows $|x_t| \to 0$ (population extinction) and

$$\lim_{t\to\infty} \frac{x_t}{|x_t|} = \frac{r}{|r|}.$$

Then, even though the population vanishes the dependency ratio converges:

$$D_t^{\text{ext}} = \frac{u'x_t}{v'x_t} = \frac{u'\frac{x_t}{|x_t|}}{v'\frac{x_t}{|x_t|}} \longrightarrow_t D_\infty^{\text{ext}} \equiv \frac{u'r}{v'r}.$$

Proof of Lemma 1 (via QuantEcon PF results). A is primitive, i.e. A^t becomes strictly positive after some periods. Let $\rho = r(A)$ denote the spectral radius (dominant eigenvalue) of A. Under sub-replacement fertility ($f < \pi_o$) we have $\rho \in (0,1)$. By Theorem 39.2 in the QuantEcon PF lecture, if A is primitive then (i) all other eigenvalues satisfy $|\lambda| < \rho$, and (ii) there exist strictly positive right/left Perron eigenvectors $v \gg 0$, $w \gg 0$ (normalized with $w'v = 1$) such that

$$\rho^{-t} A^t \longrightarrow v\,w' \qquad (t \to \infty).$$

Hence, for any $x_0 \geq 0$ with $w'x_0 > 0$,

$$x_t \;=\; A^t x_0 \;=\; \rho^t \Big(v\, w' x_0 \;+\; o(1) \Big),$$

so $\|x_t\| \to 0$ (extinction) and the *normalized* population vector converges in direction:

$$\frac{x_t}{\|x_t\|} \;\longrightarrow\; \frac{v}{\|v\|}.$$

Therefore the dependency ratio has a finite limit given by the Perron right eigenvector:

$$D_t^{\text{ext}} \;=\; \frac{u' x_t}{v' x_t} \;=\; \frac{u' \frac{x_t}{\|x_t\|}}{v' \frac{x_t}{\|x_t\|}} \;\longrightarrow\; D_\infty^{\text{ext}} \;\equiv\; \frac{u' v}{v' v}.$$

(Equivalently, one can write $D_\infty^{\text{ext}} = \frac{u'v}{v'v}$ or any positive scaling of v.) This proves convergence of D_t^{ext}.

Moreover, if the initial age structure is already the stable one, $x_0 = c\,v$ with $c > 0$, then $x_t = \rho^t c\, v$ and $D_t^{\text{ext}} \equiv \frac{u'v}{v'v}$ for all t (exact equality at each date). □

A.1.2 Proof of Lemma 2

Fixing $M_t = M > 0$, the recursion $x_t = Ax_{t-1} + Mv$ has fixed point

$$x = (I - A)^{-1} M v = M \sum_{k=0}^{\infty} A^k v,$$

so $x_t \to x$ from any x_0. The limiting dependency ratio is

$$D_\infty^{\text{SI}} = \frac{u'x}{v'x} = \frac{\sum_{k\geq 0} u' A^k v}{\sum_{k \geq 0} v' A^k v} = \frac{\pi_o}{\pi_m} + \frac{f}{\pi_a}$$

which is independent of M.

A.1.3 Proof of Proposition 1

The system of difference equations can be written as

$$x_t = A^t x_0 + \sum_{s=1}^{t} A^{t-s} M v \equiv x_t^{(0)} + M z_t,$$

where $x_t^{(0)} \equiv A^t x_0$ represents the remaining members at time t of the cohorts present at time 0, and $z_t \equiv \sum_{s=1}^{t} A^{t-s} v$ a unit of the new migrants group. The dependency ratio of the total population can, at any point, be defined as:

$$D_t(M) = \frac{u'x_t^{(0)} + u'z_tM}{v'x_t^{(0)} + v'z_tM}.$$

Its partial derivatives w.r.t. M are:

$$\frac{d}{dM}D_t(M) = \frac{u'z_tv'x_t^{(0)} - v'z_tu'x_t^{(0)}}{(v'x_t^{(0)} + v'z_tM)^2}; \text{ and } \frac{d^2}{dM^2}D_t(M) = -\frac{2v'z_t(u'z_tv'x_t^{(0)} - v'z_tu'x_t^{(0)})}{(v'x_t^{(0)} + v'z_tM)^3}. \tag{9}$$

Thus to prove the proposition, it suffices to show that

$$u'z_tv'x_t^{(0)} - v'z_tu'x_t^{(0)} < 0 \Leftrightarrow \frac{u'x_t^{(0)}}{v'x_t^{(0)}} > \frac{u'z_t}{v'z_t}. \tag{10}$$

Note that the left-hand-side ratio is simply the dependency ratio of the native group given some initial population x_0 and no migration. The right-hand-side ratio is the dependency ratio of the migrant group, which is composed of a succession of cohorts each starting out at working-age. As we will show, this inequality must hold since migrants only enter at the working age, given they have the same fertility and transition probabilities as natives. We proceed in three steps.

Step 1. For $k \geq 0$ define the dependency ratio of a first-generation migrant cohort k periods after arrival as

$$g_k^{F_1} \equiv \frac{u'A^kv}{v'A^kv}.$$

By construction, $g_0^{F_1} = 0$ since new migrants arrive entirely as workers. The migrant block at time t is the sum of t successive cohorts, one arriving each period:

$$z_t = \sum_{k=0}^{t-1} A^kv,$$

which in the full population, recall, is scaled by M. The dependency ratio of this group is a weighted average of $\{g_0^{F_1}, \ldots, g_{t-1}^{F_1}\}$ with strictly positive weights,

$$\frac{u'z_t}{v'z_t} = \frac{\sum_{k=0}^{t-1} g_k^{F_1} w_k}{\sum_{k=0}^{t-1} w_k}, \qquad w_k \equiv v'A^kv > 0.$$

Hence

$$\frac{u'z_t}{v'z_t} < g_{t-1}^{F_1}, \tag{11}$$

holding with strict inequality since $g_0^{F_1} = 0$. Condition 11 establishes simply that the dependency ratio of the migrant group at a given point in time must be lower than that of a single migrant cohort one period ahead.

Step 2. Assume the parameter condition

$$\frac{1-\pi_w}{\pi_w} \;\geq\; \frac{\pi_o + f^{F_1}}{1-\pi_o}. \tag{12}$$

The left-hand side is the dependents-per-worker ratio generated by a full-life-cycle cohort after one period, i.e. one that starts at birth; the right-hand side is the same dependents-per-worker generated by a cohort starting at working age with fertility f^{F_1}, as migrants do. Condition 12 only requires that young-start cohorts are at least as dependent as worker-start cohorts after one period; in other words, unless children instantly turn into workers (π_w near 1), a young cohort generates more dependents per worker than a worker cohort does.

Under constant transition probabilities,[32] this ordering propagates over time, implying that the sequence $\{g_k^{F_1}\}_{k\geq 0}$ is nondecreasing:

$$g_{k+1}^{F_1} \;\geq\; g_k^{F_1}, \qquad k \geq 0.$$

Step 3. At horizon t, the baseline block is $x_t^{(0)} = A^t x_0$. Consider decomposing x_0 into pure starting positions for old, workers, and young groups. Adding mass in the old group can only raise the ratio (it contributes to the numerator but never to workers in the denominator). Therefore it must be that:

$$\frac{u' x_t^{(0)}}{v' x_t^{(0)}} \;\geq\; \min\{\, g_t^{F_1},\, h_t \,\}. \tag{13}$$

Under (R_{F_1}), we have at one step

$$h_1 = \frac{1-\pi_w}{\pi_w} \;\geq\; g_1^{F_1} = \frac{\pi_o + f^{F_1}}{1-\pi_o}.$$

We now show this ordering propagates to every horizon $t \geq 1$:

$$h_t \;\geq\; g_t^{F_1} \quad \text{for all } t \geq 1.$$

Indeed, write $A^{t-1}e_Y = \alpha_t e_O + \beta_t e_W + \gamma_t e_Y$ with $\alpha_t, \beta_t, \gamma_t \geq 0$. Then

$$h_t = \frac{u' A(\alpha_t e_O + \beta_t e_W + \gamma_t e_Y)}{v' A(\alpha_t e_O + \beta_t e_W + \gamma_t e_Y)} \;\geq\; \frac{\beta_t\, u' A e_W + \gamma_t\, u' A e_Y}{\beta_t\, v' A e_W + \gamma_t\, v' A e_Y}$$

(the α_t term can only increase the ratio since $v' A e_O = 0 < u' A e_O$). The right-hand side is a weighted average of $r_W(1) = g_1^{F_1}$ and $r_Y(1) = h_1$, hence it is $\geq \min\{g_1^{F_1}, h_1\} = g_1^{F_1}$ by (R_{F_1}). Applying the same

[32] It is straightforward to see why this extends to the empirical case of time-varying parameters, which would be represented in this model as falling π_o (workers take more time to move into retirement) and π_w (on average children take more time to begin their working life).

argument with $A^{t-2}e_W$ in place of e_Y shows $g_t^{F_1} \geq g_{t-1}^{F_1}$; combining yields

$$h_t \;\geq\; g_1^{F_1} \text{ and } g_t^{F_1} \geq g_{t-1}^{F_1} \quad \Rightarrow \quad \min\{g_t^{F_1}, h_t\} \;\geq\; g_{t-1}^{F_1}.$$

Using (13) we conclude

$$\frac{u' x_t^{(0)}}{v' x_t^{(0)}} \;\geq\; g_{t-1}^{F_1}.$$

Under condition 12, adding mass in the young group also raises the ratio relative to a worker-start cohort. Therefore, the baseline ratio is bounded below by that of a pure worker-start cohort at the same horizon:

$$\frac{u' x_t^{(0)}}{v' x_t^{(0)}} \;\geq\; g_t^{F_1} \;\geq\; g_{t-1}^{F_1}.$$

Conclusion. Combining the bounds from Steps 1–3 gives

$$\frac{u' x_t^{(0)}}{v' x_t^{(0)}} \;\geq\; g_{t-1}^{F_1} \;>\; \frac{u' z_t}{v' z_t}.$$

Thus inequality ($\star$) holds, so $\frac{d}{dM}D_t(M) < 0$. Since $D_t(M)$ is a ratio of affine functions in M with negative slope, it is also strictly convex, i.e. $\frac{d^2}{dM^2}D_t(M) > 0$. $\square$

A.1.4 Proof of Corollary 1

For $t < T^*$, we are in the constant-inflow case of Proposition 1.

For $t \geq T^*$, we have:

$$x_t = A^t x_0 + M \sum_{s=1}^{T^*} A^{t-s} v = x_t^{(0)} + M z_t^{(T^*)},$$

with $z_t^{(T^*)} \equiv \sum_{k=t-T^*}^{t-1} A^k v$. It follows

$$D_t(M) = \frac{u' x_t^{(0)} + u' z_t M}{v' x_t^{(0)} + v' z_t M},$$

with the same definitions of $u' x_t^{(0)}, u' z_t, v' x_t^{(0)}, v' z_t$ but using $z_t^{(T^*)}$. As in Proposition 1, $z_t^{(T^*)}$ is a positive combination of younger cohort profiles than the baseline $x_t^{(0)}$, so $\frac{u' z_t}{v' z_t} < \frac{u' x_t^{(0)}}{v' x_t^{(0)}}$ and $D_t(M)$ is strictly decreasing and convex in M for each finite t.

Since $M_t = 0$ after T^*, the system follows $x_t = A x_{t-1}$ with $f < \pi_o$, hence $x_t \to 0$ and $D_t \to D_\infty^{\text{ext}}$ by Lemma 1. Moreover,

$$\frac{u' z_t}{v' z_t} \to D_\infty^{\text{ext}}, \qquad \frac{u' x_t^{(0)}}{v' x_t^{(0)}} \to D_\infty^{\text{ext}},$$

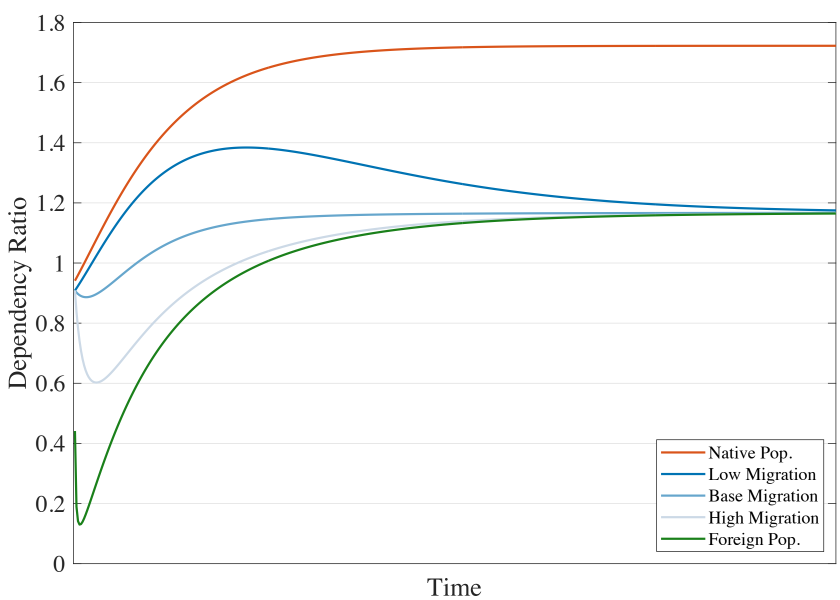
so the slope and curvature of $D_t(M)$ tend to zero as t grows (attenuation).

A.2 Simulation Results

We provide an example of these dynamics by simulating the model. The calibration does not intend to reproduce any specific country but reflects the facts, observed in most European countries, that the fertility rate of the native adults is below replacement, while that of the foreign adults is above.[33] We set the initial values of the age group shares to match the shares observed in the EA in 2021, such that the initial dependency ratio is 65%.

We examine the transition of the dependency ratio under three intensities of immigration: low, medium and high. Figure 8 plots the dependency ratio along the transition for the different scenarios.

Figure 8: Dependency Ratio Along the Demographic Transition



Note: The dependency ratio is the quotient between the young and old population over the adult population. This Figure plots this ratio of the native population (red), foreign population (green) and of the total population for different immigration intensities (shades of blue).

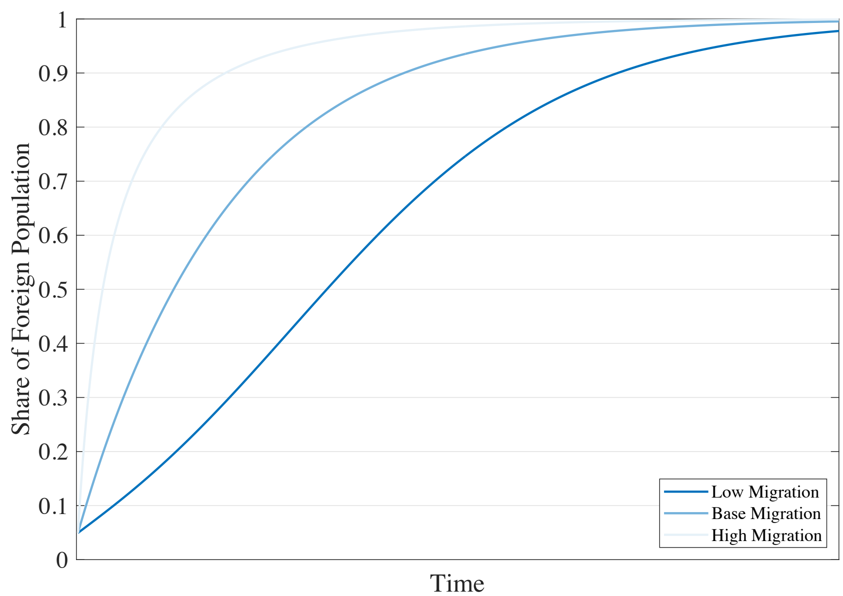
Figure 8 illustrates, first, the stable population results described above. Regardless of the intensity of immigration flows, the long-run dependency ratio of the population converges to that of the Foreign group. Without immigration, then the long-run dependency ratio would be equal to that of the native group which is substantially higher.

We now look at the transition from an initial population where the initial dependency ratio is below its steady-state level, as in the data. We also plot the share of foreign population over time

[33]This is the pattern observed in the most recent data for Europe.

in the projection, in Figure 9. The overall picture can be interpreted as follows. As the share of immigrants increases over time, the dependency ratio becomes closer to the immigrant group's and farther from the native group. At low levels of immigration, the population dependency ratio first follows similar dynamics to the native group, as the share of immigrants is low for several periods. With higher levels of immigration, instead the share of immigrants quickly rises and, as such, the dependency ratio of the population quickly jumps to the transition path of the immigrant group. Figure 8 also shows that, for any given period, the share of immigrants increases non-linearly with the intensity of immigration flows, as it is converging to 1.

Figure 9: Dependency Ratio Along the Demographic Transition



Note: The dependency ratio is the quotient between the young and old population over the adult population. This Figure plots this ratio of the native population (red), foreign population (green) and of the total population for different immigration intensities (shades of blue).

In summary, our simple demographic model has two implications for the impact of the immigration flow on the population age distribution. First, the size of immigration flow does not have an impact on the stationary population age distribution, except in the knife-edge case of zero migration. Second, increasing immigration flows improves the dependency ratio along the transition, but at a decreasing rate.

B Methodological Details

B.1 Additional Adjustments to Tax and Benefit Macro Values

B.1.1 Cyclically-neutral Fiscal Aggregates

Our methodology implies choosing a base year, $\bar{t}$, from which the demographic and macroeconomic assumptions operate in order to project the demographic profiles over time to compute the counterfactual government budget. Therefore, the results may depend on this choice as, when we project from $\bar{t}$ onward, we are implicitly carrying the business cycle position of the base year. In order to clean the long-term projections from the initial business-cycle position, there are three solutions that the literature has been using.

A first approach is choosing a base year where GDP is close to the potential GDP. This approach is used in Franco et al. (2020) where 2017 is picked as the base year which, according to the AMECO database, is the year in the last decade where the output gap was closer to 0 in Portugal (the country the authors study). A second approach that is used in Feist et al. (1999) consists in departing from the most contemporaneous period and making ad hoc adjustments along the projection to what is considered a cyclically-neutral state. In this paper, we use a third approach that computes cyclical-neutral fiscal aggregates for the base year.

The idea is to compute the budget item's level that would be observed if the economy in period $\bar{t}$ was at full employment and carry those values on the subsequent steps of the methodology. This way, we obtain cyclical-neutral fiscal aggregates. This is similar to what is done in Bonin et al. (2014) based on the work by Girouard and André (2006). In order to compute the cyclical-neutral item i ,$\left(T^i_{\bar{t}}\right)^*$, consider the following relationship:

$$\frac{\left(T^i_{\bar{t}}\right)^*}{T^i_{\bar{t}}} = \left(\frac{Y^*_{\bar{t}}}{Y_{\bar{t}}}\right)^{\varepsilon_{i,Y}},$$

where $T^i_{\bar{t}}$ is the observed value of the revenue item i in the base year, $Y^*_{\bar{t}}$ is the potential GDP of the year $\bar{t}$, $Y_{\bar{t}}$ is the observed value of GDP in year $\bar{t}$ and $\varepsilon_{i,Y}$ is the elasticity of revenue category i with respect to the output gap. We compute the cyclical-adjusted value of 4 out of the 5 revenue budget items: PIT, CIT, VAT, and SS contributions. For the expenditure items we only consider the unemployment benefits item, which observes the same relationship, mutatis mutandis. The other budget items are less subject to business cycle fluctuations. In Table 8 we describe the sources of the elasticities numbers that we use, as well as the source of the potential GDP.

B.1.2 Clemens (2022) Adjustment for Capital Income Taxes

Standard partial-equilibrium fiscal accounting omits an important channel: when a firm hires an immigrant, profit maximization requires the firm to also employ additional capital. This additional capital generates capital income—and hence additional tax revenue—which is omitted when only the labor income taxes are considered. Following Clemens (2022) we adjust our estimates by including a conservative measure of the capital income taxes induced by immigrant employment.

For each country, we adjust the baseline revenue per capita attributed to new immigrants, i.e. additional immigrants entering the population after the base year 2019, by a component given by the following expression for demographic group x:

$$\Delta\tau_x^{\kappa} = \left(\tau_x^{PIT} + \tau_x^{SS}\right) \times \left(\frac{\mathcal{T}^{\kappa}}{\mathcal{T}^{L}_{k(x)}}\right) \times \frac{\alpha}{1-\alpha} \times \omega,$$

where $\mathcal{T}^{\kappa}$ denotes the tax wedge on capital income and $\mathcal{T}^{\mathcal{L}}$ on labor income (for education level k) respectively, α is the aggregate capital share of income, and ω is the share of capital owned by natives. The adjustment is performed at the country level. Data for ${\mathcal{T}^{\mathcal{L}}}_k$ are obtained from the OECD Taxing Wages 2024 report[34], while data for $\mathcal{T}^{\kappa}$ come from the Taxation Trends in Europe 2020 report by the European Commission. α, the capital share of income, is calculated as one minus the labor share of income, computed from Eurostat national accounts for the same year, as the ratio of total compensation of employees (wages and salaries plus employers' social contributions) to gross value added in each country.

We also introduce a scaling factor due to the differences in the firm and property ownership between natives and immigrants. The fraction of corporate shares owned by immigrants is smaller than natives, thus it would be unreasonable for both groups to have the same corporate income tax demographic profile. We introduce an adjustment that takes into account these differences in the firm ownership rates that in practice allocates the burden of CIT mostly to the native group.

B.2 The AGK Imbalance Factor

While θ_τ is our preferred metric in order to the intertemporal government budget constraint (IGBC) holds, for comparability with other studies that use the generational accounting methodology, we also compute the AGK Imbalance Factor used in the GA literature. In this Appendix, we provide the formula using our notation. This metric was initially developed in the seminal work of Auerbach et al. (1991) and it corresponds to the percentage difference in net tax payments of future generations (those born after the base year) and the net tax payments of current generations. It can be interpreted as how much the government would need to increase taxes to the future generations in order to the IGBC hold. It is given by

$$\theta_\tau^{AGK} = \frac{\sum_{s=0}^{J}\sum_i\sum_{a=s}^{J}\sum_{g,k,c} D^s\left(g^i_{\bar{t},a,g,k,c} - \tau^i_{\bar{t},a,g,k,c}\right)P_{\bar{t}+s,a,g,k,c} + \sum_{s=1}^{\infty}\sum_i\sum_{a=0}^{min\{s,J\}}\sum_{g,k,c} D^s g^i_{\bar{t},a,g,k,c}P_{\bar{t}+s,a,g,k,c} + B_{\bar{t}-1}}{\sum_{s=1}^{\infty}\sum_i\sum_{a=0}^{min\{s,J\}}\sum_{g,k,c} D^s \tau^i_{\bar{t},a,g,k,c}P_{\bar{t}+s,a,g,k,c}} - 1.$$

[34] The database provides labor tax wedges for three income groups: 2/3 of the average income, average income level, and 2/3 above average. We attribute these, respectively, to primary, secondary and tertiary level of education workers.

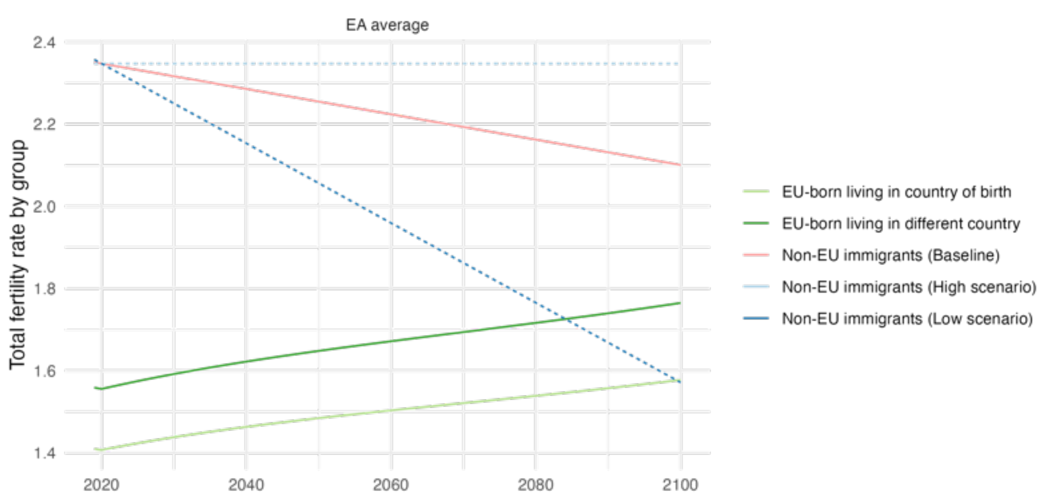
B.3 Building Population Projections

For the most part, we take inputs from EUROPOP2019 (such as mortality or fertility rates by age) and combine these with additional data and assumptions to build customized demographic projections for the population of each country by age, gender, education, and birthplace for 2019-2100. After 2100 we assume a fully stationary population.

Fertility and Mortality The mortality rate used is the same across education level and country of birth and only differs by age and gender.[35] We abstract from differences that could imply different life expectancy and mortality rates between EU-born and non-EU-born, or educational backgrounds.

Regarding fertility rates, we take data on live births by age and country of birth of the mother for the base year, 2019. Then, for the EU-born group, we use the growth of the fertility rate assumed in the EUROPOP2019 projections. This leads to an increasing linear convergence path until 2100, for all EA countries. For the non-EU-born group, we assume that it has a decreasing linear convergence path toward 2.1 by 2100. These fertility rates apply both to immigrants and their offspring. The time path of these total fertility rate assumptions is shown in Figure 10, which additionally shows the fertility rates used for the robustness check scenarios described in Appendix D.3.

Figure 10: Assumptions for the time path of fertility rates by country of birth group



Note: The plot shows the fertility rate path by country of birth group used in the demographic projections. The sourceof the EU-born population path is the Eurostat EUROPOP demographic projections. The Non-EU-born path is an assumption that we do and that and test for the sensibility of it with a high fertility scenario (where we assume it to be constant and equal to value observed in 2019) and a low fertility scenario (where we assume a linear convergent trajectory towards the projected value for natives in 2100).

[35] It corresponds to the mortality projected for each country in the central projection of EUROPOP2019 by age and gender with a small modification at the age of 100, where we set the survival probability to 0.

Net Migration and Country of Birth Net migration is set to be constant and equal to the 2019 values and age distribution in the baseline. For each age and gender, these are split by country of birth group according to the shares observed in 2019. We do the same for emigrants and then compute the net migration as the difference between both.

Education We also split the population by education level. Data on education and country of birth compositions by age group is available for 2019. We build a future path for the education distribution using the education shares observed by country of birth for the cohort aged 25 in 2019. This further relies on some assumptions for the projection: (i) for each individual, education does not fall or increase along the life cycle beyond age 25; (ii) all education paths are complete by that age; (iii) immigrants' offspring have the same education distribution as the natives.

These assumptions imply that, during the projection period, the education distribution converges to a stationary distribution. In that stationary state, the low-educated group share in the working-age population is smaller than in the base period and, conversely, the medium and high-education working-age population share is higher. Our education distribution projection can be seen as a conservative scenario since most peripheral EU countries observe an increasing share of population studying more. Because it is out of the scope of this paper to analyze the impact of different education distributions for public finances, we stick with our conservative projection on the education level evolution. Furthermore, significant changes to the education distribution have implications for productivity growth, with second-order effects on taxes and benefits possibly requiring a general equilibrium analysis.

B.4 Estimation of the Demographic Profiles

Taxes and Social Benefits The demographic profiles for all budget items except education and healthcare are estimated through Equation (7) using the EU-SILC and the EU-HBS, provided by the Eurostat, as well as the HFCS provided by the ECB. However, not all budget items and variables are available for all countries. Moreover, some countries have small samples that does not allow us to estimate for all demographic groups. Here we list the deviations we do for the different countries and budget items:

- The demographic profiles of Estonia, Latvia and Lithuania are joint estimated. Arguably, these countries share many common features that makes the benefits of increasing the statistical power of joining the countries outweigh the issues of losing this heterogeneity.
- For all countries, the profiles of the primary and the secondary education levels are joint estimated.
- Spain does not report the country of birth of the individuals. Hence, Spanish demographic profiles use the European average differences between countries of birth.

- The VAT demographic profile of Austria and the Netherlands do not have education differences

Education and Healthcare We derive an age profile of education spending based on Eurostat data that has the government spending by level of studies. We allocate the spending to the expected age that an individual attends each level of study according to the report by Motiejunaite-Schulmeister et al. (2022). We do not consider any heterogeneity in terms of gender, education, or country of birth.

Healthcare age-gender profiles are obtained directly from the data made available by the European Commission (2021). We use the EU average for all countries.

Proportional Adjustment to Match National Accounts The last step is to adjust the estimated profiles, using a proportionality rule, to match national accounts aggregates for the different budget components of interest. This allows our projection exercise to be consistent with the aggregate budget balance. Note this is not only necessary in those cases where we use the distribution of proxy variables to map taxes and benefits to demographic groups (e.g. household private equity holdings for mapping corporate income tax). This step is also necessary for variables that can be directly mapped in survey data, because the survey aggregate estimates are typically not consistent with the national accounts aggregates, either due to timing or due to limitations of the survey data.

C Additional Data Sources Details

Table 7: Microdata Sources

Tax/benefit	Source	Micro data variables used for distribution
PIT	EU-SILC	Income taxes (HY140G)
Property tax	HFCS	Real estate holdings (DA1400)
VAT	HBS	Total consumption (EUR_HE00)
CIT	HFCS	Business wealth (da1140 + da2104 + da2105)
Social Contributions	EU-SILC	Labor income (PY010G)
Disability pension	EU-SILC	Disability benefits (PY130G)
Old-age pension	EU-SILC	Old-age benefits (PY100G)
Sickness allowance	EU-SILC	Sickness benefits (PY120G)
Survivor pension	EU-SILC	Survivor benefits (PY110G)
Unemployment subsidy	EU-SILC	Unemployment benefits (PY090G)

Note: time samples used were the 2019 wave of EU-SILC, the 2015 wave for the HBS and wave 3 (2017) of the HFCS.

Table 8: Macrodata Sources

Aggregate	**Variable**	**Observations**
	Demographic data (from Eurostat)	
Population projections	proj_19n	
	Fiscal data (from Eurostat - gov_10a_ggfa data-set)	
Personal income	D51A	
Property	D29A	
Value-added	D211	
Corporate income	D51B	
SS contributions	D611+D612+ D613	
Disability pension	GF1001	Split according to the public accounting
Sickness allowance	GF1001	Split according to the public accounting
Old-age pension	GF1002	
Survivor pension	GF1003	
Unemployment subsidy	GF1005	
Education expenditure	GF09	Capital expenditure is uniformly distributed.
Health expenditure	GF07	Capital expenditure is uniformly distributed.
	Other macro variables	
GDP	Eurostat: CP_MEUR	
Potential GDP	AMECO: OVGDP	
Elasticities budget items	From Price et al. (2015)	
GDP deflator	Eurostat: PD15_EUR	
Net Gov. wealth	Eurostat: gov_10a	

D Robustness Tests

D.1 Macroeconomic Assumptions

Our methodology requires assuming a path for the future interest rate, i, and the productivity growth rate, γ. In order for the present discounted value of revenues and expenditures to be a finite number, we must have these parameters such that $D \in (-1, 1)$. Otherwise, the intertemporal budget constraint loses its meaning and the exercise becomes inconsistent. Within these bounds, we perform a sensitivity analysis under two different extreme scenarios: the first with the demographic profiles not growing in real terms, and the second the knife-edge case where the profiles growth rate is almost equal to the interest rate.[36] Table 9 shows the imbalance metrics for these two different scenarios. The θ_τ imbalance factor changes very little to different macroeconomic assumptions.

Furthermore, we see that our preferred metric has an advantage over the other two, due to its non-sensitivity to the macroeconomic assumptions. The discount factor affects both the revenues

[36] In practice, we set $i = \gamma - \varepsilon$, with $\varepsilon = 10^{-7}$.

and the expenditure, and hence the effects on θ_τ are very small – they are not zero because of the public debt value.

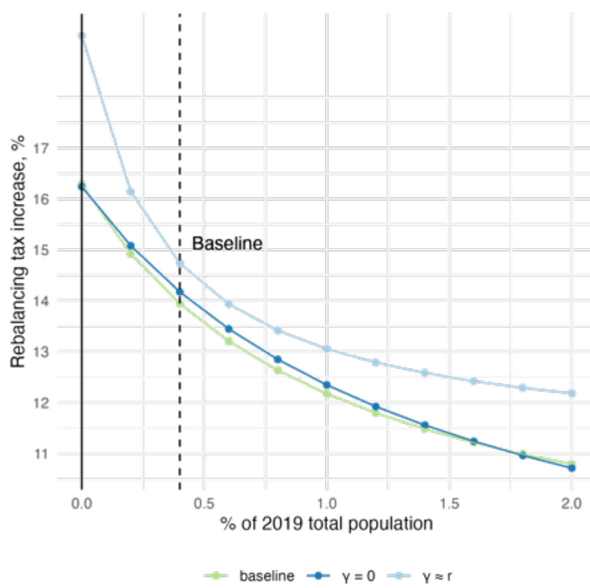
Table 9: Imbalance Metrics under Different Macroeconomic Assumptions

Macro Scenario	θ_τ	θ_τ^{AGK}
Baseline	14.0%	28.3%
$\gamma = 0$	14.2%	39.3%
$\gamma = r$	14.9%	14.9%

Note: The value of θ_τ reported corresponds to the weighted average of the rebalancing tax increase of each country computed according to Equation (6), weighted by the potential GDP of 2019 of each EA country. The other two metrics are also weighted averages of the country-specific metrics, using the 2019 potential GDP as weights and they are described in Appendix B.2.

To see that the macroeconomic hypotheses do not play a role in the increasing costs on public finances of reducing migration, we also recompute the frontier between the rebalancing tax increase and the immigration level. It follows from the fact that D has a minimal influence on θ_τ that it also does not affect the convex relationship between migration and the tax adjustment. In Figure 11 we plot the frontier between the immigration level and θ_τ for the different assumptions regarding the discount factor.

Figure 11: Frontier between the Level of Net Migration and the Imbalance Factor Implied for Different Values of the Discount Factor, D



Note: The figure shows the weighted average θ_τ across countries using the 2019 potential GDP as weights, for the different net migration scenarios. θ_τ is computed according to Equation (6), under different values for the discount factor, D. The dashed line is the baseline net migration value.

D.2 Immigrants Offspring Fertility

In the baseline scenario, we assume that the immigrants offspring fertility is equal to the fertility of the native population. In this robustness exercise, we show that the nonlinearity result does not depend on this assumption. For that we consider the case where the descendants of the immigrants keep the same fertility parameters as their parents. In Table 10 we report the imbalance metrics for the alternative offspring fertility assumption.

Table 10: Imbalance Metrics under Different Assumptions for Immigrants' Offspring Fertility

Offspring Fertility Scenario	θ_τ	θ_τ^{AGK}
Native (baseline)	14.0%	28.3%
1st generation	14.1%	27.5%

Note: The value of θ_τ reported corresponds to the weighted average of the rebalancing tax increase of each country computed according to Equation (6), weighted by the potential GDP of 2019 of each EA country. The other two metrics are also weighted averages of the country-specific metrics, using the 2019 potential GDP as weights and they are described in Appendix B.2.

The difference in the rebalancing tax increase between the two scenarios is 0.1 percentage points, and for the θ^{AGK} is 0.8 percentages points. This illustrates that our baseline results are robust to the immigrants offspring fertility rate hypothesis. Figure 12 shows the frontier between the level of immigration and the rebalancing tax increase. The convex relationship between the two remains under the alternative assumption.

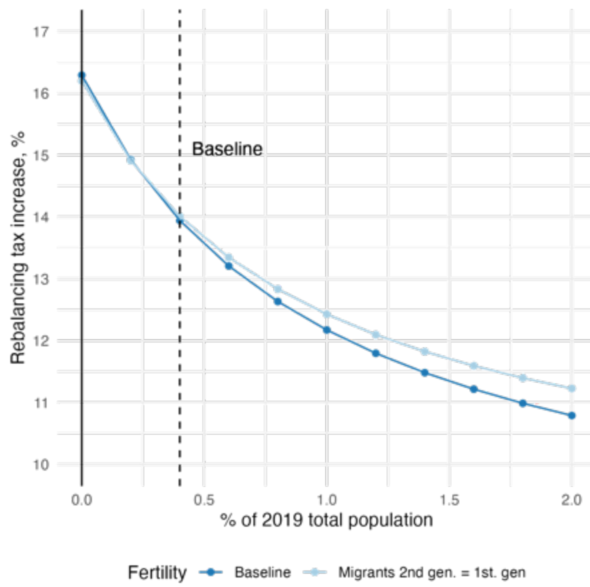
D.3 Immigrants Fertility

Generally, fertility rates are higher in developing countries. It is well known that this carries over to higher fertility in migrants. We also observe this demographic behavior in our data. The total fertility rate of residents born in non-EU countries is almost double that of the native population. We perform sensitivity exercises to check to what extent the impact of migration relies on the fertility of non-EU immigrants. We consider two cases:

1. High Fertility: Constant to the Base Year This amounts to keeping constant the fertility of non-EU-born immigrants coming to the Euro-area in 2019. This is an optimistic scenario, as it seems more plausible that fertility will decline over time: the data on fertility rates of developing countries shows they have been decreasing in the last decades.

2. Low Fertility: Convergent to the Natives' Value The second alternative scenario is a rather pessimistic one. We set the fertility rate of non-EU immigrants to converge towards 1.6 children per woman, the same as nationals are expected to have by 2100.

Figure 12: Frontier between the Level of Immigration and the Imbalance Factor under Different Assumptions for Immigrants' Offspring Fertility.



Note: The figure shows the weighted average θ_τ across countries using the 2019 potential GDP as weights, for the different net migration scenarios. θ_τ is computed according to Equation (6), scenarios of the non-EU born fertility rates. The dashed line is the baseline net migration value.

These scenarios are illustrated in the time path for the total fertility rate, shown in Figure 10 (see Appendix B.3).

We then, recompute the rebalancing tax increase. Table 11 shows this metric together with the θ_τ^{AGK} and the IBG. The differences are quite small across fertility scenarios. This is due to an increase in the costs related to education that is not offset by a larger working-age population in the long run.

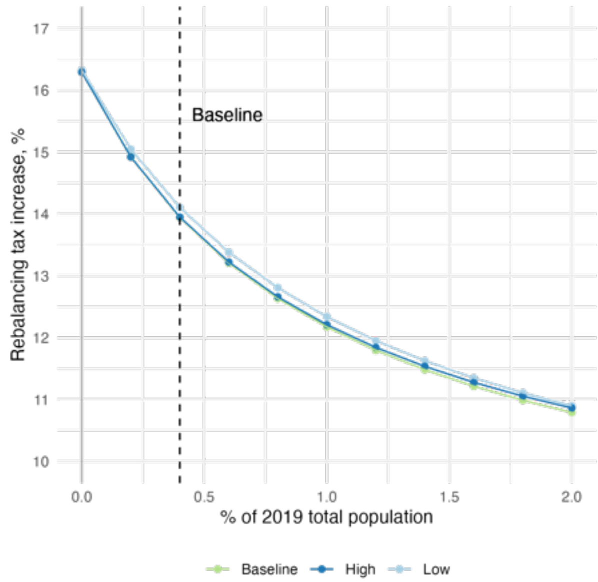
Table 11: Imbalance Metrics under Different Non-EU Immigrant Fertility Rates

Immigrants Fertility Scenario	θ_τ	θ_τ^{AKG}
Baseline	14.0%	28.3%
High fertility	13.6%	55.4%
Low fertility	14.2%	29.8%

Note: The value of θ_τ reported corresponds to the weighted average of the rebalancing tax increase of each country computed according to Equation (6), weighted by the potential GDP of 2019 of each EA country. The other two metrics are also weighted averages of the country-specific metrics, using the 2019 potential GDP as weights and they are described in Appendix B.2.

We then, change the net migration scenario for the two additional fertility hypotheses. Figure 13 plots the frontier between the level of migration and the imbalance factor for the different immigrants fertility hypothesis. The convex relationship between the two variables still hold, showing that our result is robust to this hypothesis, as well. Notoriously, the convexity of the frontier is higher for the cases when the fertility rate of immigrants is smaller. This happens because the education costs in the short run get amplified when there are more immigrants flowing into the EA.

Figure 13: Frontier between the Level of Immigration and the Imbalance Factor for Different Immigrants' Fertility Hypotheses.



Note: The figure shows the weighted average θ_τ across countries using the 2019 potential GDP as weights, for the different net migration scenarios. θ_τ is computed according to Equation (6), scenarios of the non-EU born fertility rates. The dashed line is the baseline net migration value.

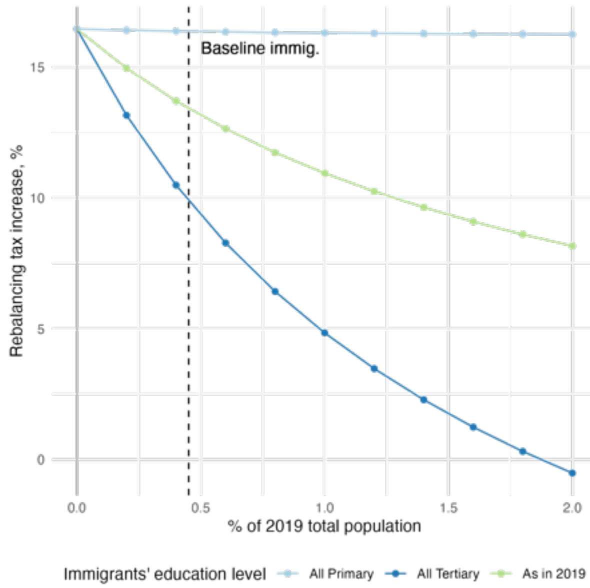
D.4 Immigrants Education Composition

In the baseline scenario, we assume that the education composition of new immigrants is constant and equal to the 2019 composition. In this appendix, we show that this hypothesis does not change our key result that the rebalancing tax increase have decreasing returns to immigration.

Figure 14 shows the frontier between the rebalancing tax increase and net migration for alternative, rather extreme, assumptions for the education composition of migration. The green line represents the baseline as in the main text, the light blue line represents the frontier if immigration consists only individuals with primary education, and the dark blue line represents the frontier when immigration consists only of individuals with higher (university) education.

In all three cases, the frontier has a negative and convex shape, as described above. Recall that this means immigration lowers the rebalancing tax increase but at a decreasing rate. However, the convexity changes with the education composition of immigration. In the case where immigration consists only of low-educated population, the frontier is almost flat, indicating that more immigration does not significantly affect θ_τ, consistent with a lifetime net contribution of working-age,

Figure 14: Frontier between the Level of Immigration and the Imbalance Factor for Different Immigrants' Education Composition Hypotheses.



Note: The figure shows the weighted average θ_τ across countries using the 2019 potential GDP as weights, for the different net migration scenarios. θ_τ is computed according to Equation (6) for different hypothesis about the education composition of immigrants. The dashed line is the baseline net migration value.

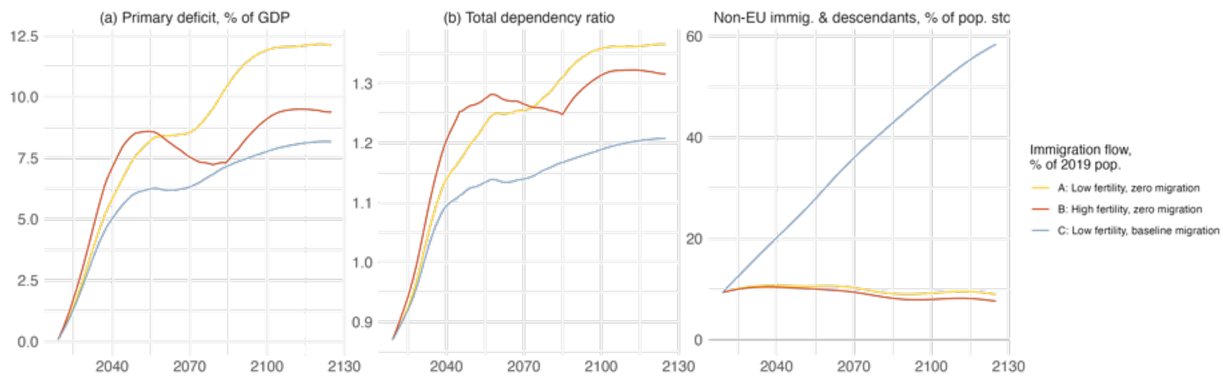
low-education immigrants close to zero. On the other hand, if immigration consists only of higher-educated individuals, the frontier between the size of immigration inflow and the rebalancing tax increase is steeper, with immigration bringing more positive effects for public finances.

Overall, these results highlight that, even with lower education levels than the resident population, non-EU immigrant flows can help relieve the fiscal burden of aging. The fiscal costs of building walls would be significant, and increasing, even if the education levels of non-EU immigrants were lower than at present.

E Additional Figures

E.1 Increasing the Native Fertility Rate

Figure 15: Primary Deficit and Demographic Dynamics under the Fertility Scenarios

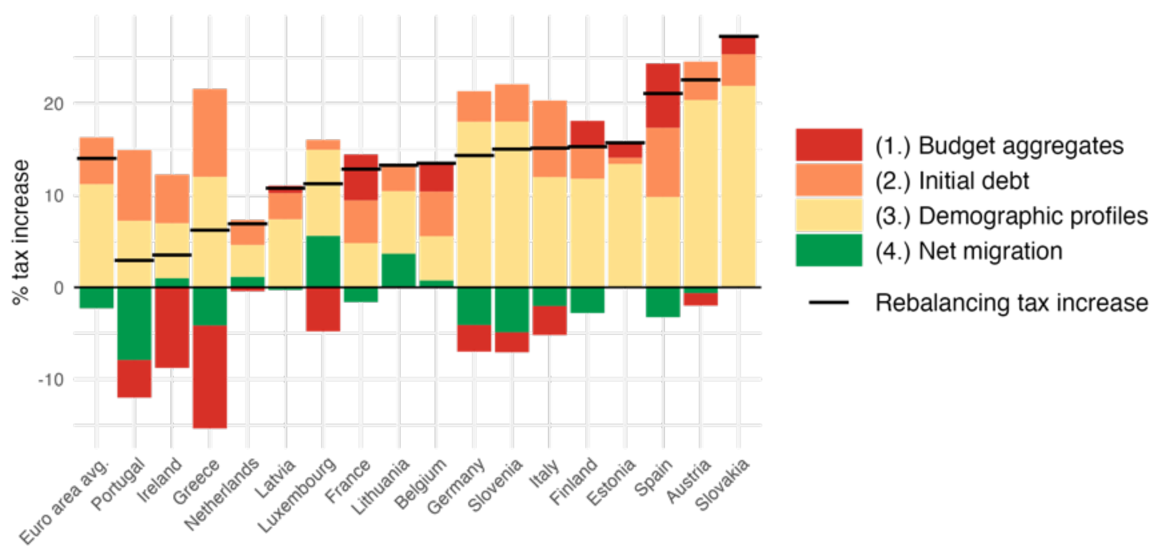


Note: Panel (a) shows the projected primary deficit as a percentage of the potential GDP for the scenarios with low (baseline) and high fertility, labeled as in Table 6. Panel (b) plots the age-dependency ratio (computed as the sum of the young and old populations divided by the working-age population) for these same scenarios. Panel (c) shows the share of non-EU born and descendants in the population stock for the same net migration scenarios. Recall that scenario C corresponds to the baseline scenario in the main exercise.

E.2 Country-specific Rebalancing Tax Increase Decomposition

To understand what is behind the observed differences across countries, we develop a decomposition of the rebalancing tax increase that allows calculating the contribution of the initial debt, the initial aggregate fiscal imbalance, the demographic structure of the budget and migration. For that, we recompute the rebalancing tax increase holding different components fixed. This yields the contribution of different factors to the metric. Figure 16 shows the results of this decomposition for each country and for the EA average. We proceed in four steps, leading up to the baseline θ_τ.

Figure 16: Decomposition of the Rebalancing Tax Increase for EA Countries



Note: The figure reports the rebalancing tax increase, θ_τ, for the different countries of the EA and the EA average (solid black line). It also shows the decomposition of this metric in four components: initial debt, budget aggregates, demographic profiles and net migration.

Recall the expression of the rebalancing tax increase

$$\sum_{s=0}^{\infty} \sum_{i} \sum_{x \in X} D^s \left[g^i_{\bar{t},x} - (1+\theta_\tau)\tau^i_{\bar{t},x} \right] P_{\bar{t}+s,x}\left(f, m, M\right) + B_{\bar{t}-1} = 0,$$

where we make explicit that population is a function of fertility, f, mortality, m, and net migration, M. We compute successive values of the rebalancing tax increase under different assumptions of the macro aggregates, profiles and population such that we get the contributions of the initial public debt, the initial primary balance, the demographic profiles, and net migration.

Define $\tau_{\bar{t}} \equiv \Sigma_i \Sigma_x \tau^i_{\bar{t},x}$ and likewise for g. Then, we obtain the following measures.

1. Contribution of initial debt. Set $g^*_{\bar{t}} = \tau_{\bar{t}}$, such that the budget is balanced.

$$\sum_{s=0}^{\infty} \sum_{x \in X} D^s \left[g^*_{\bar{t}} - (1+\theta^{debt})\tau_{\bar{t}} \right] P_{\bar{t},x}\left(f, m, 0\right) + B = 0$$

We start with uniform demographic profiles – all individuals pay the same net taxes –, a balanced initial primary budget, and net migration equal to zero. The only source of imbalances in the IGBC – Equation (5) – is the initial debt, as the revenue collected matches the expenditure done in the same year. The rebalancing tax increase, in this case, gives only the contribution of the initial debt stock, which is always positive – it is the permanent tax increase that would be necessary to sustain the public debt, even if the budget was balanced.

2. Contribution of the initial deficit.

$$\sum_{s=0}^{\infty} \sum_{x \in X} D^s \left[g_{\bar{t}} - (1 + \theta^{debt} + \theta^{fiscal}) \tau_{\bar{t}} \right] P_{\bar{t},x} \left(f, m, 0 \right) + B = 0$$

Second, we change the budget aggregates to the observed values in the base year, while keeping uniform demographic profiles. The rebalancing tax increase, in this case, covers the initial public debt stock and the initial primary balance repeated over time. By difference with the previous, we obtain the contribution of the budget aggregates, which for some countries is positive and others negative, depending if the primary balance in 2019 is a deficit or a surplus.

3. Contribution of the demographic profiles.

$$\sum_{s=0}^{\infty} \sum_{i} \sum_{x \in X} D^s \left[g^i_{\bar{t},x} - (1 + \theta^{debt} + \theta^{fiscal} + \theta^{dem}) \tau^i_{\bar{t},x} \right] P_{\bar{t}+s,x} \left(f, m, 0 \right) + B = 0$$

Third, we reintroduce the demographic profiles from the data, where different age or education groups pay different net taxes. Now, the change in the age structure of the population affects the budget balance over time. The change in the θ_τ metric from this step gives the impact of demographic change on the rebalancing tax increase. For all countries, the impact on θ_τ is always positive: the current structure of government budgets in Europe is not prepared for an aging society.

4. Contribution of the net migration flow.

$$\sum_{s=0}^{\infty} \sum_{i} \sum_{x \in X} D^s \left[g^i_{\bar{t},x} - (1 + \theta^{debt} + \theta^{fiscal} + \theta^{dem} + \theta^{M}) \tau^i_{\bar{t},x} \right] P_{\bar{t}+s,x} \left(f, m, M \right) + B = 0$$

Finally, we add the net migration flow, which changes population dynamics. This last step recovers the baseline θ_τ.

Analyzing the decomposition of the rebalancing tax increase in the EA, the budget aggregates contribution has a negligible impact on θ_τ, given the nearly balanced primary deficit registered in 2019. The initial public debt stock contributes 5.1 percentage points to the rebalancing tax, while the demographic composition of the budget accounts for 11.2 percentage points. Additionally, net migration has a positive effect, reducing θ_τ by to 2.2 percentage points, as shown before.

The Figure allows for cross-country comparisons of the contribution of each factor. For instance, France and Germany have very similar overall rebalancing tax increases, however, the root causes are different. The impact of demographic change is more favorable in France, but the initial budget balance position is much worse, contributing almost one-third of the value of θ_τ. Germany, on the other hand, has a favorable initial fiscal position, but a very unprepared demographic structure of the budget, considering the aging trends it will face.

E.3 Country-specific Lifetime Contributions

E.3.1 Expected Contribution at Age 30 for Natives and Migrants

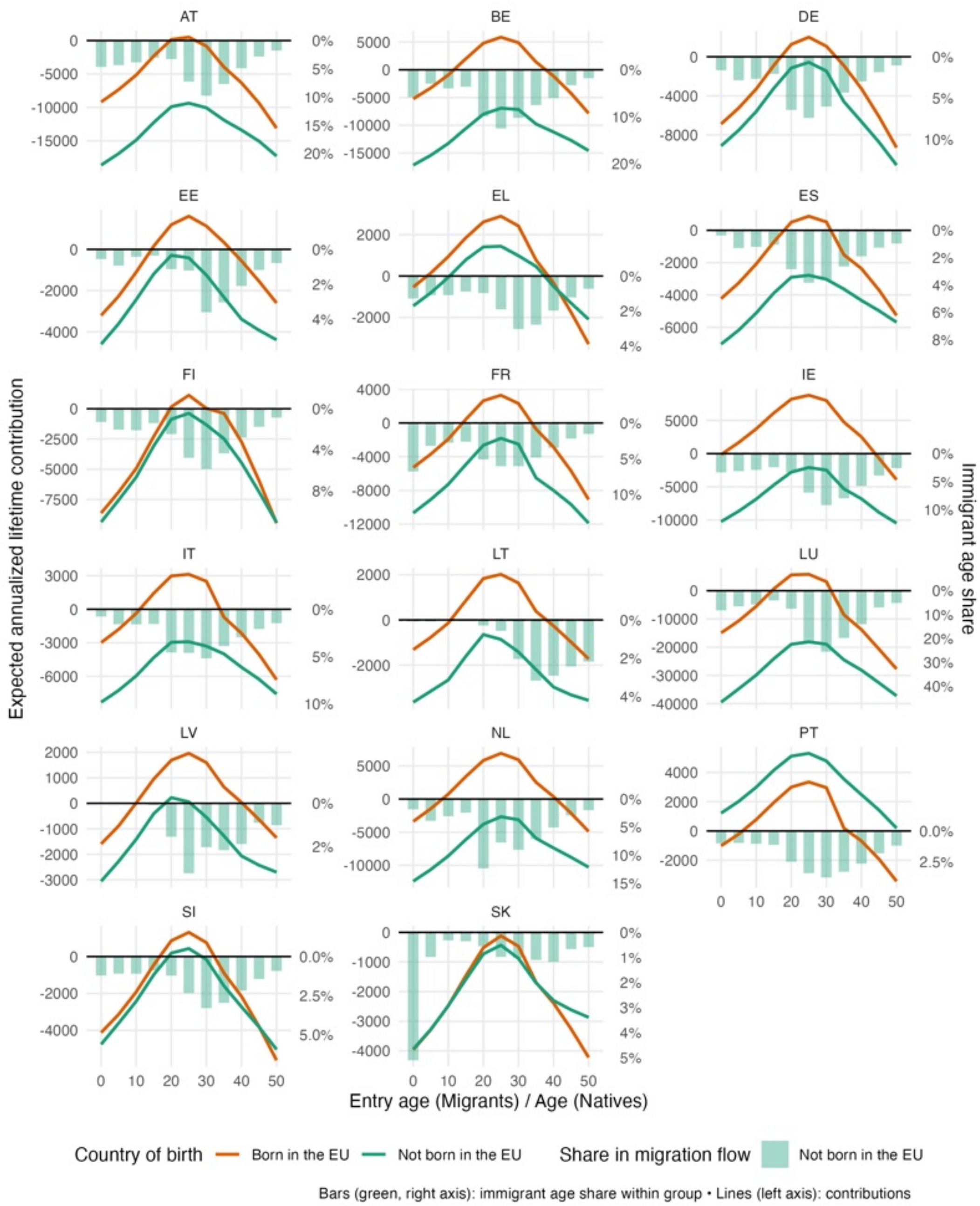
Table 12: Expected yearly lifetime contributions and tax increase for taxpayers aged 30 in 2019, by country

Country	CoB Group	Net Contribution	Tax payments	Tax increase by θ_τ		
				baseline	no migration	Diff.
AT	EU-born	-825	44619	10067	10343	-276
AT	Not EU-born	-10064	31276	7057	7250	-193
BE	EU-born	4883	45596	6156	5819	337
BE	Not EU-born	-7159	29975	4047	3826	222
DE	EU-born	1073	37037	5312	6828	-1515
DE	Not EU-born	-1462	31978	4587	5895	-1308
EE	EU-born	1129	15412	2428	2423	5
EE	Not EU-born	-1248	13119	2067	2062	4
EL	EU-born	2421	19149	1192	1986	-793
EL	Not EU-born	981	14339	893	1487	-594
ES	EU-born	517	24333	5136	5926	-790
ES	Not EU-born	-3027	16675	3519	4061	-541
FI	EU-born	32	44735	6852	8103	-1251
FI	Not EU-born	-1329	39245	6011	7109	-1098
FR	EU-born	2311	43177	5549	6243	-693
FR	Not EU-born	-2511	35810	4603	5178	-575
IE	EU-born	7997	44885	1573	1131	442
IE	Not EU-born	-2481	32674	1145	823	322
IT	EU-born	2499	32898	4978	5644	-666
IT	Not EU-born	-3300	22482	3402	3857	-455
LT	EU-born	1629	11712	1553	1125	428
LT	Not EU-born	-1417	9009	1195	865	329
LU	EU-born	3213	100285	11282	5676	5605
LU	Not EU-born	-18937	71989	8098	4075	4024
LV	EU-born	1596	11335	1220	1253	-33
LV	Not EU-born	-548	9322	1004	1031	-27
NL	EU-born	5931	43917	3033	2540	493
NL	Not EU-born	-3127	35649	2462	2062	400
PT	EU-born	2962	21489	631	2327	-1696
PT	Not EU-born	4785	20155	592	2183	-1591
SI	EU-born	754	19987	3003	3981	-978
SI	Not EU-born	-161	16856	2533	3358	-825
SK	EU-born	-470	12742	3478	3488	-10
SK	Not EU-born	-881	9958	2718	2726	-8

Note: Annuity values, in Euros per year. The table shows, for taxpayers aged 30 in 2019 in each country, by country of birth group, the average projected lifetime net contribution and tax payments, and, for the baseline and no-migration scenario, the additional payments corresponding to the rebalancing tax increase, along with their difference.

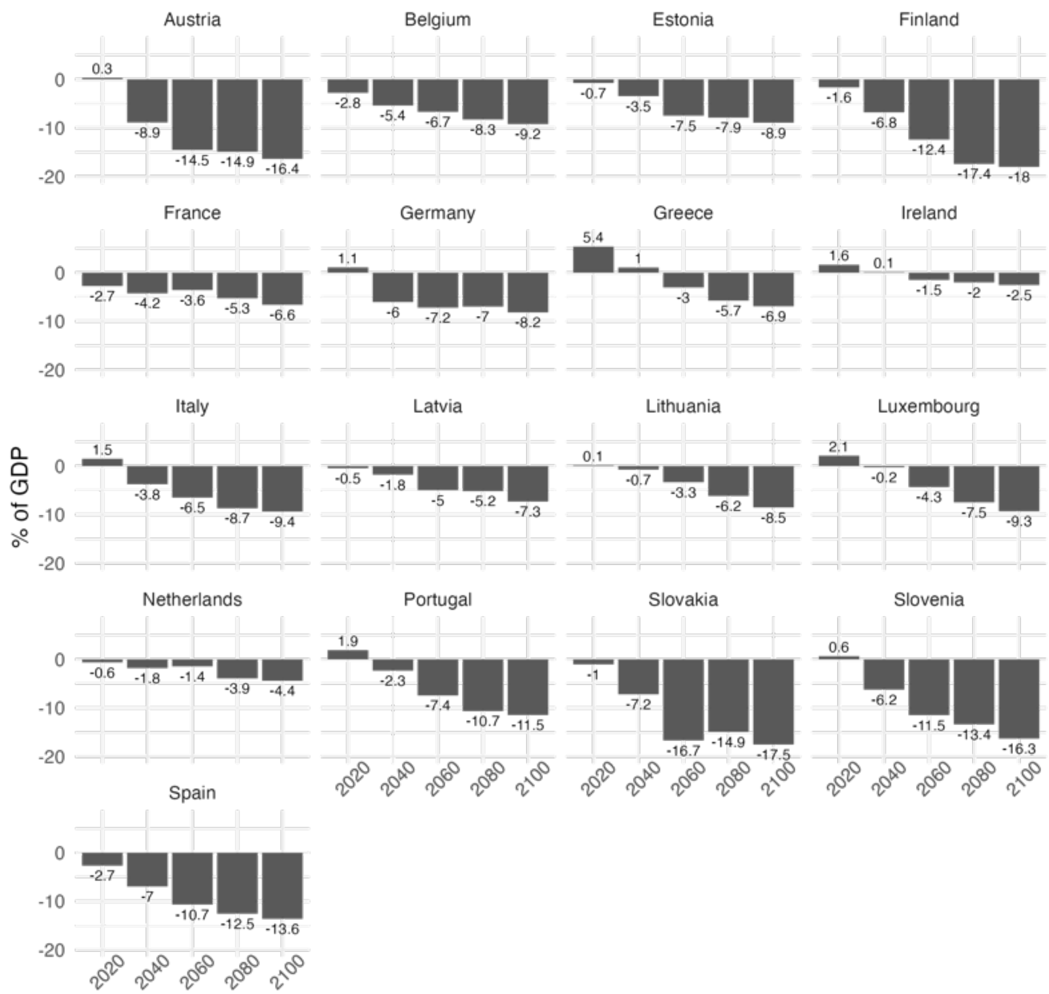
E.3.2 Expected Contribution at Different Ages and Age Structure of Migration Flow

Figure 17: Expected Annualized Lifetime Contribution by Age and Country of Birth, and Age Structure of Immigration, for the Different EA Countries



E.4 Country-specific Primary Balance

Figure 18: Counterfactual Primary Balance implied by the Population Projections for the Different EA Countries.

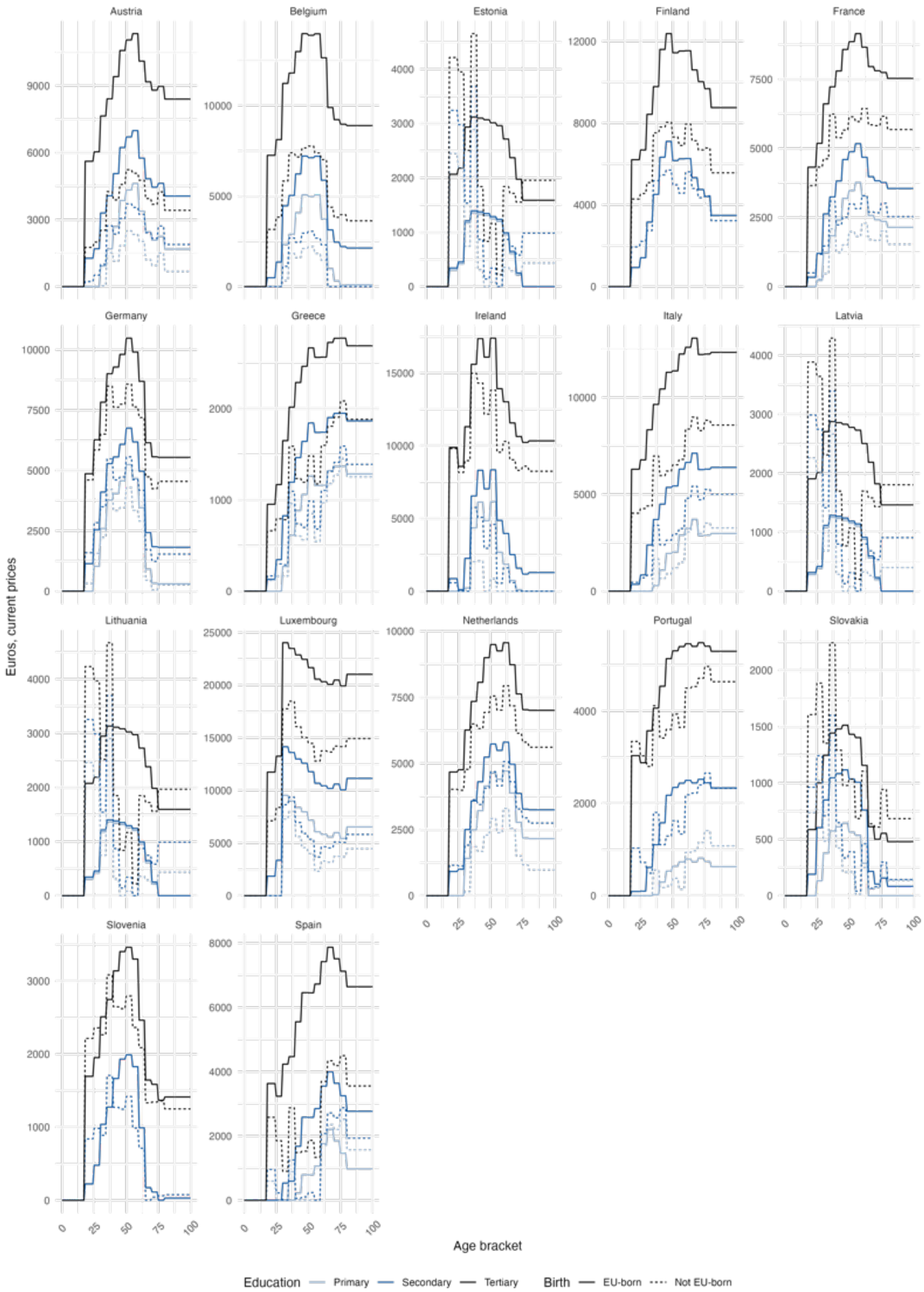


Note: The Figure shows the country-specific primary balance projection for selected years in percentage of the potential GDP.

E.5 Country-specific Estimations

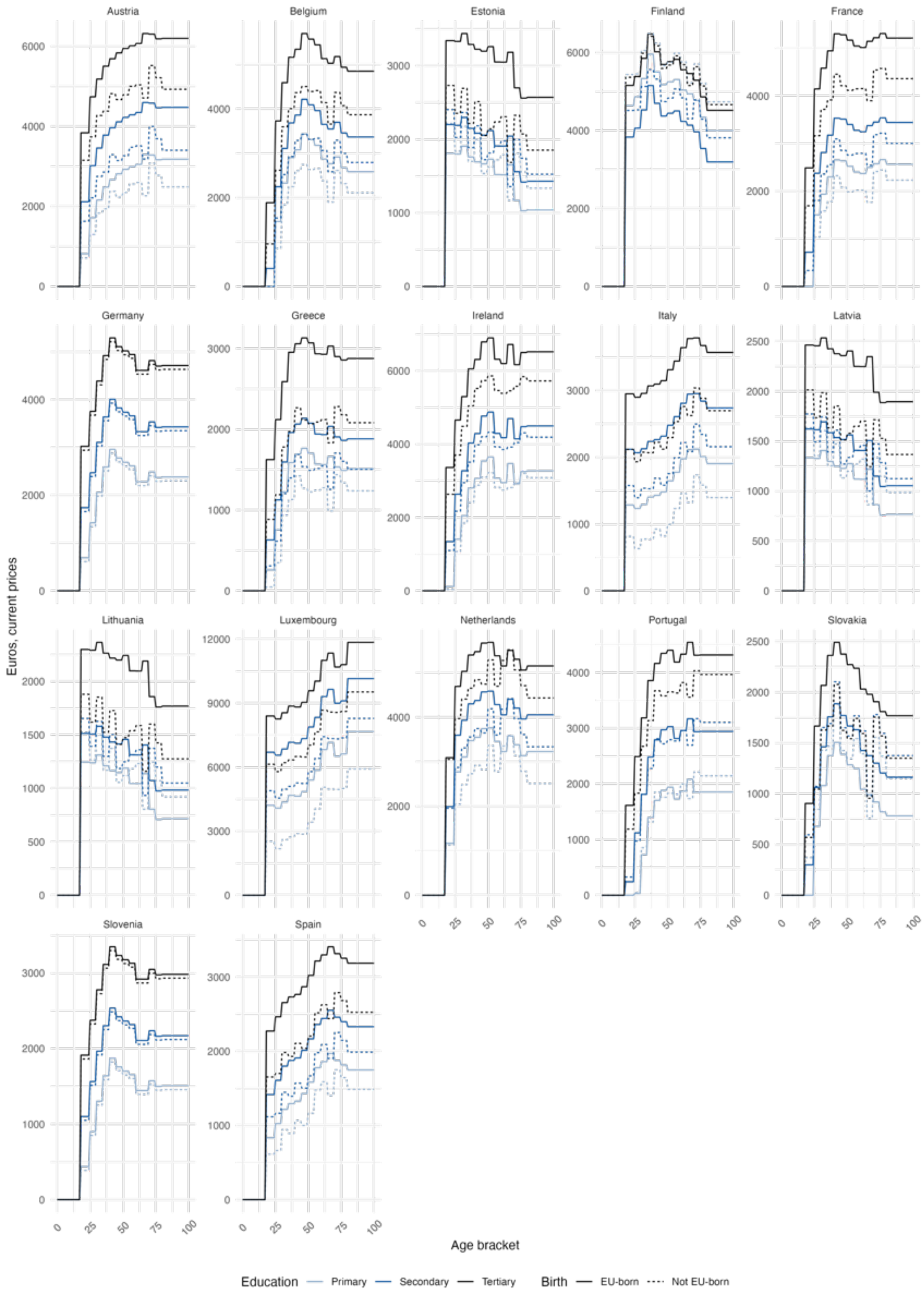
E.6 Other Figures

Figure 19: Demographic Profiles of Income Tax Payments



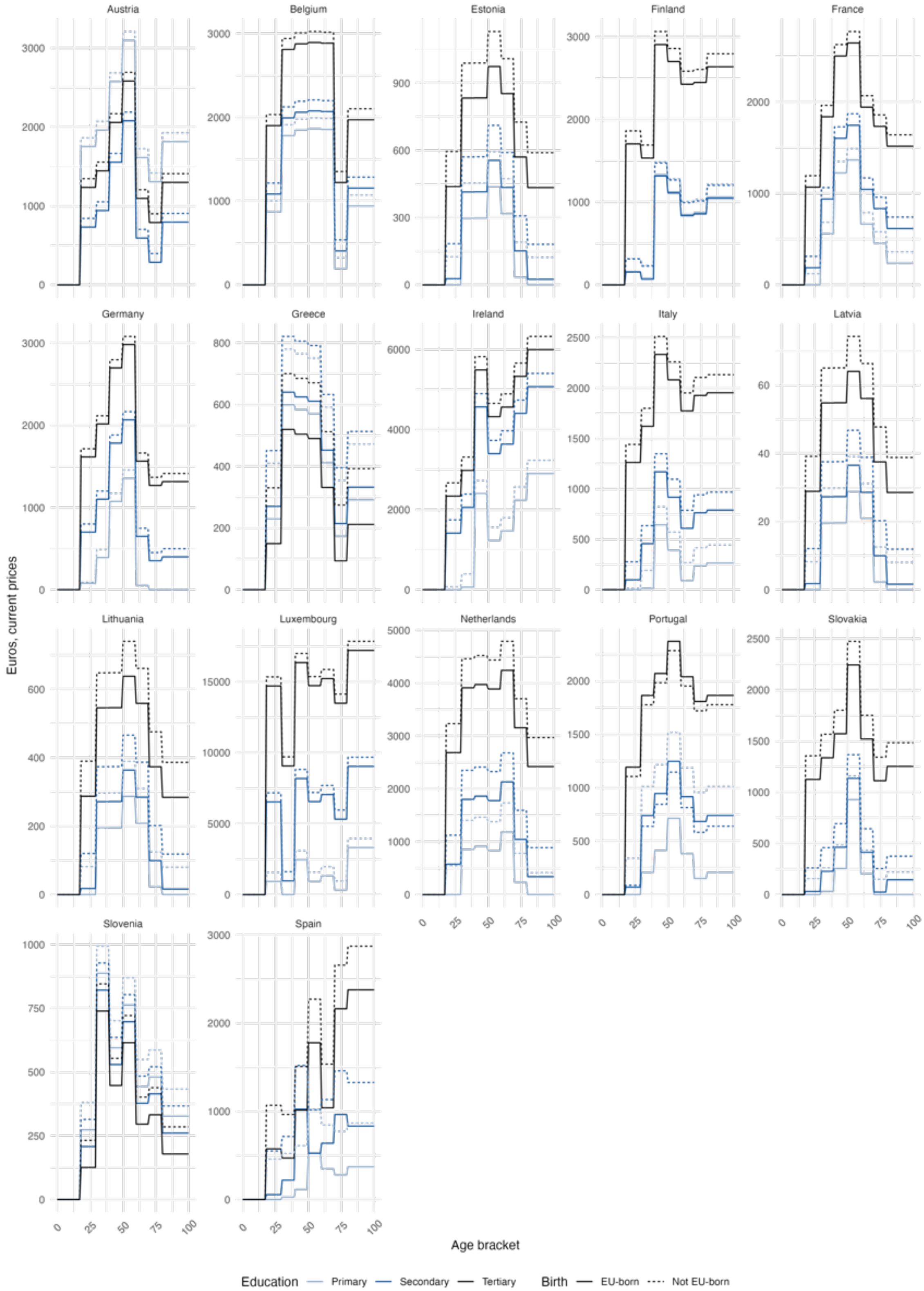
Note: Data from EU-SILC, 2019 wave on household-level income tax payments and Eurostat, assigned to household members in proportion to their respective share in the total household income. Data is plotted for each country, age-bracket, education level and country of birth.

Figure 20: Demographic Profiles of Consumption



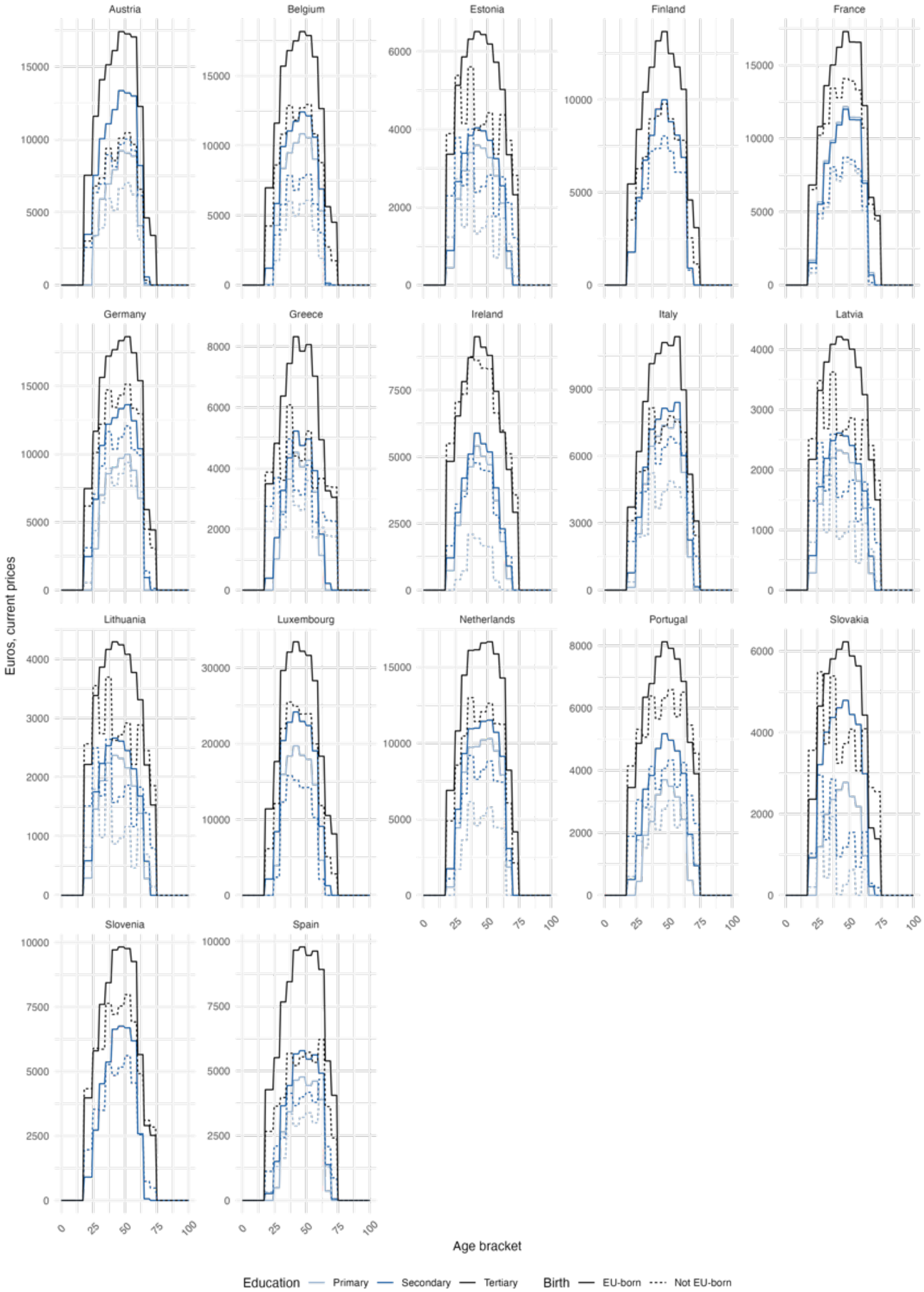
Note: Data from HBS, 2015 wave on household-level total consumption spending and Eurostat, assigned to household members in proportion to their respective share in the total household income. Data is plotted for each country, age-bracket, education level and country of birth.

Figure 21: Demographic Profiles of Business Wealth



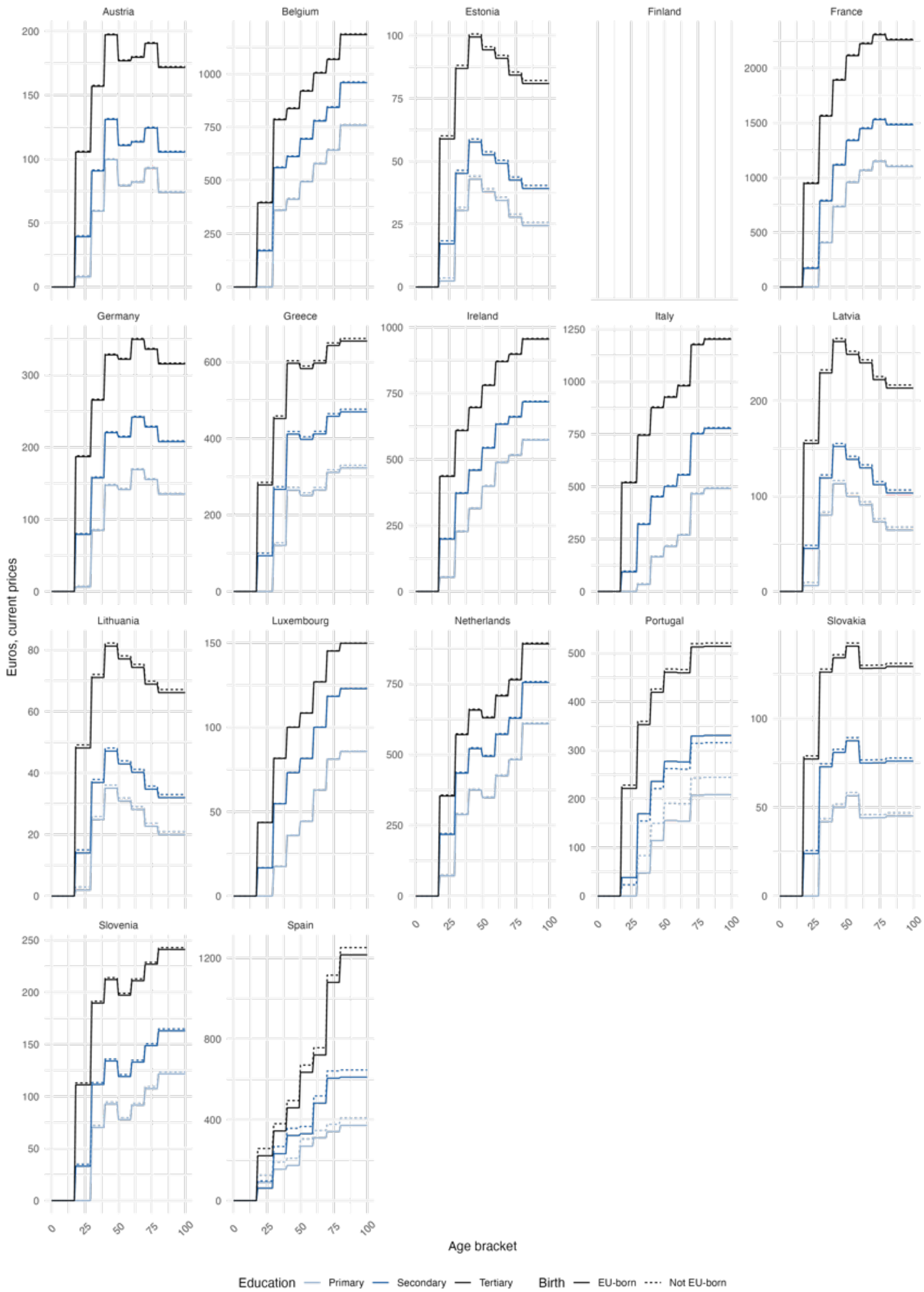
Note: Data from HFCS, 2017 wave on household-level business wealth holdings and Eurostat, equally split between adult household members. Data is plotted for each country, age-bracket, education level and country of birth.

Figure 22: Demographic Profiles of Labor Income



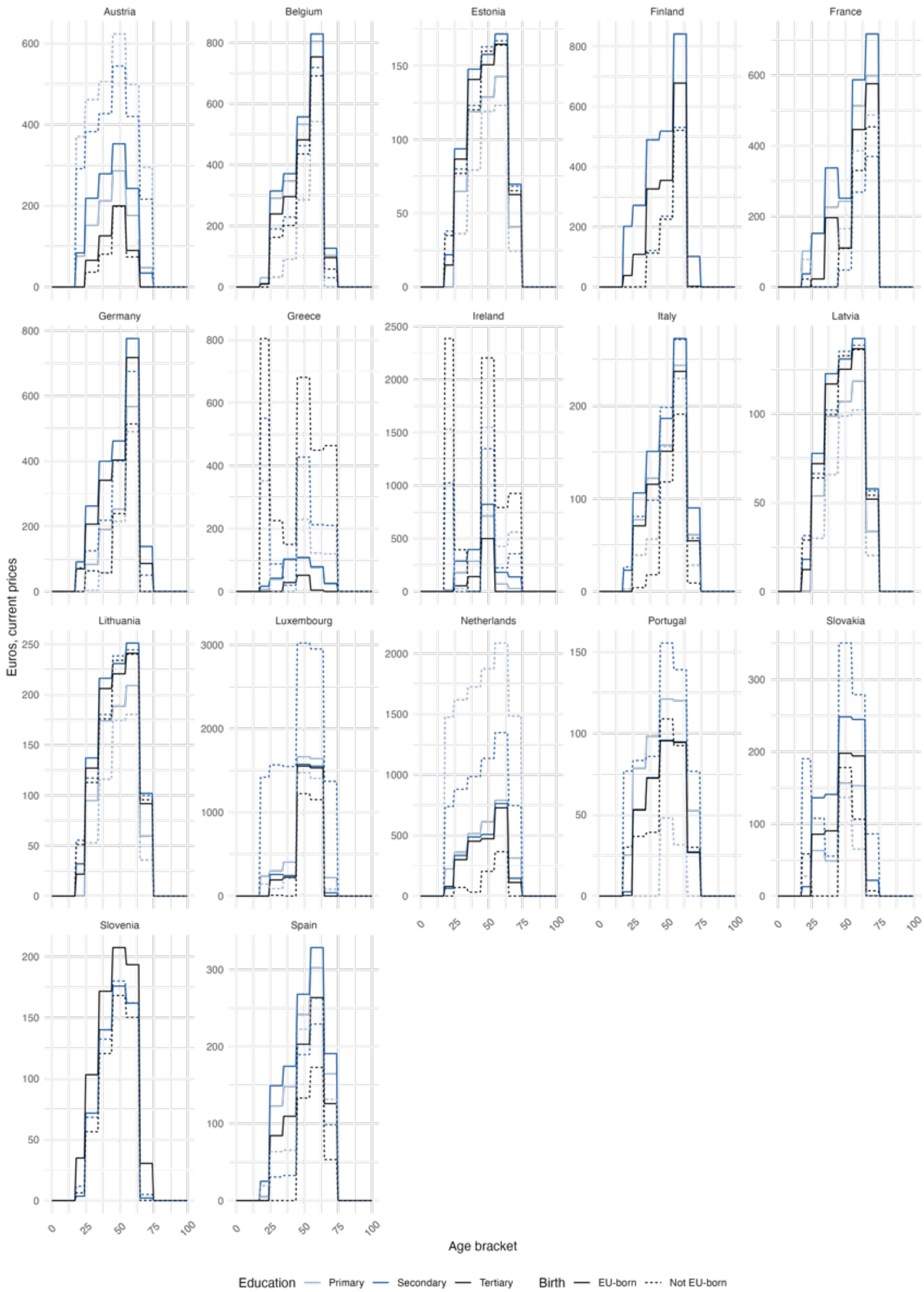
Note: Data from EU-SILC, 2019 wave on individual labor income and Eurostat. Data is plotted for each country, age-bracket, education level and country of birth.

Figure 23: Demographic Profiles of Wealth Taxes



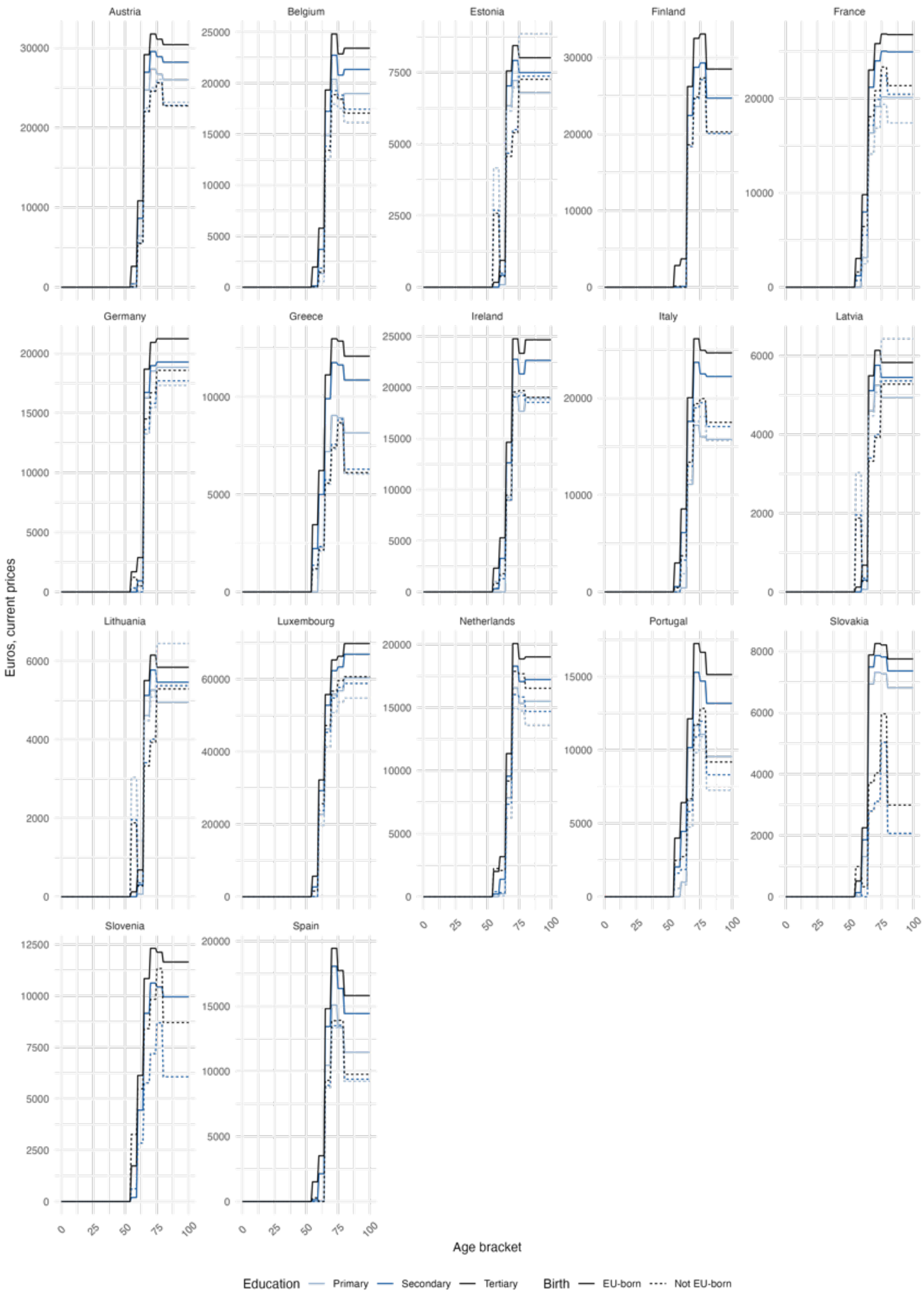
Note: Data from HFCS, 2017 wave on household-level real estate holdings and Eurostat, equally split between adult household members. Data is plotted for each country, age-bracket, education level and country of birth.

Figure 24: Age Profiles of Sickness Allowance



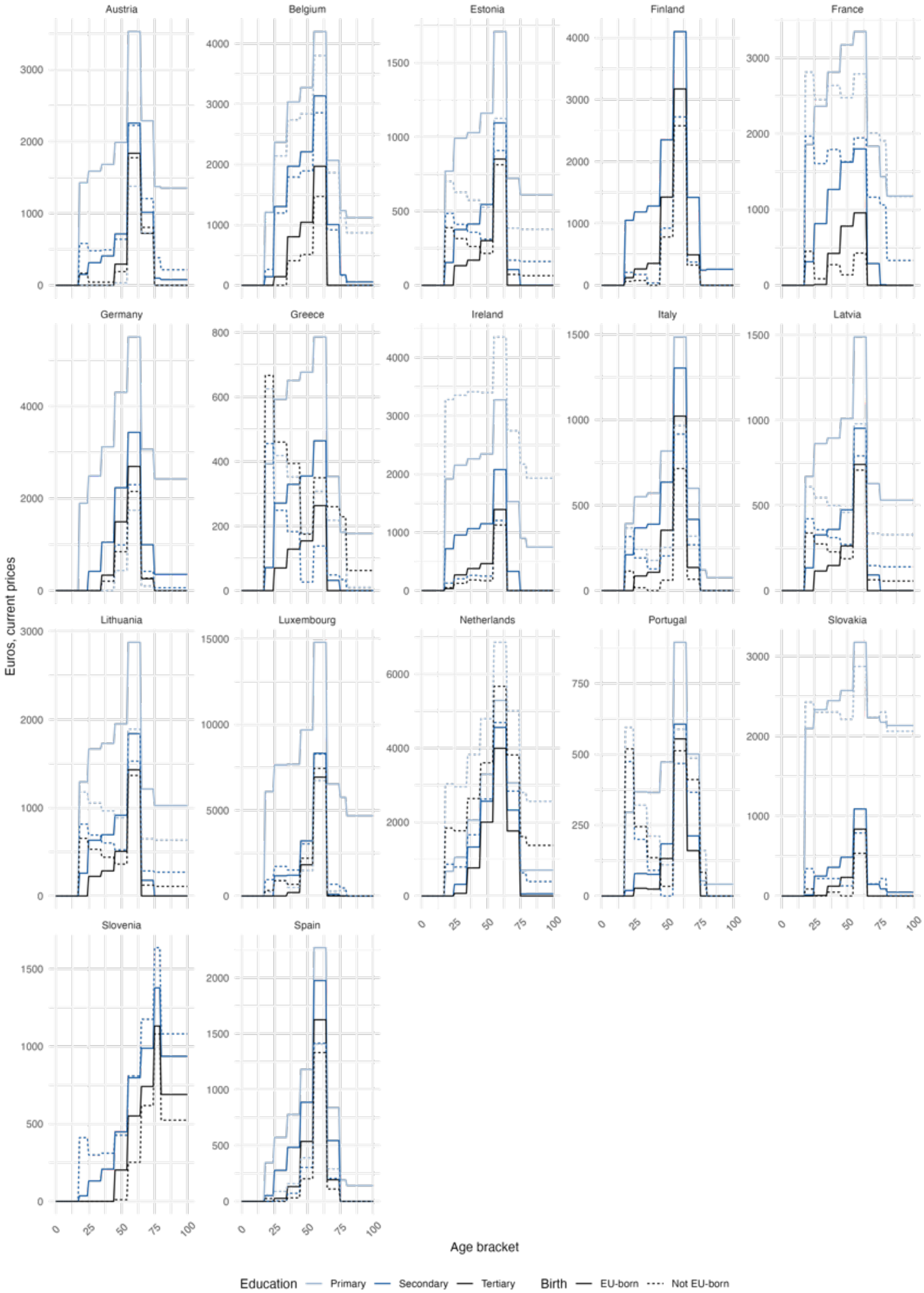
Note: Data from EU-SILC, 2019 wave on individual sickness benefits and Eurostat. Data is plotted for each country, age-bracket, education level and country of birth.

Figure 25: Demographic Profiles of Old-Age Pension



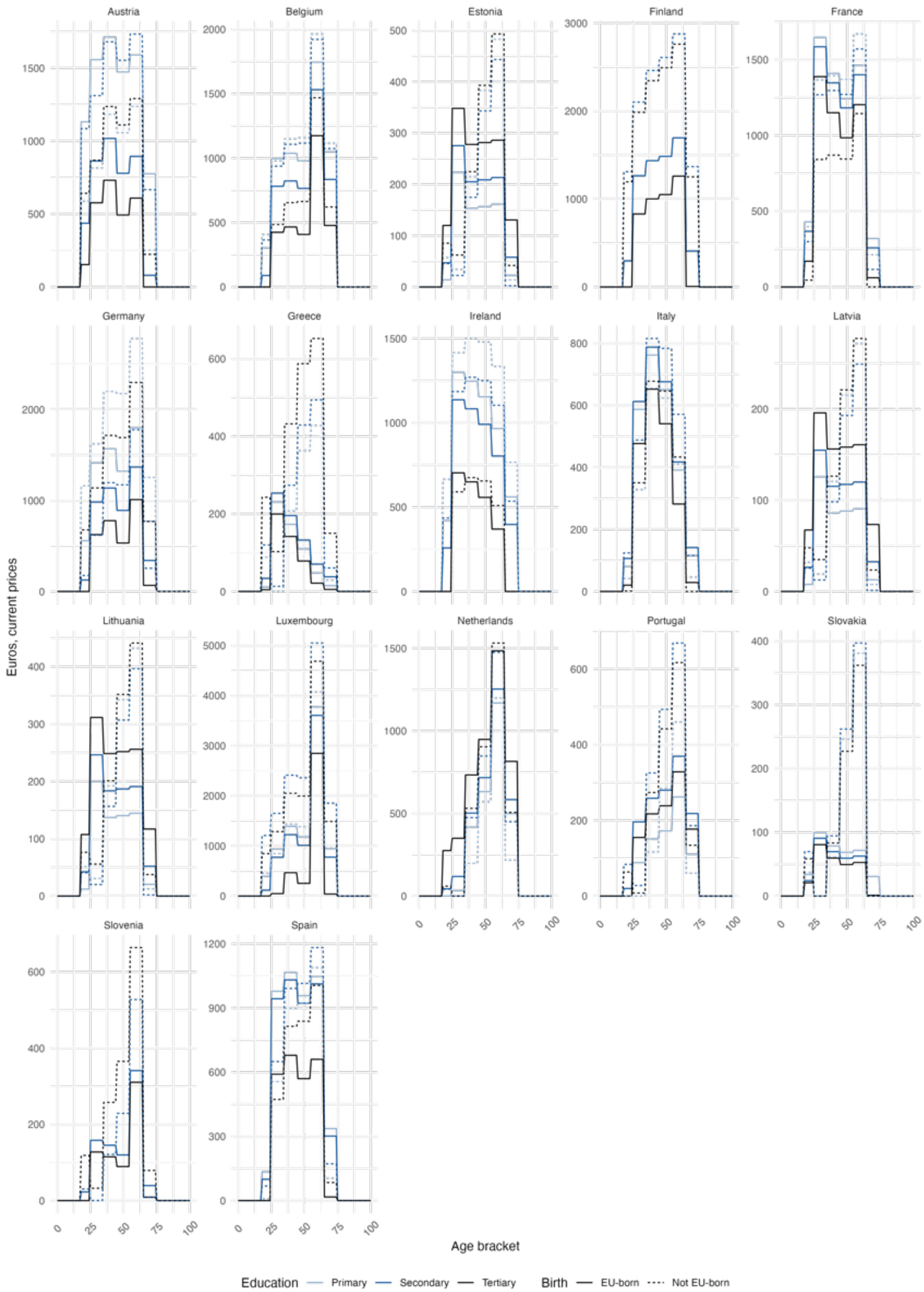
Note: Data from EU-SILC, 2019 wave on individual old-age benefits and Eurostat. Data is plotted for each country, age-bracket, education level and country of birth..

Figure 26: Demographic Profiles of Disability Benefits



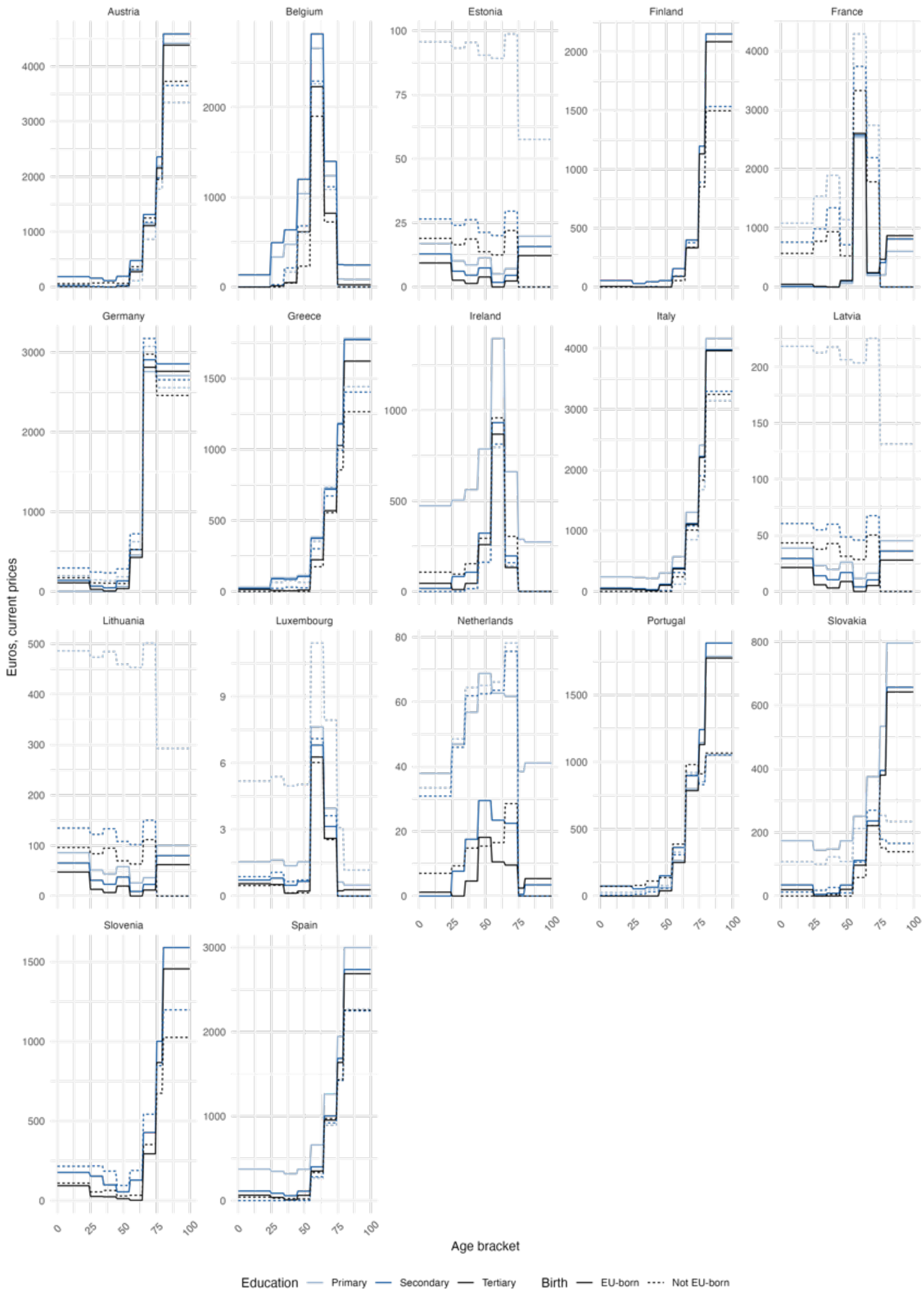
Note: Data from EU-SILC, 2019 wave on individual disability benefits and Eurostat.Data is plotted for each country, age-bracket, education level and country of birth..

Figure 27: Age Profiles of Unemployment Benefits



Note: Data from EU-SILC, 2019 wave on individual unemployment benefits and Eurostat.Data is plotted for each country, age-bracket, education level and country of birth..

Figure 28: Age Profiles of Survivor Pension



Note: Data from EU-SILC, 2019 wave on individual survivor benefits and Eurostat.Data is plotted for each country, age-bracket, education level and country of birth..

Figure 29: Demographic profile of revenues and expenditures per capita, by country

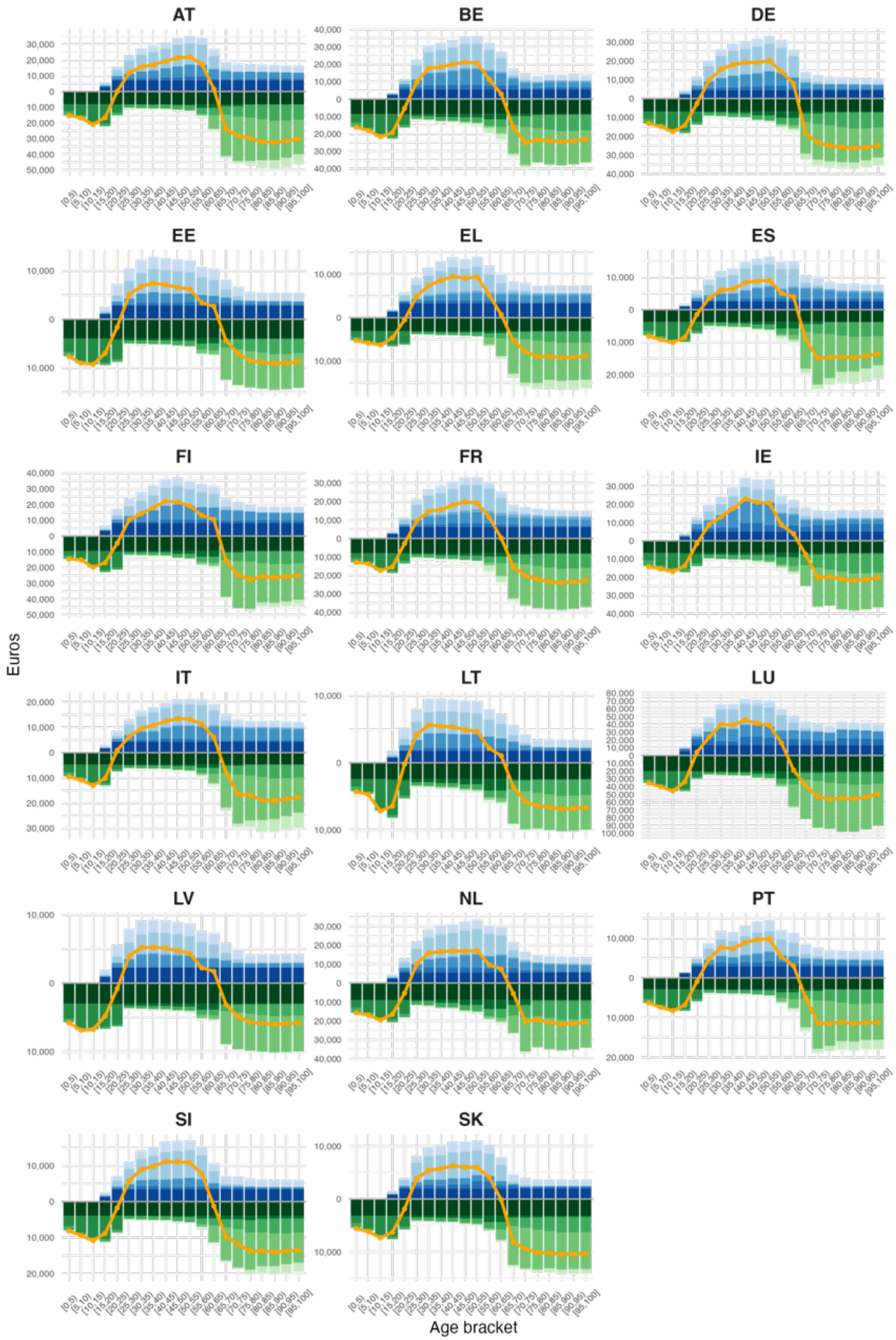


Figure 30: Mean age profile of revenues and expenditures per capita, by education level

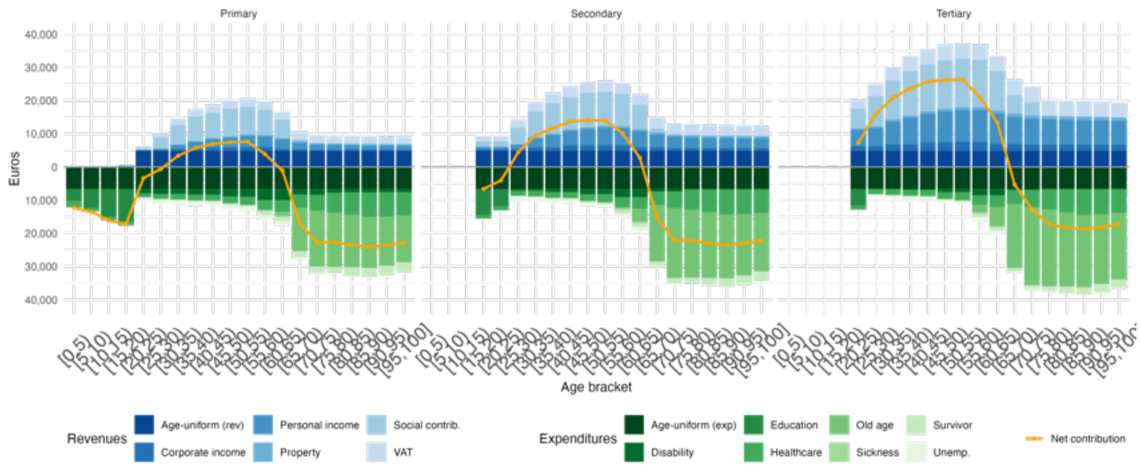


Figure 31: Counterfactual Primary Balance Implied by the Population Projections Decomposed by Gender and Education Level