Public Finances
An Intergenerational Perspective

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CALOUSTE GULBENKIAN
FOUNDATION

FUTURE FORUM

Final Report[1]

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PREFACE

The Gulbenkian Foundation, through the Future Forum, aims to contribute to the identification, study and discussion of the fundamental challenges of society's future. We aim to promote critical mass about these topics and to entail the reflection about today's public policies based on the challenges ahead.

With these objectives in mind, an initiative is being carried out to introduce Intergenerational Justice on the public agenda and to encourage the different public representatives to answer the intergenerational impact of public policies.

These are complex and ambitious objectives: on the one hand, because the focus is on covering the rights of people that, in many cases, are not yet born and, for this reason, still don't have a voice in the public space; on the other hand, because we attempt to counter what the Spanish political philosopher Daniel Innenarity named short-termism in public policies design, whose benefits are frequently dominated by the short-term interests.

One of the key elements of this initiative is a set of studies that aims to evaluate the impact of the different public policies among generations. That is the only way to measure all the costs and benefits of these public policies. This is particularly important in structural and long term areas with high impact on people's lives: housing, public finances, labour market and environment.

In this particular study – "Public Finances: An Intergenerational Perspective" – sustainability in public finances is seen has inseparable from resources sharing among generations: if public finances aren't sustainable, households in the future will be required to pay more taxes, receive lower benefits or enjoy less public goods and services.

We would like to thank the authors Francesco Franco, Tiago Bernardino and Luís Teles de Morais for the work done, as well as to Ricardo Reis and to all the experts that contributed with their comments and revisions.

We believe that the Intergenerational Justice initiative, along with Foresight Portugal 2030 and other projects in the pipeline, can provide an important contribution to the reflection on the great future challenges that the country faces and to the strategical options to address it on the long term.

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SUMMARY

Sustainable public finances matter for intergenerational fairness. If they are not sustainable, households in the future will be required to pay more taxes, receive lower benefits, or enjoy less public goods and services. At the same time, those taxes and benefits vary a lot over the life cycle.

Sustainable public finances matter for intergenerational fairness. If they are not sustainable, households in the future will be required to pay more taxes, receive lower benefits, or enjoy less public goods and services. At the same time, those taxes and benefits vary a lot over the life cycle.

This report explores the implications of ageing and low fertility for the sustainability of public finances in Portugal, and for monetary costs and benefits of government policy across generations. Measuring this sustainability is a challenging task. First, the temporal horizon of a nation is in principle unlimited, so the adjustment can be delayed for a long time. Second, sustainability depends on the future evolution of the macroeconomic environment, the design of public finances, and demographics. In this work, we focus on the latter, for which long-term forecasts are generally reliable.

Traditional budgetary measures, such as the debt-to-GDP ratio, fail to capture the impact of demographics. Here, we rely on an alternative measurement technique known as generational accounting, introduced by Auerbach et al. (1991a, 1994). This approach relies on mapping government revenues and expenditures to different age groups. We can then track the consequences for the government budget of changes in the age structure of the population.

The demographic projections published by Eurostat point to a marked change in the distribution of popu- lation by age. While today there is a concentration of people between the ages of 35 and 60, towards the end of the century this mass will move to the ages between 60 and 85 years old. We find that this new age composition of the population will have strong adverse consequences for the government budget. This result is obtained by keeping constant the present age profile of revenue and spending, and projecting it into the future under demographic change. The present (2017) surplus would change to a large deficit within a few decades. This deficit would be permanent, since the current trends of low fertility and increased life expectancy will not revert.

In this scenario, fiscal sustainability would require a permanent increase in all revenues by 22%. This is not simply a temporary effect of the ongoing demographic transition, from a population with a large working age group to a more aged one. The age profile of taxes and benefits is structurally inconsistent with actual fertility and life expectancy. Alternative, more optimistic, scenarios of economic growth do not dissipate this inconsistency.

Restoring sustainability demands a change in at least one of two: population dynamics or the age distribution of taxes and benefits. We examine, with our framework, policies addressing both.

The first refers to fertility and immigration policies. Fertility promotion can be important to control the evolution of total population, but it cannot, within reasonable bounds, prevent ageing. Increasing immigration can only scantily help. Under a high immigration scenario, in the medium term (30 years) fiscal revenues increase. It is not enough, though, to make up for higher public spending due to ageing. Moreover, the young immigrants of today would also age. Immigration alone, under any realistic scenario, cannot generate a population age distribution compatible with permanent sustainability. Although it could ease the pain of adjustment in the medium term, it does not solve the structural problem posed by ageing.

The second policy area is chiefly about social security reforms. Pensions and social contributions are both large and age-sensitive budget items. We analyse two dimensions in which already enacted poli- cies will have a positive effect on fiscal sustainability. First, automatic retirement age increases lead to less benefits and more tax payments over the life cycle. This, by itself, closes a part of the future imbalances induced by ageing. Second, the scenario outlined in the latest EU Ageing Report implies that the generosity of pension benefits will fall substantially over the coming decades. If realized, this can fully close the sustainability gap we project. Yet, under current legislation, the introduction of bene- fit reductions is very gradual. This suggests a pattern of redistribution between those retired now, or almost, and those retiring in the future.

Finally, we use our framework to look at net payments over the life cycle. The current age profile of spending and revenue, projected over a full lifetime, implies the average taxpayer would receive a lifetime monetary benefit of €150,000, net of taxes (and other revenues). This value highlights how the tax-benefit age profile of 2017 is incompatible, in the long run, with current fertility and mortality rates.

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1.

INTRODUCTION

The United Nations defines sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Though seemingly neutral, this definition stems from an idea of justice between generations, or intergenerational equity: living generations bear a certain responsibility towards the unborn. While criteria of justice, like in standard arguments of intra-generational equity, are manifold and ultimately a matter of individual preference, this definition is largely consensual.[2]

Under this definition, justified concerns about sustainability in modern society have long been at the forefront of the global political agenda, most notably in environmental issues. However, in advanced economies, sustainability problems are also about changes in demographic trends and the secular pattern of low economic growth. The Gulbenkian Foundation Sustainability Programme, with its Intergenerational Justice project, aims to contribute to this complex debate from a necessarily interdisciplinary perspective.

In this report, we restrict our attention to the implications of the ageing and lower fertility process affecting Portuguese society, like other developed nations. We assess the impact they may have on the sustainability of public finances, given their present design. While in recent decades the public sphere has devoted much attention to annual government budget deficits and the public debt position – both of which have improved remarkably since the crisis – these indicators do not reflect the long-term repercussions of recent, let alone projected, ageing trends. Nor do they capture distributional effects, in terms of different generations, of fiscal policies.

The aim of this report is to shed light on these issues. It unveils how the public finances of Portugal, and its current surplus position, rely on the current age distribution of the population. It provides insights about how that distribution will impact the government budget in the medium term, and how it will become structurally incompatible, for the long run, with the current mix of revenues and expenditures.[3] As this implies that rebalancing policies must take effect at some point in the future, this can imply that the young and future generations will be disproportionately affected by them, given the life cycle profile of taxes and benefits. Public finances also redistribute between generations through investing in durable public goods (infrastructures); our analysis abstracts from this point.

This report is structured as follows. Section 2 describes current demographic trends and the shock they represent for the age structure of the population. Section 3 shows the age distribution of government revenue and spending and describes how the budget will be impacted by current trends in fertility and mortality. Section 4 shows our main result, a simple measure of fiscal sustainability, explaining it in detail and exploring how it changes with different assumptions. Section 5 explores the implications of alternative policy scenarios, that provide further information on the effects of immigration and pension policies. Section 6 provides a distinct reading of our results, presenting revenues and expenditures attributed to specific year-of-birth cohorts. Section 7 concludes.

2 See Gosseries (2008) (or, in Portuguese, Gosseries, 2018) for an accessible summary of the relevant concepts in the philosophy of intergenerational justice.
3 The costs for future taxpayers associated with current government debt are small compared to this potential long-run imbalance. This conclusion is not changed by the large growth of public debt brought by the pandemic crisis.

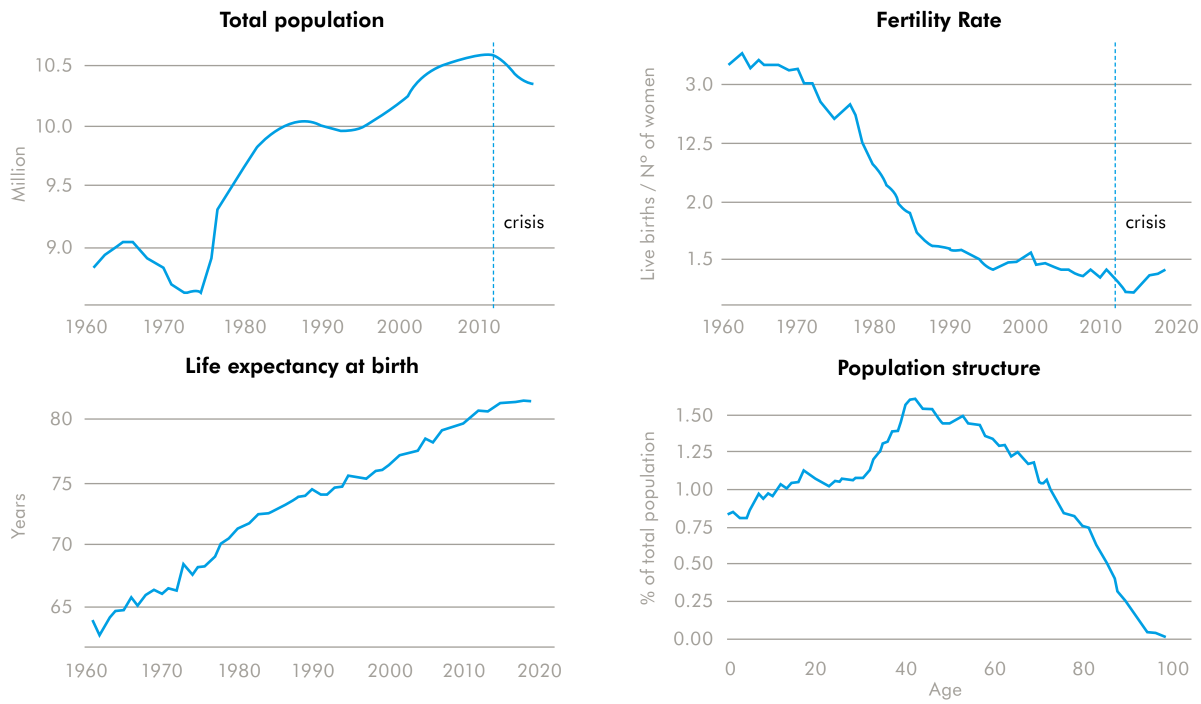
2.

A LARGE DEMOGRAPHIC SHOCK IN PORTUGAL

Strong swings in the population growth due to changing fertility, mortality, and migration have characterised demography during the last six decades in Portugal. These past population dynamics are worth noting because they have determined the age distribution of the Portuguese population at present. The first panel of Figure 1 shows that the total population increased from around 8.8 million people in 1960 to 10.2 million in 2017. Large migratory flows have significantly affected the overall population during the turbulent period that goes from the mid-1960s to the mid-1980s[4]. The second panel of Figure 1 shows that the fertility rate decreased from more than three children per woman in the 1960s to less than 1.5 in 2017. The decrease mainly occurred during the 1980s, and in that period, the fertility rate fell below 2.1 children per woman – the "replacement rate", below which total population will eventually fall (ignoring migration).[5] The third panel shows a linear increase in life expectancy from 64 years old in 1960 to 82 years old in 2017, predominantly explained by improvements in healthcare.

Finally, the fourth panel shows the shares of the population by age in 2017. The population shares by age or population distribution by age, are central to our analysis and results from the past rates of fertility and mortality shown in panels 2 and 3. The population distribution by age shows that the dynamics of the past years resulted in a population structure with a larger concentration of people in the groups of between 35 and 60 years of age.

Figure 1
Population dynamics in Portugal, 1960-2017



Source: Eurostat

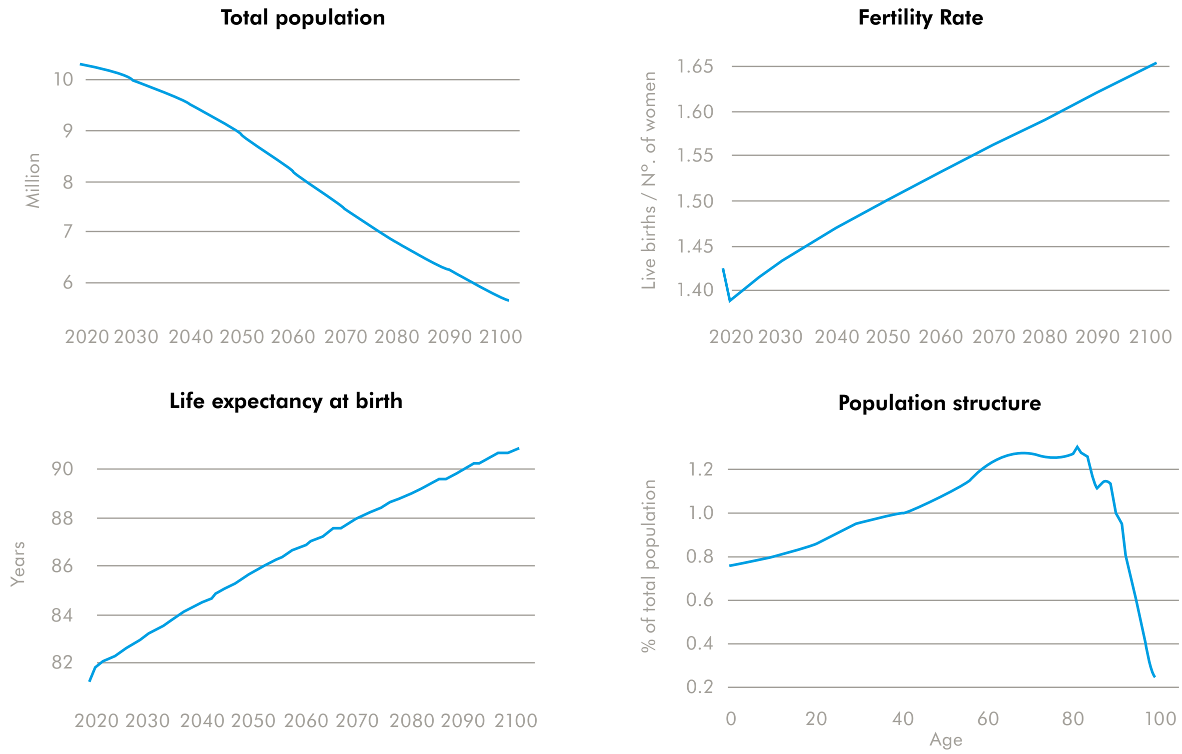
The first panel shows the total population. The large swings in the total population are mainly due to large migratory flows. The second panel shows the fertility rate. A fertility rate of 2.1 guarantees that the population remains constant. The third panel shows the life expectancy at birth in years. The fourth panel shows the age population structure in 2017. The panel shows that the largest cohort in 2017 was the 40-years old with a share of 1.6% of the population.

4 We are not showing migratory flows as official data on migrations started in 1990.
5 It is interesting to note the negative effect of the recent financial crisis on the population dynamics. It is well known that population decreased mostly because of a large emigration. Maybe less known is that the fertility rate also decreased during the crisis.

Currently, available projections imply that the age structure of the population will change in the next decades. Figure 2 shows the latest baseline projections (without migration) for the total population, the fertility rate, and life expectancy. According to panel 1, the population will follow the trend of the last years and continue to decay, falling below 6 million people in 2100, the last year of the projection. Panel 2 shows that the decreasing pattern of the fertility rate inverts after 2020 and starts to increase to a value of roughly 1.65 children per woman in 2100, a value that continues to imply negative population growth. Panel 3 shows that life expectancy will continue to increase and reach 91 years old by 2100. The fourth panel shows the change in the age structure of the population with a significant shift towards older persons.

Demographic projections point to a marked change in the structure of the population. While today there is a concentration of people between the ages of 35 and 60, towards the end of the century this will move to the ages between 60 and 85 years.

Figure 2
Projected population dynamics in Portugal, 2018-2100



Source: Eurostat, EUROPOP2018.

The first panel shows the projected total population under a no-migration scenario. The second panel shows that fertility rate is projected to increase but will remain below the fertility rate of 2.1 that guarantees that the population remains constant. The third panel shows life expectancy at birth in years is projected to increase by 10 years. The fourth panel shows the projected age population structure in 2100. The panel shows that the largest cohort in 2100 will be the 81 years old with a share of 1.3% of the population.

3.

THE CONSEQUENCES OF DEMOGRAPHIC CHANGE

FOR PUBLIC FINANCES

This section of the report outlines the consequences of the profound demographic changes described in Section 2 for the public finances of Portugal. Throughout, we restrict formality to a minimal level. Alongside the text, we provide analytical boxes that present the formal derivation of the methodology and the equations relevant for the results. Note that every time we use the term cohorts, we mean groups of individuals born in the same year.

Our study is based on a methodology named generational accounting, developed initially by . This is a useful tool to evaluate the sustainability of fiscal policy and, in the process, measure how taxes, revenues, social transfers, and public expenditures are distributed across different generations. Though we follow it closely in the strategy to obtain this information from the data, we depart from it in the analysis of fiscal sustainability and generational imbalance, by focusing on a different metric which we believe has a more intuitive and robust interpretation.

3.1 MAPPING EXPENDITURES AND REVENUES TO AGE

In this section, we first describe the methodology used to obtain estimates of the age profile of government spending and revenues. We also present our data.

The starting point is the budget constraint of the government in the year t:

$$B_t = G_t - T_t + (1 + i_t)\, B_{t-1} \tag{3.1}$$

where B_t is government debt, G_t is total public expenditure net of interest payments on the outstanding debt, T_t is total revenues and i_t the implicit nominal interest rate on debt. The budget constraint states that the debt of period t is equal to the debt of the previous period, t−1, plus the interest payments and the primary deficit ($G_t - T_t$). The following table shows these quantities in Portugal for the year 2017.

Table 1
The government budget constraint in 2017

	Value in 2017
Net debt, B_t	208.586,3
Total primary spending, G_t	81.498,5
Total revenues, T_t	83.105,1
Primary balance, $T_t - G_t$	1.606,6
Implicit interest rate, i_t	3.5 pc

Souce: Eurostat.

Except for the interest rate, the unit is million euros at current prices. r_t is the implicit interest rate on government debt, computed as the ratio of interest payments to the stock of debt. The primary balance excludes interest receivable by the government.

We choose 2017 as our reference period as it was the last available year in terms of data when we first started this project. It happens that 2017 is a good candidate for a base year because, as we will explain more extensively below, it is a year with a sufficiently neutral cyclical effect and a primary deficit close to balance.

Generational accounting maps the expenditure and revenues of the specific year *t* to subgroups of the population according to age (and gender[6]). More precisely, let $\tau^{i}_{t,a}$ be the average government revenue of category *i* attributed to a person with age *a* in the year *t*. For example, the average personal income tax (*i*= *PIT*) paid by a 40 year-old (*a* = 40) in 2017 (*t* = 2017). Let $P_{t,a}$ the number of persons of age *a* alive in year *t*. Then we can distribute the total revenues as follows:[7]

$$T_t \equiv \sum_{i} \sum_{a}^{J} \tau^{i}_{t,a} P_{t,a}. \tag{3.2}$$

This simply states aggregate government revenues as the sum across age groups of all taxes and revenues. Similarly, let $g^{i}_{t,a}$ be the average government spending *i* attributed to a person of age *a* in the year *t*, so that total spending is:

$$G_t \equiv \sum_{i} \sum_{a}^{J} g^{i}_{t,a} P_{t,a}. \tag{3.3}$$

Using survey micro data (see Appendix for details) we compute the $\bar{\tau}^{i}_{t,a}$ and $\bar{g}^{i}_{t,a}$ that are directly mappable to age; those that are not we denote by $\tau_{t,a}$ e $g_{t,a}$. In the latter case we distribute revenue equally by the adult population (those above 17 years old). Spending is distributed equally by all the population, such that per capita spending is the same for all ages.[8] Tables 2 and 3 report the 2017 aggregates of revenue and spending. Roughly 70% of the budget can be mapped in this way. Note also that we only distribute the primary balance, excluding interest payments.

6 To keep notation simple we only consider age in these expressions.
7 *J* is the oldest age, that in this work we take to be 100. In practice, we bunch all the persons with an age equal or above 100 in the 100 years old bracket. They are only a few in 2017, but this is expected to increase significantly in the future
8 We choose to distribute the total primary surplus across cohorts and also derive average per-capita revenues and expenditures that are empirically not mappable to age to ensure the results are not biased by the decrease in total population size. Our understanding of the standard methodology is that the fraction of *G* and *T* that is not mappable to specific cohorts is kept in a separate term and projected to grow at the productivity rate in future years. We believe this approach to be reasonable for a fairly stable population but can overestimate (underestimate) the future age-uniform *G* and *T* when the population is projected to decrease (increase).

Table 2

Revenue used in the GA exercise, 2017

Category	Value (M€)	(%)
Distributed by age		
Personal Income Tax	12.610	15,2
Corporate Income Tax	6.281	7,6
Corporate Income Tax	1.610	1,9
Value Added Tax	16.810	20,2
Social Contributions	22.685	27,3
Uniformly distributed	23.114	27,8
Total revenue	**83.110**	**100,0**

Source: Eurostat.

Table 3

Expenditure used in the GA exercise, 2017

Category	Value (M€)	(%)
Distributed by age		
Disability pension	2.020	2,3
Old-age pension	22.310	25,1
Sickness allowance	443	0,5
Survivor pension	3.364	3,8
Unemployment subsidy	1.540	1,7
Children and Family subsidy	2.089	2,4
Education expenditure	9.420	10,6
Health expenditure	11.361	12,8
Uniformly distributed	28.892	32,5
Interest payments	7.437	8,4
Total expenditure	**88.876**	**100,0**

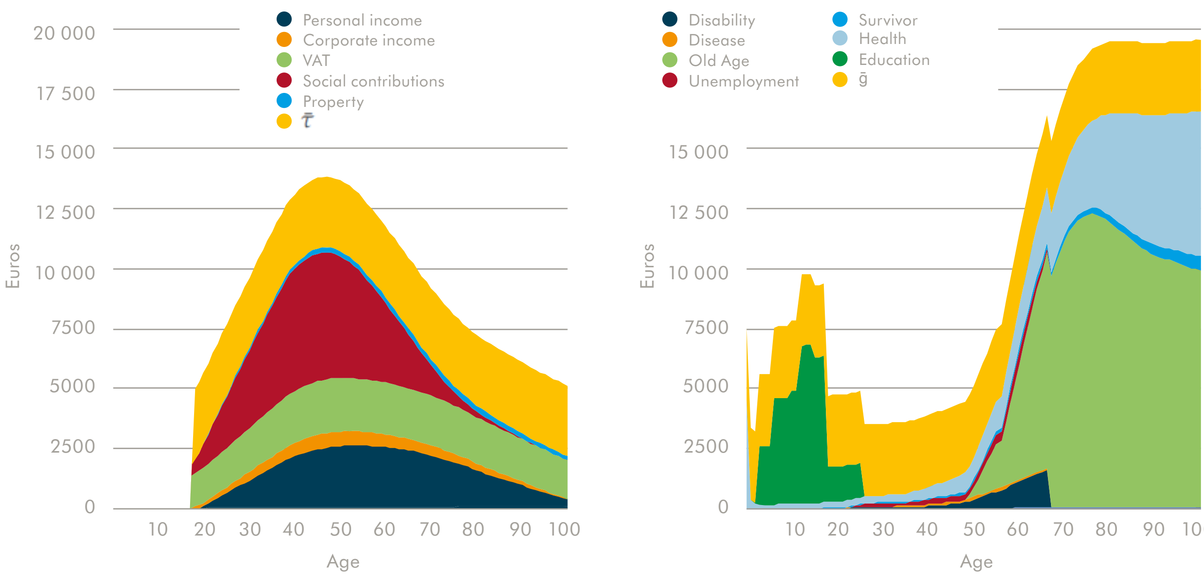
Source: Eurostat.

The result of our mapping produces the following age-profiles t_a^i and g_a^i, illustrated in Figures 3 and 4 for males and females, respectively.

Revenues associated with income, such as PIT (personal income tax), CIT (corporate income tax)[9] and Social Security contributions increase along the working-life up to the ages 50-55 years old, at which point they start to decrease. Social contributions eventually vanish as workers retire and start to benefit from pensions. Survivor and old-age pensions appear in a later stage of life, increasing up to the age of 75 years old. The property tax (called IMI, *Imposto Municipal sobre Imóveis*, in the Portuguese system) is relatively small and appears in the cohorts after 30 years old. VAT, the value added tax, is more uniformly distributed along the adult life as children consumption is accounted for by parents in our exercise. Concerning other social benefits, we observe that unemployment and sickness subsidies[10] tend to have a small impact but an increasing one along the working-life. Finally, education expenditure is only attributed to the early ages (up to 25), while health, except in the first year of life, increases with age.

These plots must be interpreted with care: for a given age, higher average spending does not imply a higher average benefit per recipient (and likewise for taxes). Some people of that age may not receive (or pay) it. For example, the higher average pension spending attributed to the 70 years old group compared to 65 year-olds results from the fact that more people are retired (i.e. less people receive 0 in pensions). It does not imply that the average 70 years old retiree receives a higher pension than the average 65 years old retiree.[11]

Figure 3
The revenues and expenditures $\mathrm{T}_{t,a}^{i}$ and $g_{t,a}^{i}$ for males in 2017.

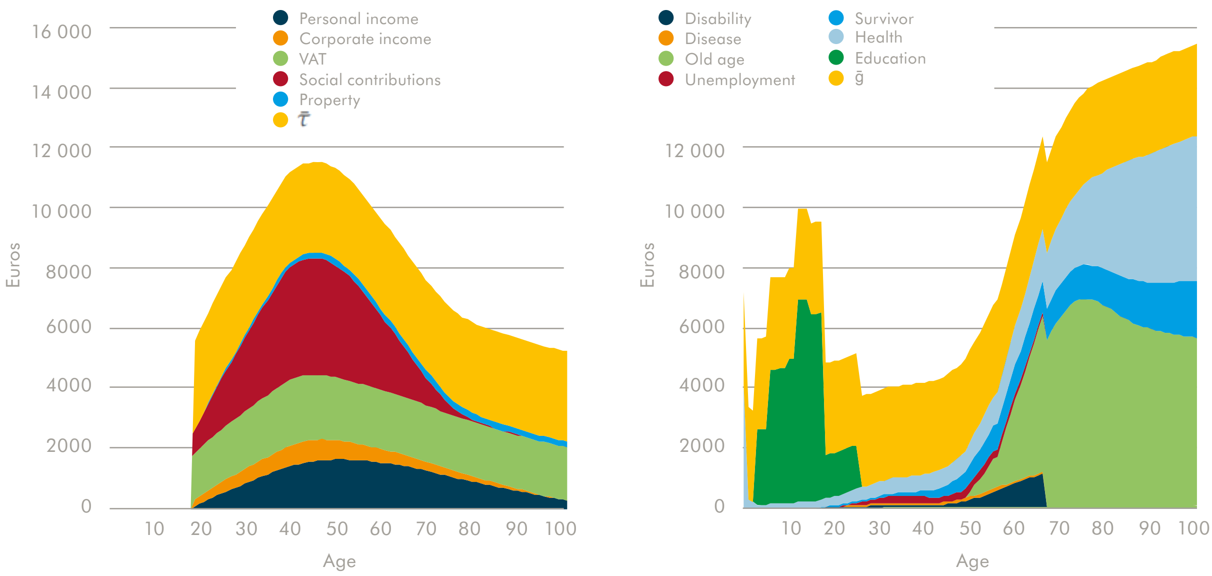


Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.
τ̄ represents uniformly distributed revenues and uniformly distributed spending.

9 An important part of IRC revenues is generationally neutral (for resident taxpayers) because a significant portion of domestic firms' equity is owned by non-residents. We detail in the Appendix that approximately a 1/3 of the IRC is paid by non-residents. We plan to incorporate this generationally neutral revenues in future work.
10 The abrupt drop in disability and disease benefits at 65 years old is due to the fact that neither can be accumulated with old age pensions, i.e. upon reaching retirement age (65) they are replaced by pensions. More details can be found in the Appendix
11 It would be interesting to extend the study to include income or wealth heterogeneity within the age-gender cohorts.

Figure 4

Per capita revenues and expenditures $\mathrm{T}_{t,a}^{i}$ and $g_{t,a}^{i}$ for females in 2017



Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.
$\bar{\tau}$ represents uniformly distributed revenues and $\bar{g}$ uniformly distributed spending.

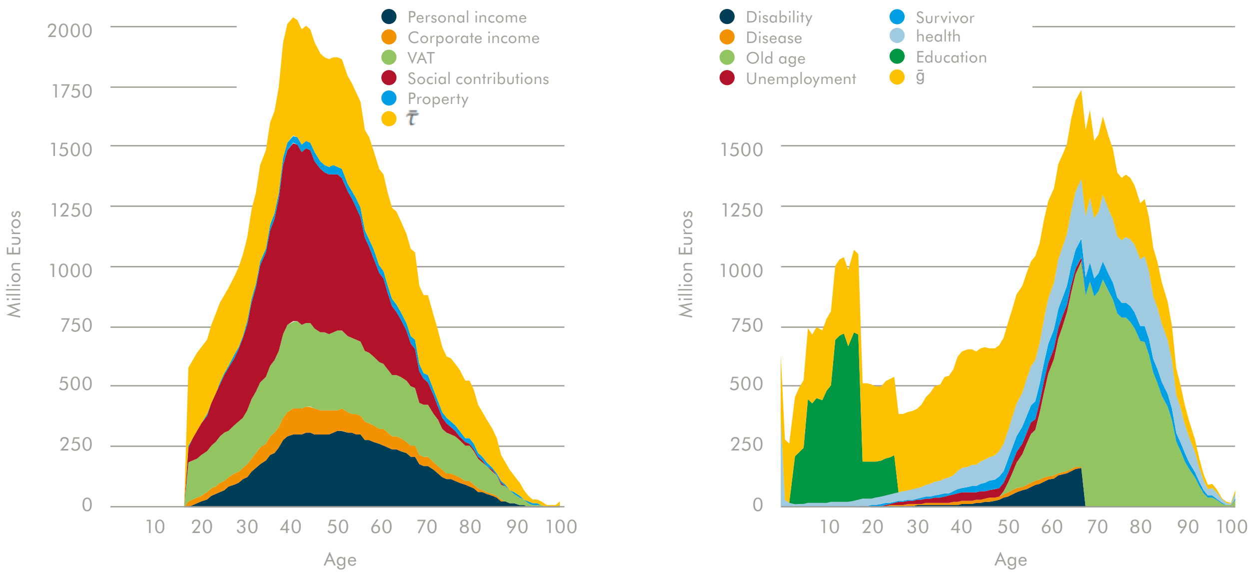
A salient feature of these distributions is the well known life cycle pattern of revenues and expenditures. A much larger share of spending is attributed to the inactive cohorts, namely the younger and older cohorts, and a much larger share of revenues respects to active cohorts.

Comparing male and female patterns, we can see the existing gender divide: the per capita values of personal income tax, social contributions and old age benefits are substantially lower. This is consistent with the lower wages and labor market participation of females. Health spending is larger in young adult females, a reflection of the costs of childbearing. But they are smaller in the first inactive ages. Another noteworthy difference is in survivor benefits, which are a significant portion of per capita spending attributed to older females, whilst they are residual in men. The last two points are consistent with the higher life expectancy of females (and, to some extent, with lower labor market participation).

The primary deficit, the difference between aggregate spending and aggregate revenues, $G_t - T_t$, was balanced in 2017. This is a result that, given these age profiles of per capita expenditures and revenues, depends on a particular age structure of the population. We show this in Figure 5, which plots the total contribution of each age to the different budget items, i.e. multiplying each $\mathrm{T}_{t,a}^{i}$ e $g_{t,a}^{i}$ by the respective age group of the population, $P_{t,a}$.[12]

12 The net contribution of each age to the primary surplus in 2017, i.e. the sum of these spending items minus the sum of the revenues, is shown later in Figure 6.

Figure 5
Total revenues and spending by age, 2017.



Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.
$\bar{\tau}$ represents uniformly distributed revenues and $\bar{g}$ uniformly distributed spending.

As explained in the previous section, the present age distribution reflects historical demographic dynamics, especially the higher fertility and mortality rates observed in the past. These resulted in relatively large cohorts that today are concentrated in the active population and contribute the most to tax and contribution revenues. Then, in the near future, as these generations move into retirement, this large concentration of population will move to the older age groups, without being replaced by new ones. In the next section, we turn to the question: what does this demographic change imply for the primary surplus, holding everything else constant?

Technical box 1:
Generational accounting methodology

Our methodology follows Auerbach et al. (1991b). $g_{t,a} = \sum_i g^i_{t,a}$, $\tau_{t,a} = \sum_i \tau^i_{t,a}$ are the sum of different items (i) in expenditures and revenues, respectively, attributable to the average person aged $a \in \{0,1,\ldots,100\}$ at time t.

In order to attribute net revenues to different ages, and project them in the future, we first derive from the survey micro data age-gender distributions of spending and revenue.

With data for the entire population, it must be that $G^i_t = \sum_{a=0}^{J} \left[g^i_{t,a} P_{t,a} \right]$, where G^i_t is the aggregate value of expenditure category i. This equality does not necessarily hold using the per capita average estimates $\hat{g}^i_{t,a}$ that we obtain from survey micro data (based on a sample of the population). To ensure coherence with the national accounts, the method consists of extracting the ratios $\frac{\hat{g}^i_{t,a}}{\hat{g}^i_{t,40}}$, i.e. the per capita averages relative to a benchmark (e.g.40 years old). The previous equality is used to obtain an adjusted estimate $\tilde{g}^i_{t,40}$ for the benchmark age group average payment:

$$
\begin{aligned}
G^i_t &= \tilde{g}^i_{t,40} \sum_{a=0}^{J} \left[\frac{g^i_{t,a}}{g^i_{t,40}} P_{t,a} \right] \\
\Rightarrow \tilde{g}^i_{t,40} &= \frac{G^i_t}{\sum_{a=0}^{J} \left[\frac{\hat{g}^i_{t,a}}{\hat{g}^i_{t,40}} P_{t,a} \right]}
\end{aligned} \tag{3.4}
$$

And then revert the process to obtain estimates coherent with the national accounts for all ages based on the distribution of the ratios to the 40 years old benchmark:

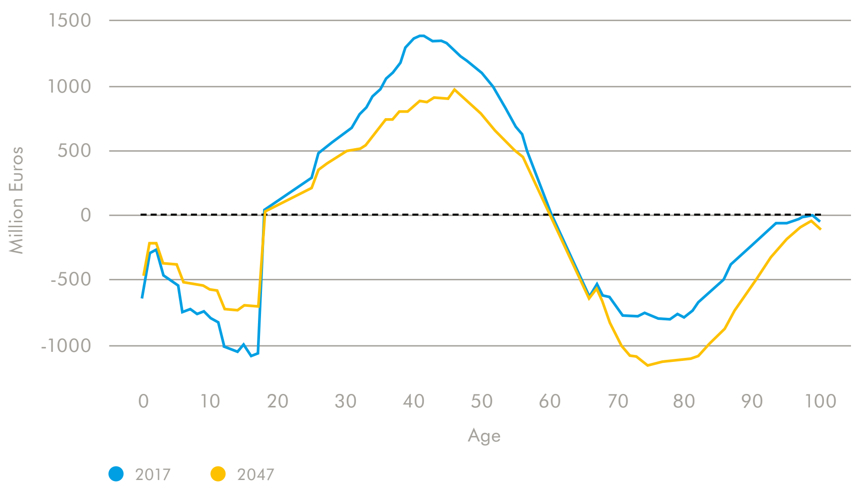
$$
\tilde{g}^i_{t,a} = \tilde{g}^i_{t,40} \frac{\hat{g}^i_{t,a}}{\hat{g}^i_{t,40}} \ \forall a \tag{3.5}
$$

The revenues and expenditures age-gender profiles plotted in Figures 3 and 4 represent $\{ \tilde{\tau}^i_{2017,a} \}$ and $\{ \tilde{g}^i_{2017,a} \}$.

3.2
IMPACT ON THE PRIMARY SURPLUS

In ensuing discussions, we refer to revenues net of expenditures as net payments. In order to isolate the effects of demographic change on the primary surplus, Figure 6 shows the total net payments attributed to each age group in 2017 and 2047. This means the contribution of each cohort to the primary surplus in these two years. To be clear, here we keep per capita revenue and spending, averaged out at the age-gender level, constant at their 2017 values. The only change is in population, i.e. the number of people in each age bracket.[13]

Figure 6
Contribution of each year-of-birth age group to the primary surplus in 2017 and 2047.

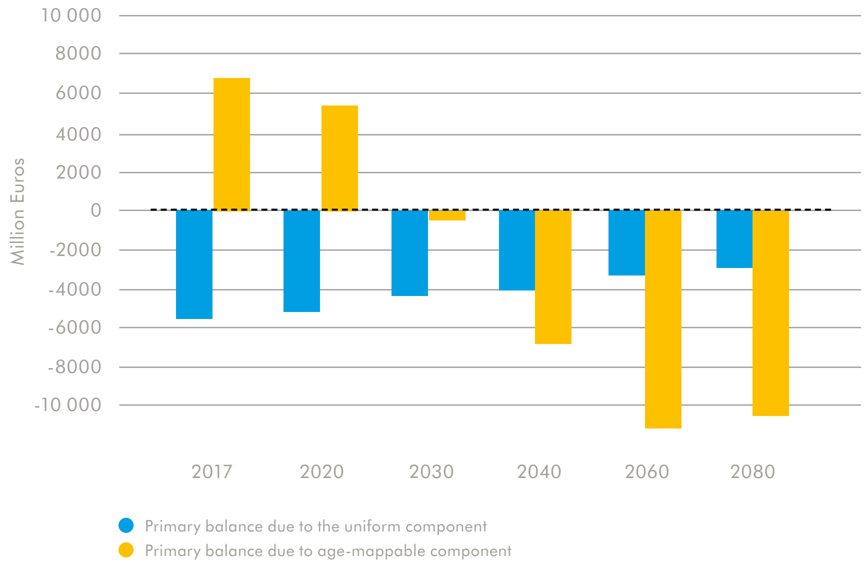


Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

The contribution of each cohort to the primary surplus exhibits the typical life cycle pattern. In 2017, the sum of the contributions was almost null, meaning that total revenues were enough to pay for the total expenditure and generate a small primary surplus (that amounts to €1.3 billion in 2017)[14]. The contributions projected for 2047 show lower spending for the young cohorts, lower revenues in the active cohorts and higher spending for the older cohorts. The result is that the projected changes in population imply that the primary balance will switch from the surplus of today to a deficit.

13 In this exercise we are abstracting from productivity growth, inflation, and discounting.
14 The actual primary surplus in the national accounts is slightly higher because in our projections, for consistency, we deduce interest received from general government.

Figura 7
The primary surplus projections due to demographic changes, 2018-2080.



Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

In 2017 the positive budget balance is the result of a large surplus in the age-sensitive spending and revenue items, that compensates for a deficit in the age-uniform part of the budget. The former is projected to decrease and switch to a deficit in the mid 2030's. The latter is projected to contract slowly as the population decrease and the share of adults in the population changes.

Figure 7 shows that the existing primary balance in 2017 relies on a large surplus (8.91 billion euro) in the difference between age-mappable revenues and expenditures. On the other hand, the primary balance from the revenues and expenditures that we distribute uniformly across ages is negative (−7.64 billion euro).[15] The projected change in demographics implies that the primary surplus due to the age structure will switch to a deficit around 2030. The primary balance related to the uniform component will only improve, slowly, with the decrease in population and the change in the share of adults.[16] An implication of this figure is that even if the primary deficit in the uniform component was brought to zero by decreasing or increasing $\bar{g}$ or increasing $\bar{\tau}$, the primary balance would eventually become negative due to the change in the age structure.

The demographic shock will have adverse consequences for the public finances of Portugal. With the actual age profile of expenditures and revenues, we find that the projected demographic trends would bring down the current primary surplus to a large deficit within a few decades. This deficit would be permanent, given the trends of low fertility and increased life expectancy.

15 The total primary balance is the difference of the two lines.
16 The latter is due to the fact that uniformly distributed revenues are only assigned.

4.

LONG-TERM SUSTAINABILITY OF PUBLIC FINANCES

The deterioration of the primary deficit due to the adverse demographics will have a negative impact on the long-term sustainability of public finances.

In this section we provide several measures of this impact. They imply a generational imbalance insofar as future measures to restore fiscal balance have distributional effects (in terms of different cohorts).

Another factor that matters for sustainability is the future macroeconomic environment, here summarized by the expected GDP growth and the expected future interest rate on public debt. Our baseline projection relies on historical average values for these indicators. We discuss these in detail in Section 4.4.[17]

4.1 SUSTAINABILITY IMBALANCE METRICS

Main Result

To evaluate public finance sustainability we follow the literature on the subject, which defines public finances as sustainable if the government intertemporal budget constraint (IBC) holds. In simple terms, the IBC is the sum, over many periods into the future, of the government budget constraint described in equation 3.1. For the IBC to hold, it is only required that the public debt remains serviceable; i.e. it cannot increase too quickly.[18]

Our projections imply a certain stream of primary surpluses. The question is if they are compatible with sustainable public finances – and, if not, by how much must they adjust to restore sustainability (i.e. for the IBC to hold). To answer this question we compute several counterfactual metrics.

The first metric, that we denote θ_{T}, is the factor by which all age specific per capita taxes must increase to guarantee that the IBC holds. It is a counterfactual measure in that it assumes that all the different T_a^i (IRS, IVA, etc.) increase in the same proportion and for every age. The second metric is θ_g, the factor by which all age specific per capita expenditures must decrease to guarantee that the IBC holds.

17 We also present results based on alternative assumptions.
18 Technically, this means the condition that the stock of debt can not grow, asymptotically, at a faster rate than the interest rate. See Technical Box 3 for details.

Table 4
The sustainability imbalance factors in 2017

θ_T	θ_g
1,22	0,81

Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

θ_T is the factor by which all age specific per capita taxes must increase to guarantee that the IBC holds. θ_g is the factor by which all age specific per capita expenditures must decrease to guarantee that the IBC holds.

Table 4 shows that the tax burden must increase by 22% for the current age profile of expenditures to be permanently sustainable in the baseline scenario. Alternatively, for the current age profile of revenues to be sustainable, expenditures must decrease by 19%.[19]

This is a very large adjustment. 22% of the tax and social contributions revenue in 2017 is close to €16 billion, a figure that illustrates the additional amount of taxes and contributions that would have to be levied *every year indefinitely*. The overall tax burden, inclusive of social contributions, would go from 37% of GDP to almost 45%.

These measures do not capture the change in the age profile of revenue and spending implied by already adopted policies. In this sense they are not, strictly, a *forecast* of future sustainability problems. Instead, they measure the structural impact of demographic change on public finances, and measure adjustments to the age profile necessary to ensure long-term fiscal balance. Some of these adjustments are already embedded in current policies. For example, retirement age increases will contribute to this adjustment from the expenditure side; on the revenue side, the progressive income tax schedule means that the effective average tax rate will drift upwards with real wage growth, reducing the need for rebalancing policies.

19 The difference observed in the two adjustments is explained by the age profile of revenues and expenditures. As the population ages, more people receive old-age and survival pensions which implies that the relative adjustment is smaller through expenditure than by the revenue side (taxes). On top of that, the expenditures that were not attributable to ages were distributed across the entire population, whereas the taxes were only distributed across the adult population. This contributes to explain the observed difference in the adjustment factors.

Technical box 2

Sustainability in generational accounting

Our framework to analyse fiscal sustainability is based on the IBC:

$$\sum_{s=0}^{\infty}\prod_{j=1}^{s}\frac{G_{t+s}}{(1+i_{t+j})}-\sum_{s=0}^{\infty}\prod_{j=1}^{s}\frac{T_{t+s}}{(1+i_{t+j})}+B_{t-1}=lim_{s\to\infty}\prod_{j=1}^{s}\frac{B_{t+s}}{(1+i_{t+j})} \qquad (4.1)$$

Recall that we can decompose aggregate spending and revenue into per capita averages by age and fiscal item, e.g. $T_t \equiv \sum_i \sum_a^J T_{t,a}^i P_{t,a}$. Denote as $\bar{t}$ the base year for the generational accounting projection. For $t>\bar{t}$, in our projection the revenue and expenditure profiles (as obtained in Section 3.1) are kept constant. Nominal per capita revenues on item i, for each age, $T_{t,a}^i$, grow based on assumptions for productivity growth γ_t^e and inflation rate π_t (and likewise for spending):

$$\tau_{t,a}^i=\tilde{\tau}_{\bar{t},a}^i\prod_{j=\bar{t}+1}^{t}(1+\gamma_t^e)(1+\pi_t),\ t>\bar{t} \qquad (4.2)$$

where $\tilde{\tau}_{\bar{t},a}^i$ is the per capita revenue on item i, for age a, in the base year (estimated from the survey data as described in Technical Box 1).

Define a growth/discount factor $D_t = \frac{(1+\gamma_t^e)(1+\pi_t)}{(1+i_t)}$ and recall $\tilde{\tau}_{\bar{t},a}=\sum_i \tilde{\tau}_{\bar{t},a}^i$. We can then rewrite the IBC as:

$$\sum_{s=0}^{\infty}\sum_{a=0}^{J}\prod_{j=1}^{s}D_{t+j}\tilde{g}_{\bar{t},a}P_{t+s,a}-\sum_{s=0}^{\infty}\sum_{a=0}^{J}\prod_{j=1}^{s}D_{t+j}\tilde{\tau}_{\bar{t},a}P_{t+s,a}+B_{t-1}=lim_{s\to\infty}\prod_{j=1}^{s}\frac{B_{t+s}}{(1+i_{t+j})} \qquad (4.3)$$

We will assume throughout that the growth and discount rates are constant, i.e.

$D_t = D\ \forall t.$

Sustainability is defined as imposing that the IBC holds and the limit on the right-hand side is equal to zero (no-Ponzi condition). We can work out an adjustment factor θ_τ that represents the permanent change in all revenues (or likewise for spending) such that the IBC holds, i.e. that the following equation holds:

$$\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s\left(\tilde{g}_{\bar{t},a}-\theta_\tau\tilde{\tau}_{\bar{t},a}\right)P_{t+s,a}+B_{t-1}=0$$

Rearranging terms we obtain the expression:

$$\theta_\tau=\frac{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s\tilde{g}_{\bar{t},a}P_{t+s,a}+B_{t-1}}{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s\tilde{\tau}_{\bar{t},a}P_{t+s,a}} \tag{4.4}$$

Notice that a change in D will affect both the denominator and the numerator similarly, so the sensitivity of θ_τ to the discount factor assumptions is small, depending only on the relative size of the initial debt.

This approach is somewhat different from that originally proposed by , which separates currently living generations from unborn ones. In that case, the above expression for projected spending is decomposed as follows. In that case, the adjustment factor θ_τ^{AKG} represents a permanent change in the revenues attributable to future generations only, i.e. that the following equation holds:

$$\sum_{s=0}^{J}\sum_{a=s}^{J} D^s\left(\tilde{g}_{\bar{t},a}-\tilde{\tau}_{\bar{t},a}\right)P_{t+s,a}+\sum_{s=1}^{\infty}\sum_{a=0}^{min\{s,J\}} D^s\left(\tilde{g}_{\bar{t},a}-\theta_\tau^{AKG}\tilde{\tau}_{\bar{t},a}\right)P_{t+s,a}+B_{t-1}=0$$

Again rearranging we obtain the expression for this factor:

$$\theta_\tau^{AKG}=\frac{\sum_{s=0}^{J}\sum_{a=s}^{J} D^s\left(\tilde{g}_{\bar{t},a}-\tilde{\tau}_{\bar{t},a}\right)P_{t+s,a}+\sum_{s=1}^{\infty}\sum_{a=0}^{min\{s,J\}} D^s\tilde{g}_{\bar{t},a}P_{t+s,a}+B_{t-1}}{\sum_{s=1}^{\infty}\sum_{a=0}^{min\{s,J\}} D^s\tilde{\tau}_{\bar{t},a}P_{t+s,a}} \tag{4.5}$$

Intuitively we can observe that the effect of a change in D will in this case affect the denominator and the numerator differently, since it will affect the relative importance of current generations' net taxes (unaffected by the counterfactual tax increase).

Finally, another measure often reported in this literature is the "intertemporal budget gap". In this case, we do not compute an adjustment factor, and simply report directly the intertemporal imbalance implied by the IBC as a ratio to GDP in the initial period (Y_t):

$$IBG_t=\frac{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s\left(\tilde{g}_{\bar{t},a}-\tilde{\tau}_{\bar{t},a}\right)P_{t+s,a}+B_{t-1}}{Y_t} \tag{4.6}$$

Debt-to-GDP ratio – a detour

A second natural metric to measure fiscal sustainability is to consider public debt as a share of GDP. We can rewrite the same framework in terms of the debt-to-GDP ratio. The government budget constraint can be represented as:

$$\frac{B_t}{Y_t} = \frac{G_t}{Y_t} - \frac{T_t}{Y_t} + \frac{(1+i_t)}{(1+\gamma_t)}\frac{B_{t-1}}{Y_{t-1}}, \tag{4.7}$$

where Y_t is GDP and γ_t is GDP growth.[20]

Simply transforming the problem into this version of the IBC does not change the results. If we instead imposed stability of the debt-to-GDP ratio, this would be a change in the definition of sustainability, and the result would be different and depend on the targeted path of debt-to-GDP. This is a relevant issue, since European fiscal rules are based on this concept.

Delaying the adjustment

Computing our sustainability metric does not impose any bounds on debt dynamics in a particular point in time. In our baseline projection, the adjustment of 22% implies large primary surpluses in the first couple of decades, while the benefits of a relatively young population can still be reaped. This generates a "buffer" to support the costs of an aged population later on.

As an illustration, we compute an example which implies delaying the adjustment, leading to a smaller adjustment in the short term and a larger one in the long run. In this example, we change our projections to impose a 60% debt-to-GDP ratio (the Maastricht criterion) 17 years from 2017, as forecasted in the 2019 Stability Programme for Portugal. Imposing this debt ratio goal in our projection eases, rather then hastens, the adjustment within these seventeen years. It limits the increase in taxes to the level consistent with that goal, and leaves more of the adjustment for afterwards. Through a higher cost of sustaining the public debt, this makes the total adjustment higher. This is seen in Table 5 below. The metric θ^{b}_{T} has two components. The first, θ^{bT}, gives the increase in revenues necessary to attain the debt-to-GDP ratio goal by 2034, given our projection assumptions. The second, $\theta^{b\infty}$, gives the increase in revenues (with respect to those of 2017) that would be necessary, from 2034 onwards, to permanently ensure sustainability.

Table 5

Sustainability imbalance factors with a fixed objective for the debt-to-GDP ratio, 2017.

θ_T^{bT}	$\theta_T^{b\infty}$
1,12	1,26

Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

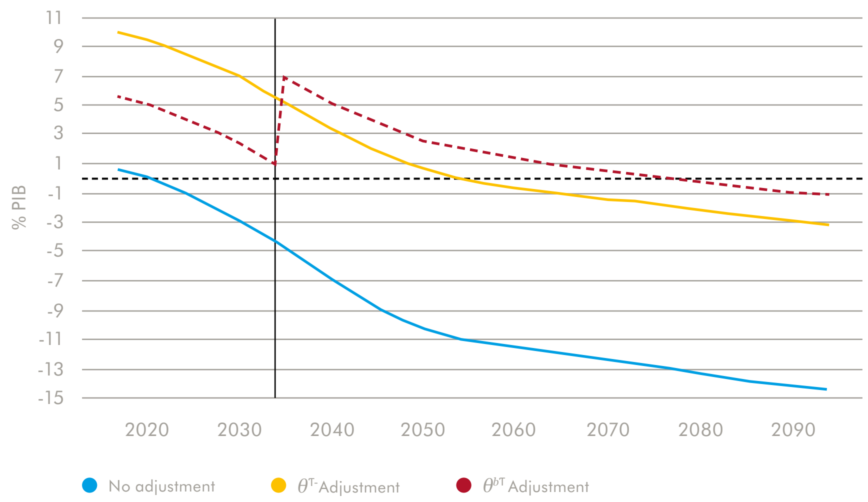
θ^{bT} gives the increase in revenues necessary to attain a 60% debt-to-GDP ratio goal in 2034. $\theta^{b\infty}$ gives the increase in revenues (with respect to those of 2017) that would be necessary from 2034 onwards.

20 $1 + \gamma_t = (1+\gamma^e_t)(1+n^e_t)(1+\pi_t)$ where γ^e_t is the productivity growth rate, n^e_t is the employment growth rate and π_t is the inflation rate.

The adjustment necessary up to 2034 would, in this case, be substantially smaller – it is just over half. On the other hand, the permanent adjustment from that point on would have to be higher. To illustrate this point, we plot the evolution of the primary balance implied by the projection in Figure 8. The permanent adjustment given by our baseline metric implies a much larger primary surplus, starting at 10% of GDP and then declining, in the beginning of the projection horizon. This accommodates a larger deficit during the time at which older ages weigh more in the population. If instead we limit the adjustment such that a debt ratio of 60% is achieved in 17 years, we would have smaller primary surpluses in the beginning, at the cost of having to raise them permanently afterwards.

In conclusion, the path of public debt over time, which reflects the timing of adjustment, matters for both the overall size of the necessary adjustment and its distribution across generations. However, as explained in the Technical Box 2, compared with the magnitude of the challenge posed by ageing, the initial level of debt is of little importance for the distribution of fiscal costs and benefits across generations.

Figure 8
Primary balance implied by the projection assumptions.



The vertical line marks the year 2034 (17 years after 2017).

Technical box 3
Sustainability in generational accounting as a ratio of GDP

If we substitute T_t and G_t in equation 4.7 by equation 3.2 and equation 3.3, respectively, we obtain:

$$\frac{B_t}{Y_t} = \frac{\sum_a^J g_{t,a} P_{t,a}}{Y_t} - \frac{\sum_a^J \tau_{t,a} P_{t,a}}{Y_t} + \frac{(1+i_t)}{(1+\gamma_t)} \frac{B_{t-1}}{Y_{t-1}} \tag{4.8}$$

In the above equation, γ_t represents nominal GDP growth, i.e. $(1 + \gamma_t) = (1 + \gamma^e_t)(1 + \pi_t)(1 + \pi_t)$, where n^e is the growth rate of the working-age population and the other variables have the same meaning as before.

Recall that $\tilde{\tau}^i_{\bar{t},a}$ is the per capita revenue on item *i*, for age *a*, in the base year (and likewise for spending) and the growth/discount factor $D_t = \frac{(1+\gamma^e_t)(1+\pi_t)}{(1+i_t)}$. Iterating forward, we obtain the IBC in a ratio form:

$$\sum_{s=0}^{\infty} D^s \frac{\sum_a^J \left(\tilde{g}_{\bar{t},a} - \tilde{\tau}_{\bar{t},a}\right) P_{t+s,a}}{Y_t} + \frac{1+i}{1+\gamma} \frac{B_{t-1}}{Y_{t-1}} = \lim_{s\to\infty} \left(\frac{1+\gamma}{1+i}\right)^s \frac{B_{t+s}}{Y_{t+s}} \tag{4.9}$$

Suppose we want to reach a certain objective for the debt-to-GDP ratio within *T* years, given by $\frac{B_{t+T}}{Y_{t+T}} = \frac{B}{Y}$. If demographics are not stationary, the primary surplus must continue to change after $t + T$. so in fact we will not stabilize debt to GDP at that point but just reach that value. To include this objective in the IBC we must split it into two timeframes, before and after $t + T$:

$$\sum_{s=0}^{T} D^s \frac{\sum_a^J \left(\tilde{g}_{\bar{t},a} - \tilde{\tau}_{\bar{t},a}\right) P_{t+s,a}}{Y_t} + \frac{1+i}{1+\gamma} \frac{B_{t-1}}{Y_{t-1}} = \left(\frac{1+\gamma}{1+i}\right)^T \frac{B}{Y}$$

$$\sum_{s=T+1}^{\infty} D^s \frac{\sum_a^J \left(\tilde{g}_{\bar{t},a} - \tilde{\tau}_{\bar{t},a}\right) P_{t+s,a}}{Y_t} + \left(\frac{1+\gamma}{1+i}\right)^T \frac{B}{Y} = \lim_{s\to\infty} \left(\frac{1+\gamma}{1+i}\right)^s \frac{B}{Y} \tag{4.10}$$

Sustainability is defined as imposing that the IBC holds and the above limit is equal to zero. This is equivalent to the condition imposed on the IBC in levels (and does not imply stability of the debt-to-GDP ratio). For the IBC to hold in our projection, the imbalance metric $\theta^b \equiv \{\theta^{bT}, \theta^{b\infty}\}$ is defined as the adjustment factors necessary to ensure sustainability, i.e. that these equations hold:

$$\sum_{s=0}^{T} D^s \frac{\sum_a^J \tilde{g}_{\bar{t},a} P_{t+s,a}}{Y_t} - \theta^{bT} \sum_{s=0}^{T} D^s \frac{\sum_a^J \tilde{\tau}_{\bar{t},a} P_{t+s,a}}{Y_t} + \frac{1+i}{1+\gamma} \frac{B_{t-1}}{Y_{t-1}} = \left(\frac{1+\gamma}{1+i}\right)^T \frac{B}{Y}$$

$$\sum_{s=T+1}^{\infty} D^s \frac{\sum_a^J \tilde{g}_{\bar{t},a} P_{t+s,a}}{Y_t} - \theta^{b\infty} \sum_{s=T+1}^{\infty} D^s \frac{\sum_a^J \tilde{\tau}_{\bar{t},a} P_{t+s,a}}{Y_t} + \left(\frac{1+\gamma}{1+i}\right)^T \frac{B}{Y} = 0 \tag{4.11}$$

This means that, comparing with t, taxes must be higher by a factor of θ^{bT} between *t* and $t + T$ and by a factor of $\theta^{b\infty}$ beyond $t + T$.

Stability of the debt-to-GDP ratio
When the population is stationary, primary balance as a ratio to GDP is stabilized in the projection. The way we define our imbalance factor targets the primary balance. We could restate the problem in a way that finds instead an adjustment factor that stabilizes the budget balance (with interest payments). This would generate convergence of the debt-to-GDP ratio. However, the primary balance in terms of GDP would no longer be pinned down.

AKG and IBG imbalance measures

Finally, we also compute the traditional measure used in the original work of Auerbach et al. (1991, 1994), which we call the AKG imbalance factor, for comparability with other generational accounting studies.

This imbalance factor is also a counterfactual measure of the permanent tax/benefit change necessary to restore intertemporal fiscal balance. However, in this case, the tax/benefit adjustment only affects spending and revenue attributable to future generations. Moreover, the rebalancing policy would, in that case, have to be much larger, since not only would it start later in time, but for a long period only a fraction of taxpayers would contribute to it.

To be precise, in this case, it is only the revenue attributable to members of cohorts born after 2017 future that is scaled by a factor θ_T^{AKG} (or similarly for spending) to rebalance the intertemporal budget constraint. This makes the measure somewhat difficult to interpret.

With this adjustment, someone born in 2018 would face higher taxes during her life, but since she will only become a taxpayer at 18 (in our exercise), the adjustment would only start in 18 years' time. It would not affect people that were alive in 2017. In this example, a person aged 31 in 2050 would carry a share of the adjustment burden while a person aged 32 or above would not. This separation between currently alive and unborn not only is unrealistic, but it pushes the adjustment further in the future, making things worse as imbalances accumulate in the meantime. It is also too sensitive to changes in the discount/growth factor.

We believe this measure is conceptually interesting but not very instructive from a policy perspective. In any case, for comparison purposes, we compute it. We obtain a result of 1.57, reported in Table 6. This metric must be interpreted in the following way: in order to ensure fiscal sustainability, the revenues sourced from people born after 2017 must be 57% higher than those attributed to current generations as of 2017 (assuming no changes to the latter will ever occur). The corresponding metric for spending means that it would have to be cut by about half for future generations.

Table 6
AKG and IBG imbalance measures, base year 2017

θ_T	θ_T^{AKG}	IBG (ratio 2017 GDP)	IBG (billion euros)
1,22	1,57	5,37	1.052,42

Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

Table 6 also presents the intertemporal budget gap measures, which refers simply to the size of the total (approximately infinite horizon) imbalance that our projections imply. We measure an intertemporal budget gap in 2017 of 537% of GDP. This matches almost exactly the result for Portugal, of 538% of GDP, reported by the European Commission report of . This means, in 2017 prices, over 1 trillion euros. This result is highly sensitive to the assumptions for and , and as such must be taken with caution.

Technical box 4

A brief review of generational accounting

Several studies have used generational accounting and applied it to developed economies, focusing first on the US. The earliest exercise applying this methodology is due to Sturrock (1995) in a pub-lication for the Congressional Budget Office (CBO) that attempted to estimate the lifetime net tax rate necessary to finance all levels of the US government. It projected that, if tax-benefit policies were not changed, lifetime net tax rates on future generations (the AKG measure) would have to be extremely high levels (80-90 percent of national income).

Raffelhuschen (1999), under the patronage of the European Commission, published a comprehensive study with generational accounts for 12 EU member states. The main message is similar to that in Auerbach et al. (1998) (another international study): in many countries current policies were not sustainable.

Auerbach et al. (1998) included the first generational accounting study made for Portugal. Despite some data limitations, this study found that, under the authors' baseline assumptions, future generations in Portugal would face a roughly 50 percent higher fiscal burden than did current generations at the time.[a] More recently, Pinheiro (2018) finds the burden on future generations in Portugal would have to be close to 400 percent higher than on current generations to restore fiscal sustainability.

Berti et al. (2019), in a report to the European Commission, find less alarming numbers, using 2016 as their base year. In this report's baseline scenario (which projects the future effects of current policies) the imbalance factor indicator is 0.9, meaning that the lifetime net taxes for future newborns are lower than for current newborns.

This result looks counter-intuitive but is justified essentially because of the scenario takes into account changes in pension rules. In the static scenario (which assumes constant per capita revenues and expenditures), the imbalance is in line with the one estimated in Pinheiro (2018), at 380%.

As in this work we employ a different sustainability metric, and a different treatment of both age-mappable and age-uniform spending and revenue, we find different results to these studies.

[a] The authors conclude that part of this result for Portugal is due to a generous pension system, finding similar results for other countries.

Adjustment metrics based on single tax/benefit items

We can also assess what would be the permanent increase on a single tax or benefit necessary to restore intertemporal sustainability; i.e. if one specific tax or benefit program had to be used to solve the whole fiscal imbalance. Limiting the adjustment to a single fiscal item is unrealistic as a policy, but allows for a more intuitive interpretation of the size of the imbalance. Also, we can observe what would be the effort necessary if the rebalancing adjustment is focused on the expenditures and revenues more affected by ageing. Table 7 presents these metrics for selected tax-benefit items.

Table 7

Imbalance factors – individual spending/revenue items counterfactuals, 2017

Revenue item	θ_i	Spending item	θ_i
Age-uniform revenue	1,62	Age-uniform spending	0,48
Personal income tax	2,32	Old age pensions	0,49
VAT	1,96	Health care	-
θ_T	1,22	θ_g	0,81

Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

We focus on pensions and contributions. Social contributions would have to double permanently to restore the intertemporal balance. Or, alternatively, pensions should decrease permanently by more than half. Mind that this is beyond what would be necessary to ensure the social security system is balanced, since this counterfactual exercise means, e.g., that contributions adjust to compensate not just for higher pensions due to ageing, but for the imbalance due to all other revenues and expenditures. Also, the vast majority of spending items, such as healthcare, are not large enough to be able to, on their own, cover the imbalance, i.e. even if they were eliminated entirely, this would not be enough to close the gap.

4.2
THE LONG-RUN RELATIONSHIP BETWEEN FISCAL SUSTAINABILITY AND DEMOGRAPHY

Our results indicate that the change in the age *structure* of the population has a *structural* effect on fiscal sustainability. In this section, we clarify that the fiscal implications of ageing are not merely a transition phase lasting only while the "baby boomers" enjoy retirement. Instead, we show that the current age profile of spending and revenue is incompatible with the population pyramid that Portugal is converging to, given current trends in fertility and life expectancy.

Official projections imply that the age distribution of the population will be close to stationarity by 2100.[21] Actual age profiles of per capita revenue and spending, applied to the age structure of that year, result in a fiscal imbalance. This means that, under our generational accounting projection, this imbalance would carry on forever. This observation suggests that fiscal sustainability can only be ensured for the very long run by designing tax-benefit age profiles consistent with the stationary distribution of the population.[22] This approach would be a significant change from current views on fiscal policy and certainly has some counter-indications.

First, the population has not been stationary: wars, migrations, vaccines, health care, and other factors have contributed to a changing age distribution. In this case, it is the revenues and benefits per age that have to adjust periodically to guarantee long-term fiscal sustainability. Second, even if a level of development is reached where the causes of large fluctuations in population have been tamed, the population steady state can be associated with either growth, stagnation or decline of the total population size (this can be influenced by policy). Current projections for Portugal foresee a decline.

We remain agnostic on these critical points, which are societal choices beyond the scope of this work. In what follows, we interpret our results having this framework in mind.

21 In the official projections, expectancy and fertility are still slowly growing at that point. For more details on the population projection assumptions and methodology see Eurostat (2019).
22 Technical Box 5 presents this point in more detail.

Technical box 5
Fiscal sustainability with a stationary population

We present how to evaluate whether the revenue and spending age profiles are compatible with fiscal sustainability in an environment where the population is stationary.

Total population grows at the rate n_t determined by a set of fertility rates $f_{a,t}$ for each age a over time. We denote mortality rates as "probabilities of survival" $s_{a,t}$ between age a and age $a + 1$. The total population at time t is $Pt = \sum_{a=0}^{J} Pa,t$.

Therefore, the new born at $t + 1$ are given by $P_{0,t+1} = \sum_a f_{a,t} P_{a,t}$ and each cohort evolves according to:
$P_{a+1,t+1} = s_{a,t} P_{a,t}$

In the stationary population $f_{a,t} = f_a$ e $s_{a,t} = s_a$ $\forall a,t$ e $n_t = n$ $\forall t.$

After some algebra, it can be shown that population growth in that case is determined by the following equation:

$$1 = \sum_{j=1}^{J} \frac{f_j}{(1+n)^{j+1}} \prod_{a=0}^{j-1} s_a. \tag{4.12}$$

Having determined n, we can derive the complete stationary age distribution using:

$$1 = \mu_0 \left[1 + \sum_{j=0}^{J-1} \prod_{a=0}^{j} \frac{s_a}{(1+n)^{j+1}} \right] \tag{4.13}$$

and

$$\mu_{a+1}(1+n) = s_a \mu_a, \tag{4.14}$$

where μ_a is the share of population aged $\boldsymbol{a}$ in the total population.

Finally, with the stationary age distribution at hand, we can design a spending and revenue age profile $\{g_a, \tau_a\}$ that allows to respect, given $\{\mu_a\}$, the aforementioned government intertemporal budget constraint:

$$\sum_{a}^{J} (g_a - \tau_a)\, \mu_a = -\frac{B}{P} \cdot \frac{i-\gamma}{1+i}, \tag{4.15}$$

where B/P is per capita debt.

Using the fertility and mortality rates of a certain year, we can construct a counterfactual stationary population distribution. This distribution represents what the age structure of the population would be, if the fertility and mortality rates of that year had been previously observed for a very long time. This counterfactual distribution will never be observed in reality, as we know that fertility and mortality rates will not remain constant.

Figure 9
Empirical age distribution of the population in 2017 and counterfactual stationary distribution

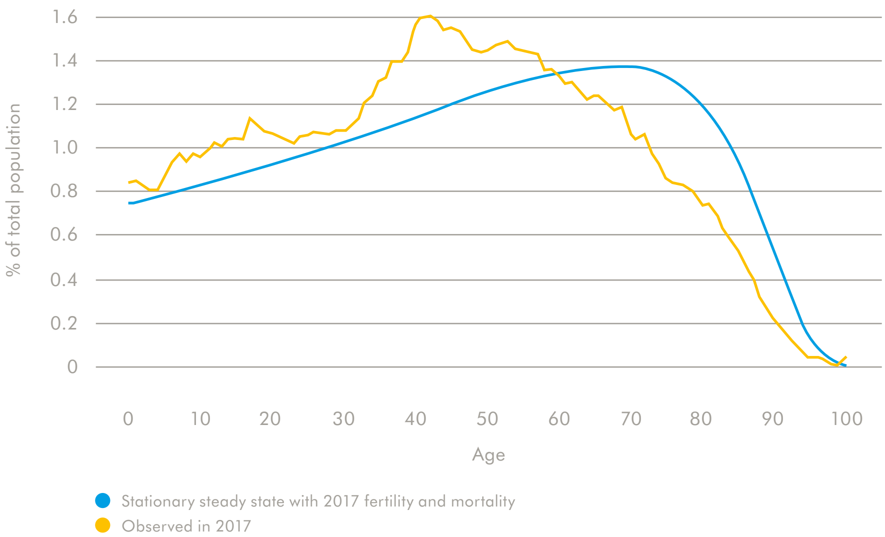


Figure 9 shows that the stationary distribution of 2017 is characterised by less young and active persons and more older persons.

Note that the actual distribution of 2017 is very different from this counterfactual. The large working age population results from the past history of mortality and fertility rates, namely the high fertility observed in the post-World War II period, that gave rise to the "baby boomer" generations.

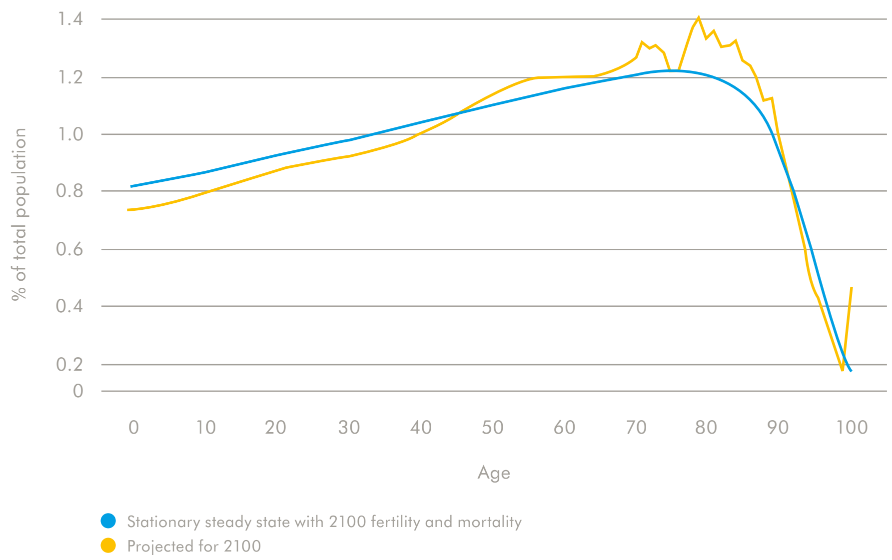
The primary deficit results from the combination of the current age profile of spending and revenues and the actual age structure ($\sum_a^J (g_{\bar{t},a} - \tau_{\bar{t},a})\, \mu_a$, where μ_a is the share of population age $\boldsymbol{a}$ in the total population). It is close to balance for $\bar{t} = 2017$. Clearly, then, if the tax-benefit age distribution does not change, a higher weight of older people in the population implies a deficit. As we have documented, older age groups receive more in (mostly pension) transfers than they pay in taxes (i.e. $(g_{\bar{t},a} - \tau_{\bar{t},a}) > 0$ for $a > 65$).

We can measure the structural incompatibility between the population parameters (fertility and mortality) and the tax-benefit age profiles, by computing imbalance factors based on the stationary distribution of population. If the 2017 counterfactual stationary distribution (i.e. with today's fertility and mortality rates) was in place and remained forever, we would obtain a imbalance, measured by $\theta_T = 1.17$.[23]

We can perform a similar exercise but using the fertility and mortality rates projected for 2100, looking at the counterfactual stationary population distribution for that year, plotted in Figure 10.

23 Under the same assumptions for growth and the interest rate as in our baseline.

Figure 10
Projected age distribution of the population for 2100 and counterfactual stationary distribution



In this case, the imbalance factor would be higher, up to θ_T = 1,25. As Figure 10 shows, in this period the projected population structure is already much closer to the corresponding stationary distribution.

4.3 SUSTAINABILITY METRICS OVER TIME

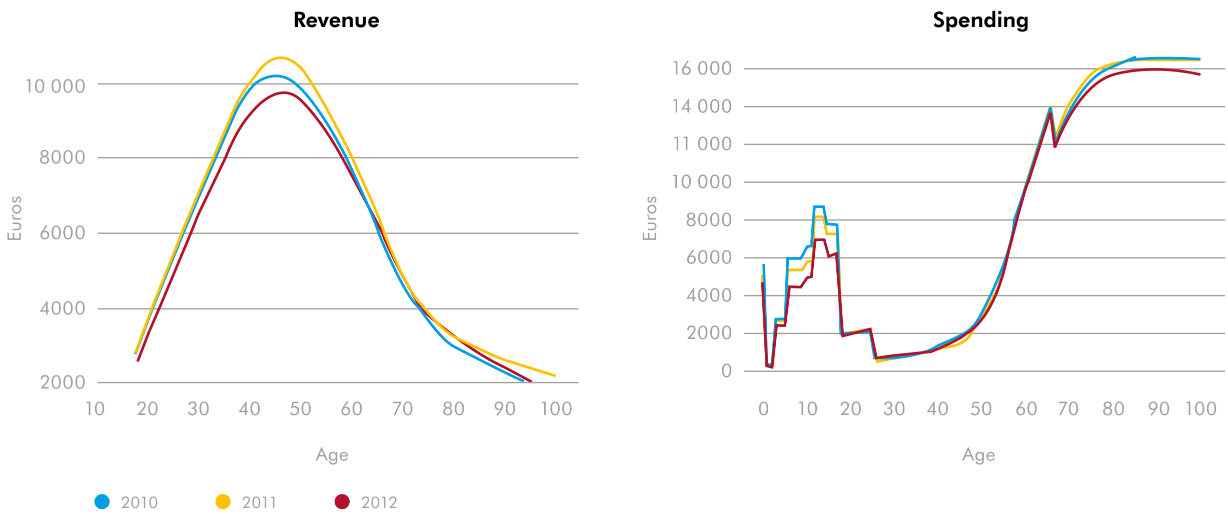
In this section we look at the evolution of the sustainability metric since 1996, which is as far as our data allows. We perform the same exercise described above, but using as a base period each of the years between 1996 and 2017. All the years are shown at 2017 prices. The goal is to observe the sensitivity of the sustain-ability metrics to cyclical fluctuations and base year choice. This is important because the projections are based on a specific base year[24] and, given a certain population projection, thesustainability metrics depend strictly on the revenue and spending age profiles of the base year. Moreover, with this long run exercise we can assess if the age profile of revenues and expenditures has evolved in a way to worsen or improve sustainability issues, by focusing on the more cyclically neutral years.

24 Although nothing prevents to use the average across several years.

Effects of the economic cycle

We look first at how the crisis of 2010-2012 would have affected our sustainability metrics. The first panel of Figure 11 shows that the shape of the age profiles of average revenues shifts up and down with the cycle. In 2012, the year where the recession hit the hardest, revenues declined across all ages, though more in the working ages. This is consistent with lower revenues due to income taxes in those ages as a result of a temporary increase in unemployment, which would not affect those in retirement. The second panel of Figure 11 shows that, in the same year, average expenditures decreased somewhat for the high-spending ages (school children and retirees).

Figure 11
Age-mappable revenue and spending, per capita (males) for 2010, 2011 and 2012.



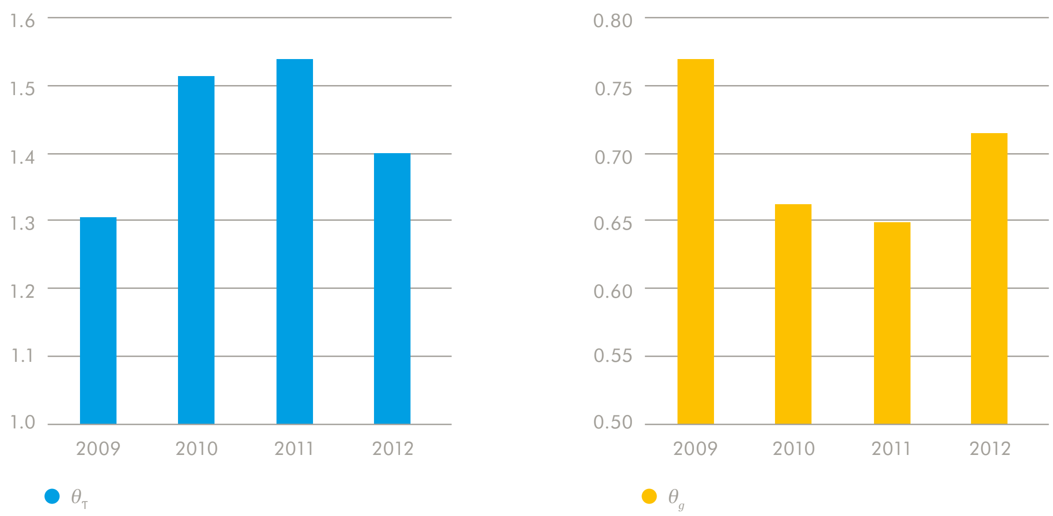
Source: Authors' calculations based on Eurostat and Statistics Portugal data.

Figures in 2017 prices.

We also report, in Figure 12, the evolution of θ_T and θ_g[25] during the 2007-2017 period. These metrics worsen significantly in the crisis, starting in 2009, when the global recession hit the Portuguese economy. This was followed by years of high primary deficits, affecting projected sustainability.

25 Recall that θ_g though slightly different, correlates exactly with θ_T.

Figure 12
Sustainability imbalance factors, 2009-2012



Source: Authors' calculations based on Eurostat and Statistics Portugal data.

The fact that θ is very sensitive to the initial fiscal position is a potential issue recognised by the generational accounting literature. Picking a base year that is neutral in terms of the business cycle is, then, crucial for the usefulness of its sustainability analysis. This ensures that the contribution of demographic trends for public finances sustainability is not confounded by cyclical imbalances: many automatic stabilizers, such as income taxes or unemployment benefits, have a heterogeneous age profile and age-uniform spending is also somewhat pro-cyclical. Furthermore, discretionary policies taken in times of crisis may also distort the age structure of taxes and benefits.

Another approach is to keep track of these sustainability metrics every year over a long period. Since it is hard to determine a stationary age structure of revenue and spending, not to mention the dating of the business cycle, observing θ repeatedly over the years can give a more robust idea of the imbalance faced in the long run.

Long-term changes: 1997-2017

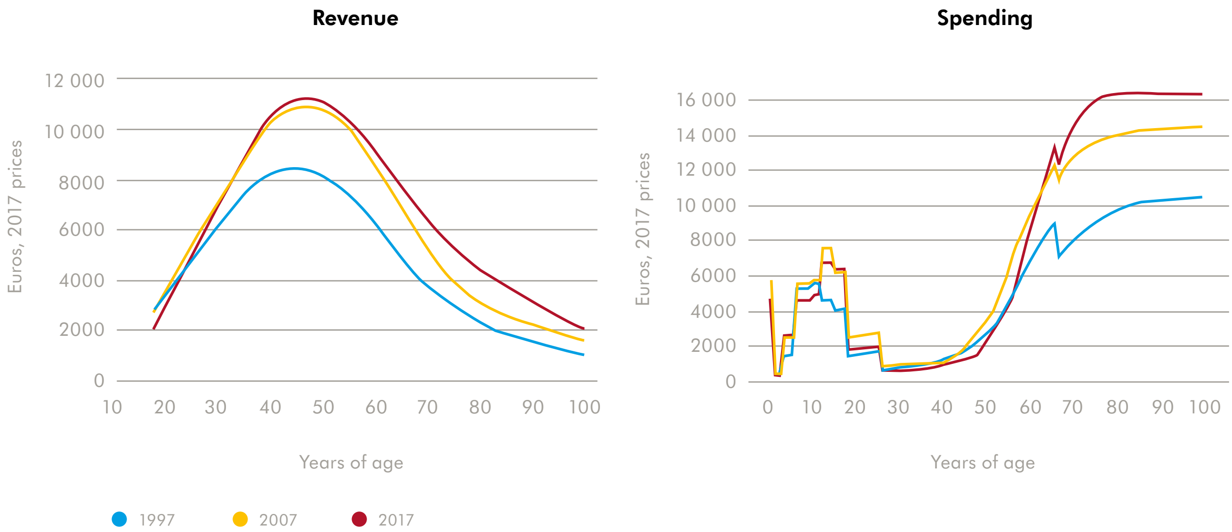
The left hand side panel of Figure 13 compares the age profiles of average revenues in 1997, 2007, and 2017 – three neutral years in terms of the output gap.[26] The curve shifts up from 1997 to 2007, and again from 2007 to 2017, which comes from both economic growth and a higher average tax burden.[27] From 1997 to 2007, he revenues from working ages increased more than the older ages. Then, from 2007 to 2017, the opposite occurred, with the revenues from taxpayers aged 60 and over increasing more than those from younger ones. It can be seen also that revenues attributed to individuals below 25 years old actually decreased from 1997 to 2017. This is consistent with higher participation in post-secondary education (and as such a later start to paid work careers).

The profile of expenditures, shown in the right hand side panel, also changed. In the younger ages, it seems that per capita expenditure (mostly education) increased from 1997 to 2007, but in the following

26 Since our data does not give us distributions for PIT prior to 2004, the change may be larger than apparent here.
27 The tax burden rose from about 30% to 34% of GDP (AMECO) in this period.

decade has either decreased (the case of school years 5-18) or remained very similar (university). Spending attributable to the working ages up to 50 years old has actually decreased from 1997 to 2017. For ages above 55, spending increased a lot from 1997 to 2017, especially over the first ten years (in which economic growth was higher). The distribution of spending became, as such, much more skewed towards the older ages.

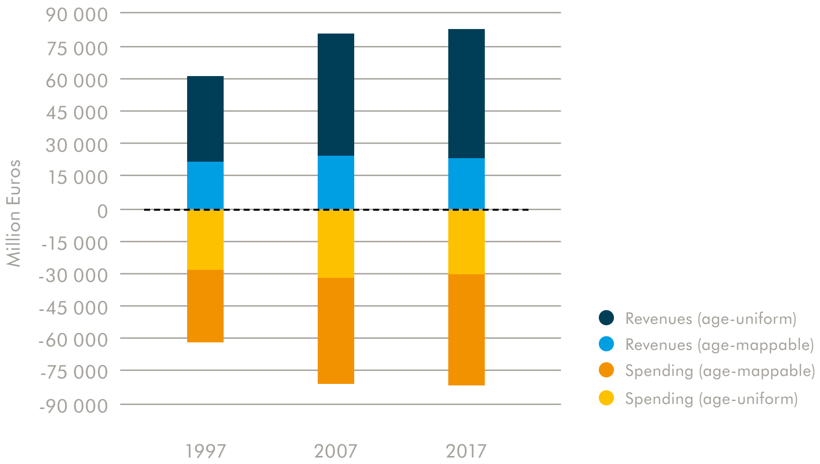
Figure 13
Age-mappable spending and revenue per capita (males) for 1997, 2007 and 2017.



Source: Authors' calculations based on Eurostat and Statistics Portugal data

These were three years of small positive primary surpluses: slightly higher in 2017, at 0.8% of GDP, than in 1997 and 2007 (0.1%). Although the size of the government budget grew substantially (above GDP), the growth of revenues more than offset the growth of spending. Also, the weight of age-sensitive spending and revenues increased, as Figure 14 illustrates.

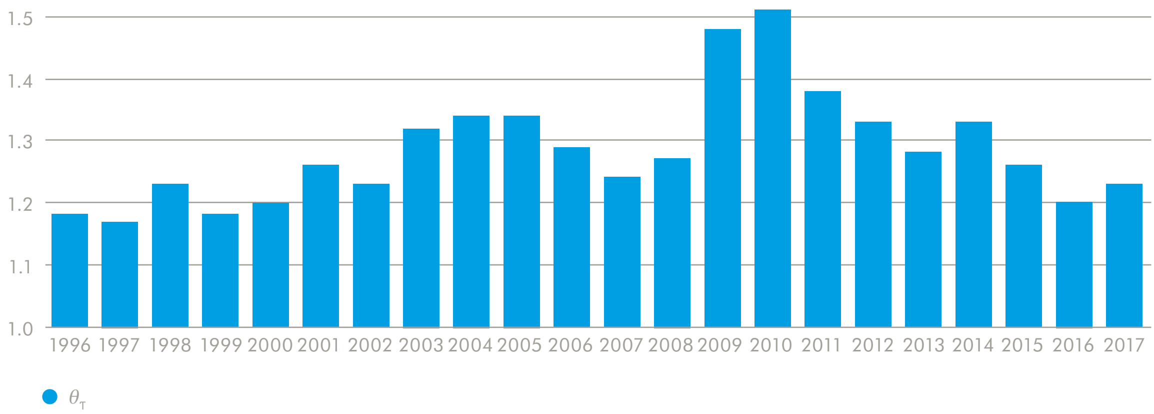
Figure 14
Age-uniform and age-mappable components of the primary balance for 1997, 2007 and 2017



Source: Authors' calculations based on Eurostat and Statistics Portugal data

Over this period, the imbalance metrics changed a lot in times of crisis, but are relatively stable in the long run,[28] as Figure 15 shows.[29]

Figure 15
Sustainability imbalance factor, 1996-2017



Source: Authors' calculations based on Eurostat and Statistics Portugal data

28 This is considering the same assumptions for r and g and the ex post population estimates in 2017. A relevant exercise for future work is to perform the same estimates with the population projections available at the time.

29 A deep crisis such as the COVID-19 one entails significant changes to the age profile of revenue and spending. Revenues from the most important taxes (where working ages weigh more) fall, while spending increases (here the impact across ages is harder to assess). Both result in measuring a rather worsened imbalance factor, if we take 2020 (or possibly one of the following ones) as base year. However, such changes to taxes are temporary, associated with the recession. The deterioration of the imbalance factor would not reflect any structural effect of demographics, which it is intended to capture. This is a good example of the importance of using as base year a period where the economy is growing at a moderate pace, close to potential (output gap near zero).

The imbalance measured as of 2017 is significantly higher than the one obtained in the beginning of the period, despite the fact that the primary balance was slightly worse in the latter.

The improvement of the primary surplus in 2018

Complete data for 2018 was not available for a full analysis in time for inclusion in this report, namely we do not have the age distributions of spending and revenue for this year. For this reason, we kept 2017 as the benchmark for our analysis. Still, we were able to recompute the sustainability factor using aggregate data for 2018 (keeping the tax-benefit age profile as of 2017).

2018 was a year marked by a substantial improvement of the primary surplus, from 0.7% to 2.9% of GDP (it has since remained stable around 3%).

As discussed, the initial fiscal position is important for our sustainability metrics, as it is tightly linked to the age structure of expenditures and revenues. For example, the 2018 improvement in the primary surplus was explained, among others, by a strong increase in direct taxes and social contributions (in line with strong employment growth). Other things equal, this has a positive effect on fiscal sustainability, as it counteracts the effect of change in the age structure of population.

The imbalance factors obtained from a projection based in 2018, presented in Table 8, improved with respect to those of 2017. They are not a very accurate measure; without updating the age profiles of revenue and spending, the difference may be somewhat overstated.

Table 8
Sustainability imbalance factors, 2017 and 2018 base year projections

Base year	θ_T	θ_T^{AKG}
2017	1,22	1,58
2018	1,17	1,43

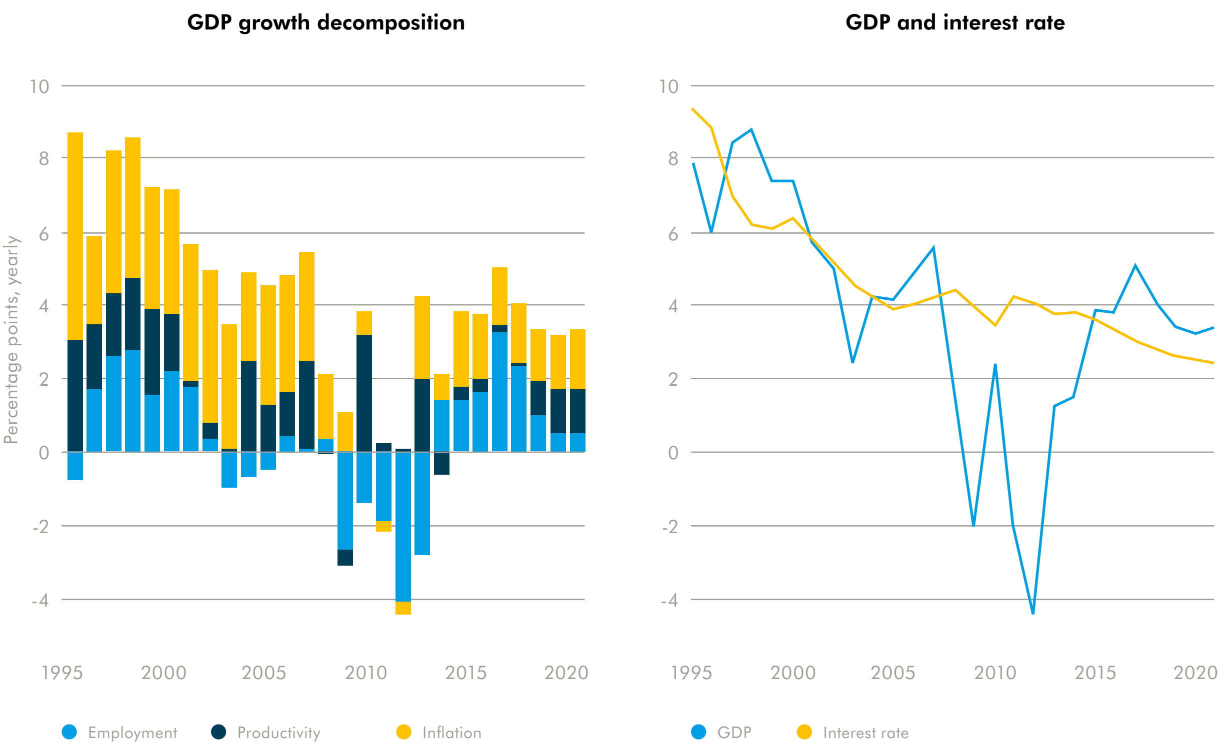
Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

4.4
MACROECONOMIC SCENARIOS

Two central variables for these projections are the interest rate and the growth rate of GDP, as in this partial equilibrium exercise, all of the projected dynamics, apart from those related to population, are determined by the relationship between these two figures. If the interest rate is below the growth rate, the IBC loses its meaning and our generational accounting exercise cannot be performed.

The latter case, which appears empirically relevant for at least a few advanced countries , is one where the debt sustainability issue becomes less pressing. Yet, the data in Figure 16 and Table 9 show that in Portugal, for the period 1995-2021,[30] the interest rate has been on average higher than the GDP growth rate. The severe crisis between 2010 and 2012 contributed to this, but this pattern is present even if those years are excluded.

Figure 16
GDP growth decomposition and interest rate



Source: AMECO

30 Data on GDP growth are available since 1960 and on debt service since 1980. However, the large transformations occurred in Portugal during the 1970's and 1980's suggest to use these data with caution. Official national accounts in Eurostat only start in 1995.

Table 9

Nominal GDP growth rate decomposition, nominal implicit interest rate on government debt and population growth rate in Portugal.

	γ	$\approx \gamma^e$	$+ n^e$	$+ \pi$	i	n
1995-2021	3,85%	1,09%	0,36%	2,33%	4,58%	0,10%
1995-2009 e 2013-2021	4,77%	1,14%	0,87%	2,68%	4,69%	0,14%

Source: European Commission, AMECO.

γ^e denotes the growth rate of productivity. π denotes the inflation rate. n^e denotes the growth rate of the working population. The first line shows the average value between 1995 and 2021. The second line shows the same average excluding the crisis years 2010, 2011, 2012.

In normal times, the nominal interest rate on debt and GDP growth closely track each other, but during a crisis they diverge. The case of Portugal shows that when there is a sudden stop in external financing, the interest rate jumps above nominal growth. Given that the future path of interest rates and GDP growth are difficult to forecast, we use the historical values of Table 9 for our projections. The value we employ in our projection is actually the growth rate of productivity, as the other component in real growth, the growth rate of the working population, is determined by the population projections. Our benchmark uses the average over the whole sample, with an interest rate 0.9 p.p. above the GDP growth rate.

We present, in Table 10, the imbalance factors obtained by performing our projections using a lower growth rate and one very close to the discount rate, so as to approximate the $i = \gamma$ case.[31] The projected imbalance, as measured by our preferred metric, is not very sensitive to the change in assumptions for interest rate and growth. In our view, this makes it most suited to the measurement of the generational imbalance induced by ageing.

The AKG and IBG imbalance factors, as they depend more on these assumptions, must be interpreted with more care, since they reflect not only the impact of ageing, but also its interaction with productivity growth.

31 In the latter case we employ a larger projection horizon to ensure convergence.

Table 10

Imbalance factors obtained from projections with different assumptions for productivity growth and interest rate (2017 base year).

γ^e	θ_T	θ_T^{AKG}	IBG
1,09	1,22	1,57	5,37
0,00	1,21	1,97	3,75
2,25	1,23	1,27	24,70

Source: Author's calculations based on EU-SILC, HFCS, IDEF and Eurostat.

The first row represents the baseline scenario. The nominal interest rate of 4.58%, inflation and population are the same in all scenarios. Values for the productivity growth rate (γ^e) and interest rate assumptions in percentage terms.

To understand this result, recall first from Figure 8 that, holding constant the tax-benefit age profile of 2017, demographic change would transform the small primary surplus of 2017 into a large, permanent deficit.

Under this assumption, each year all per capita taxes and benefits grow at a (constant) productivity growth rate. Then, in euro terms, a higher value of the growth parameter γ means larger deficits over time, because both expenditures and revenues increase.[32] This means that the "intertemporal budget gap", the infinite sum of primary deficits (plus the outstanding debt in 2016), also becomes larger.

In the case of our sustainability imbalance metric (θ_T), increasing γ has two consequences. One increases the measured imbalance: the degree to which future discounted revenues cover future discounted spending, measured as of today, becomes smaller. The other decreases the measured imbalance: since future revenues grow more, the burden of the initial outstanding debt becomes less important. In our empirical case, these two effects almost offset each other, such that the metric has a small sensitivity to changes in γ.

In the case of AKG metric (θ_T^{AKG}), these two effects are present, but a third one is added. Current generations are protected from the adjustment, which generates additional deficits in the first decades of the projection. This creates an additional debt (much larger than the initial outstanding debt). A higher value of γ makes the burden of this additional debt relatively smaller, in terms of the revenues coming from future generations (which will need to cover that new debt). This additional effect explains why the AKG metric becomes smaller with an increase of γ.

32 Technically, this effect comes from the fact that, in the discounted sums of revenue and spending, increasing assigns a larger weight to periods where the age structure implies larger imbalances. See Technical Box 6 for details.

The bottom line is that higher growth does not per se reduce the imbalances created by demographic change.[33] In one sense, it is the opposite: higher productivity growth means that both the spending and rev- enue sides of the budget grow more. If the combination of the age structure and the tax-benefit age profile leads to an imbalance, higher growth means future imbalances, measured as of today, will be larger too.

On the other hand, higher growth means that legacy debt burdens become smaller in comparison to future revenues. If future generations are richer relative to current generations (as a result of higher growth), they can more easily carry the burden created by delaying the adjustment. But it would remain, in any case, substantial.

The implications of our results for the impact of ageing on the long-term sustainability of public finances are very significant. If the 2017 age profile of revenue and spending were to remain constant, fiscal sustainability would require a permanent increase of 22% of revenues (approximately, of the overall tax burden). This is not simply a temporary effect of the demographic transition. We show that the actual distribution of expenditures and revenues is inconsistent, in a structural sense, with current trends of fertility and life expectancy (and the stationary age distribution of population that they imply). This result is invariant to alternative scenarios of economic growth.

33 This conclusion is true under the constant tax-benefit age profile assumption. With this assumption, higher growth increases both taxes and benefits by the same factor. In reality, future growth would have a differential impact on both sides of the budget. For example, pension payments within the first decades of the projection depend on wages paid before the base year and so would not grow as much.

Technical box 6
Sensitivity of the imbalance metrics

Consider the expression for our imbalance measure θ_T:

$$\theta_T = \frac{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s \tilde{g}_{\bar{t},a} P_{\bar{t}+s,a}}{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s \tilde{\tau}_{\bar{t},a} P_{\bar{t}+s,a}} + \frac{B_{\bar{t}-1}}{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s \tilde{\tau}_{\bar{t},a} P_{\bar{t}+s,a}}$$

The first term represents the degree to which revenues will cover expenditures, the second term represents the degree to which revenues will cover the current outstanding public debt.

Consider a case where the population is constant ($P_{\bar{t},a} = P_{\bar{t}+s,a} \; \forall a, s$) and the economy is in a stationary state.

The stationary version of θ_T becomes:

$$\theta_T^{stationary} = \frac{\sum_{a=0}^{J} \tilde{g}_a \mu_a}{\sum_{a=0}^{J} \tilde{\tau}_a \mu_a} + \frac{b}{\sum_{a=0}^{J} \tilde{\tau}_a \mu_a} \cdot \frac{i-\gamma}{1+i}$$

where $b = \frac{B}{P}$ is debt per capita.

Sensitivity to the initial outstanding public debt stock

The sensitivity of θ_T to the initial public debt is generally small in absolute terms. Look first at the stationary version of θ_T, abstracting from population dynamics. The second term will tend to be small as i - γ is close to zero. This is because sustainability only requires that revenues must be able to service the public debt, adjusted by growth ($b \times (i - \gamma)$).

Concretely, in the empirical θ_T the infinite horizon sum of discounted revenues is (for any realistic discount rate) an order of magnitude above the stock of outstanding debt. In our baseline case, the first term is 1.18, and the second (debt) term is 0.04 ($B_{\bar{t}-1}$ ≈ 200 and $\sum_s \sum_a D^s \tilde{\tau}_{\bar{t},a} P_{\bar{t}+s,a}$ ≈ 5000 billion euros). Suppose the public debt was 50% higher (from 126% to 190% of GDP); this would increase θ_T by only 0.02 (from 1.22 to 1.24).

In relative terms, this would increase the measured imbalance by only 9%. (Recall that the distance of θ_T to 1 measures the permanent tax increase necessary to restore sustainability. So θ_T 1 measures the size of the imbalance.)

However, the sensitivity of the metric in relative terms could be large, if future population dynamics did not imply large primary deficits. Suppose that the first term of θ_T was equal to 1. Then, other things equal, the 50% higher public debt would change the metric from 1.04 to 1.06; the measured imbalance would be 50% larger.

Sensitivity to the growth rate

In our projections we assume that revenues and expenditures keep a constant age profile and grow, in per capita terms, at rate g. Under a stationary population, this would imply that the first term is independent of g. The second term, in contrast, depends negatively on g. Since future revenues grow at rate g, a higher g makes it easier for them to cover the initial outstanding debt (which is fixed).

Let us again consider the empirical case. Rewrite θ_T so as to highlight the dynamics of the population age structure (dividing the above expression by $P_{\bar{t}-1}$):

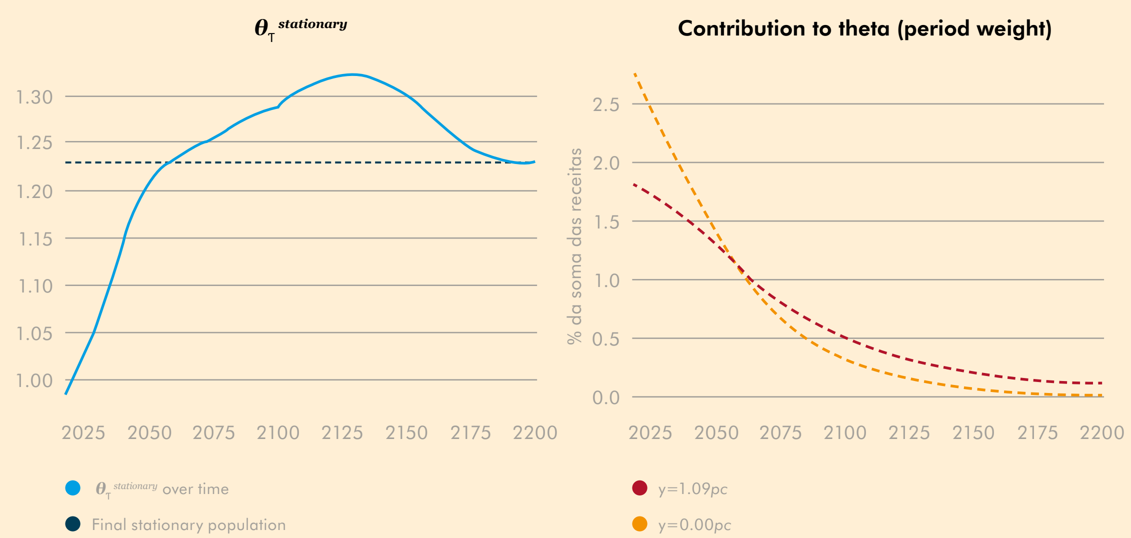
$$\theta_T = \frac{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s \tilde{g}_{\bar{t},a}\left(1+n_{\bar{t}+s,a}\right)\mu_{\bar{t}-1,a}}{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s \tilde{\tau}_{\bar{t},a}\left(1+n_{\bar{t}+s,a}\right)\mu_{\bar{t}-1,a}} + \frac{b_{\bar{t}-1}}{\sum_{s=0}^{\infty}\sum_{a=0}^{J} D^s \tilde{\tau}_{\bar{t},a}\left(1+n_{\bar{t}+s,a}\right)\mu_{\bar{t}-1,a}}$$

Unlike in the stationary case, a change in g now also affects the first term of θ_T. Note that $D^s\left(1+n_{\bar{t}+s,a}\right)$ is the weight in the first term of θ_T of the age structure in period $\bar{t}+s$ (given $\left\{\tilde{g}_{\bar{t},a}, \tilde{\tau}_{\bar{t},a}\right\}$ fixed). A change in γ alters these weights. The sign of the effect will depend on the projected population structure, which implies a certain path for the deficit.

The left panel of Figure 17 plots the stationary metrics obtained with the projected population shares (i.e. $\theta_T^{\,stationary}$, as if the age distribution of each year was a stationary one). This measures the fiscal imbalances that arise over time from combining the tax-benefit profile of 2017 with the projected population of each year.

Figure 17

Stationary counterfactual imbalance metrics and period weights in the empirical θ_T , 2017-2200.



Specifically, in our projection, in 2020-2050 people of net recipient ages represent a smaller share of the population than in the stationary benchmark, implying smaller deficits. However, that share is quickly increasing up to 2050.

Afterwards, the share of net recipient ages (mainly retired ages) increases more slowly from 2050 on, but with larger deficits than in the stationary benchmark. From 2130, the imbalance implied by the age structure begins to decline, and approaching the year 2200, the population in the projections converges to a stationary distribution, and so does the implied $\theta_{\mathrm{T}}^{estacionario}$.

A higher value for γ increases the weights of the latter periods, where the age structure implies larger deficits, in the empirical θ_{T} and it reduces the weight of the former periods, where the deficits are smaller (this is plotted in the right panel of Figure 17). This shift has a positive effect on the first term of the empirical (meaning the measured overall imbalance is worse).

This is because the large deficits projected for 2070, 2080, etc. become larger in euro terms relative to the surpluses of today. As such, they weigh more in the government intertemporal budget constraint, measured as of today; θ_{T}, which measures the infinite horizon imbalance, becomes larger. This effect is stronger than the negative effect coming from the debt term, but they are relatively similar in size. So the overall effect of a higher γ on the empirical θ_{T} is positive, but small.

The AKG metric, on the other hand, is more sensitive to changes in γ. In the AKG metric there is an additional negative effect, which comes from the term with the current generation deficits:

$$\theta_{\mathrm{T}}^{AKG} = \frac{\sum_{s=0}^{J}\sum_{a=s}^{J} D^s \left(\tilde{g}_{\bar{t},a} - \tilde{\tau}_{\bar{t},a}\right)\left(1+n_{\bar{t}+s,a}\right)\mu_{\bar{t}-1,a}}{\sum_{s=1}^{\infty}\sum_{a=0}^{min\{s,J\}} D^s \tilde{\tau}_{\bar{t},a}\left(1+n_{\bar{t}+s,a}\right)\mu_{\bar{t}-1,a}} + \frac{\sum_{s=1}^{\infty}\sum_{a=0}^{min\{s,J\}} D^s \tilde{g}_{\bar{t},a}\left(1+n_{\bar{t}+s,a}\right)\mu_{\bar{t}-1,a} + b_{t-1}}{\sum_{s=1}^{\infty}\sum_{a=0}^{min\{s,J\}} D^s \tilde{\tau}_{\bar{t},a}\left(1+n_{\bar{t}+s,a}\right)\mu_{\bar{t}-1,a}}$$

It can be shown that an increase in γ will decrease the size of this first term.[a] The overall effect of an increase in γ becomes larger and negative. The reason is that, with a higher γ the discounted revenues to be obtained from *future* generations are larger relative to the debt generated by the deficits coming from *current* generations (who are spared from the adjustment). This dominates the other two effects that are also present in our preferred metric.

[a] Note that, in this first term, the numerator is a finite sum while the denominator is an infinite sum, and both have the same weights $D^s\left(1+n_{\bar{t}+s,a}\right)$, where $D > \gamma$.

5.

ALTERNATIVE **POLICY SCENARIOS**

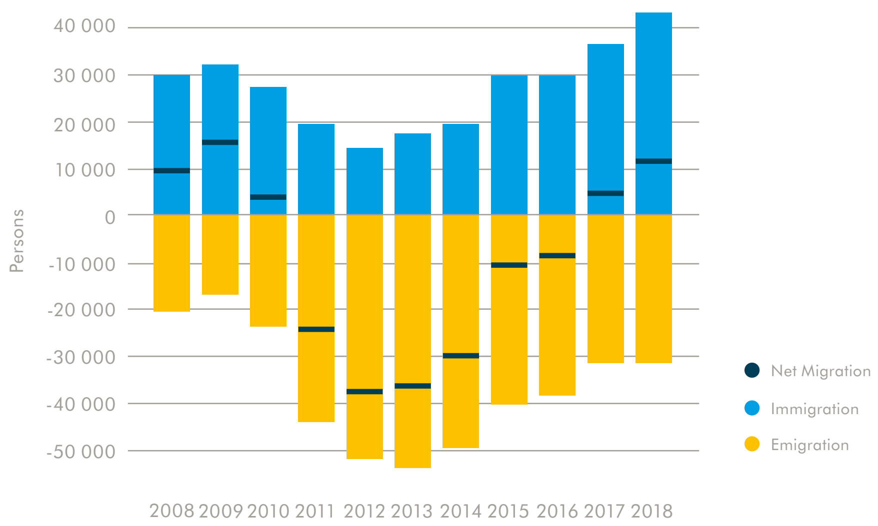
In the previous section, we discussed the significant impact that the ongoing ageing process has for the sustainability of public finances. While this is not new, we shed light on this issue by exploring a baseline scenario, pinpointing the effect on public finances of the changes in the population structure by holding everything else constant.

Our framework clarifies that the two possibilities to prevent the accumulation of fiscal imbalances are to either change the population dynamics or the age distribution of taxes and benefits. Both are often discussed in policy debates, the first via fertility and immigration policies; the second by reforming social security, namely the public pensions system. In this section we explore these topics using our generational accounting exercise.

5.1 MIGRATION

Migration policies are a tool to complement or substitute possibly undesirable changes in taxes and government spending policies. Portugal registered positive net migration from the start of official migration statistics in the 1990s up until the 2009 crisis, explaining the increase of the population in this period. During the crisis, this trend changed, and 2012 registered the most significant level of negative net migration, contributing to a population decrease of 30000 persons. Very recently, net migration turned again and became slightly positive. Figure 18 shows the evolution of immigration, emigration and net migration in the period 2008-2018.

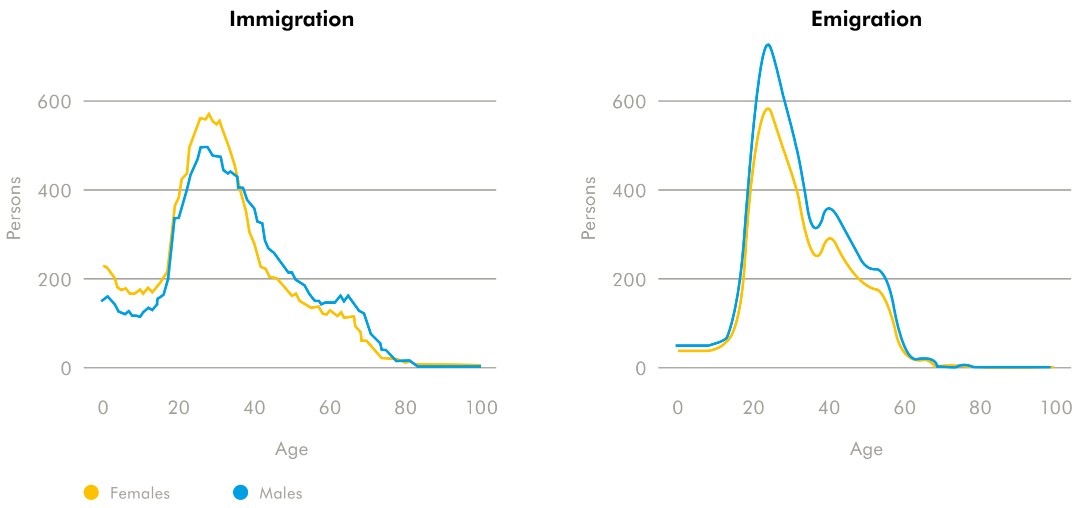
Figure 18
Migration, 2008-2018



Source: Eurostat.

The latest projections, that include a positive net migratory flow, imply that the Portuguese population will reach 6.6 million in 2100 (instead of 5.6 million in the scenario without migration[34]). While this is a significant difference in terms of total population, it does not change sufficiently the age structure of the population. Figure 19 shows the immigration and emigration flows by age in 2017.

Figure 19
Immigration and emigration by age and gender, 2017



Source: Eurostat.

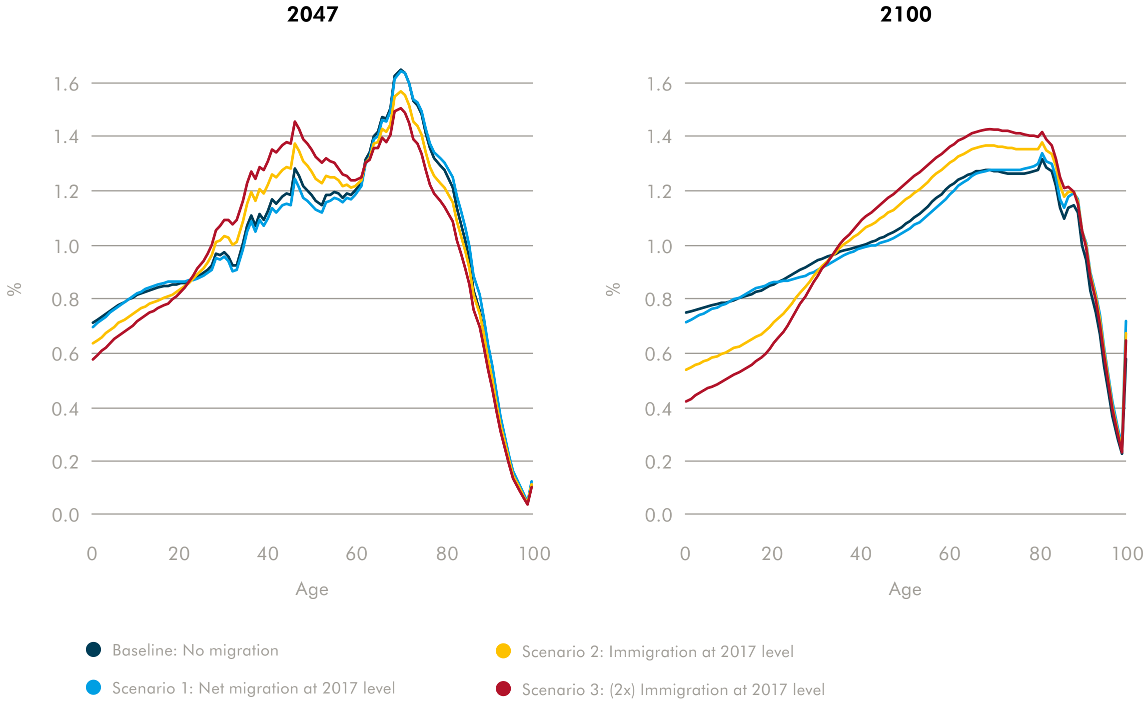
The age distribution of immigrants and emigrants appears to be fairly similar except for the younger and older cohorts.[35] For this reason, net migration has a small effect on the age structure of the resident population.

Could an active migration policy make public finances more resilient to ageing? We think of emigration as a difficult margin to control: if people have better opportunities abroad they are free to leave. Immigration, on the other hand, can be a relevant margin. It is beyond the scope of this work to discuss migration policies in detail. We can, nevertheless, produce counterfactual simulations of the imbalances under different migration scenarios. The goal is to understand whether a successful migration policy (or an exogenous immigration flow) could significantly mitigate the ageing-induced fiscal imbalance that is currently expected.

We test several counterfactual scenarios of migration. A first one, where we assume that the net migration values of 2017 are maintained throughout the projection period.[36] A second, where we increase net migration, by assuming zero emigration and keeping the immigration level of 2017. In a third case, with even higher net migration, we assume zero emigration and double the immigration of 2017 throughout the projection period. Figure 20 shows the age distributions in 2047 and 2100 implied by the three different scenarios.

34 The net immigration scenario should dampen certain consequences of the lower population on the Portuguese economy that we have not discussed here.
35 One aspect we are not yet able to incorporate in our simulations is the fact that older immigrants are likely to receive their pensions from different fiscal jurisdictions and do not have claims on the Portuguese social security system. This should improve the fiscal balance with net migration. Another aspect we are not able to incorporate is the difference between immigrants and emigrants in terms of skills and fertility.
36 This scenario is different from the Eurostat main scenario with migration, which we do not consider here.

Figure 20
Age structure in 2047 and 2100

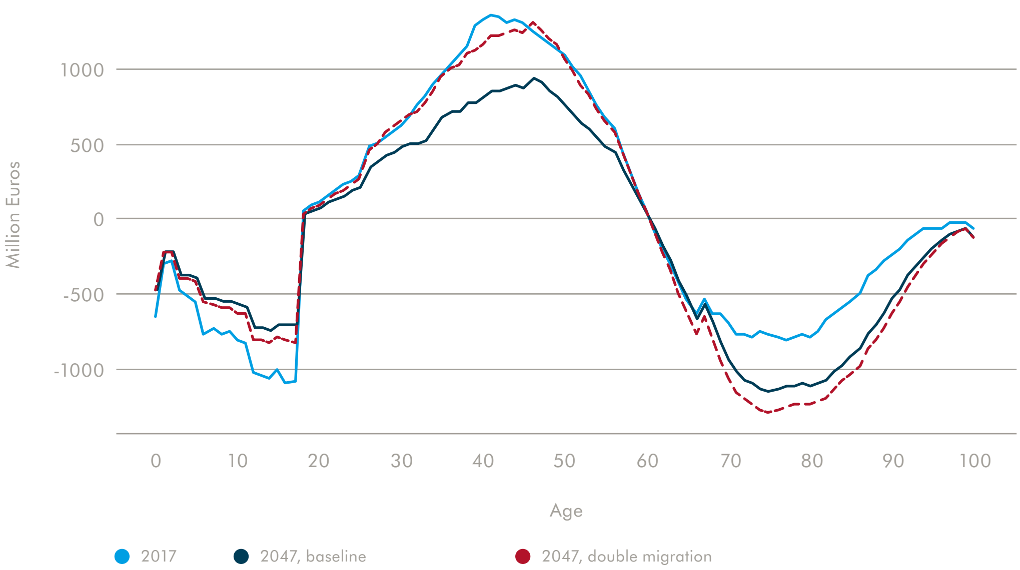


Source: Author's projections and Eurostat.

The blue line shows the age structure of the population in our baseline scenario. The red line shows the age structure of the population with net migration values of 2017 maintained throughout the projection period. The orange line shows the age structure of the population in the scenario where emigration is zero and immigration at 2017 values throughout the projection period. The green line shows the age structure of the population in the scenario where emigration is zero and we double the 2017 immigration values throughout the projection period.

The favourable immigration scenarios both imply a larger working age population for 2047 relative to the baseline. The current net migration scenario is almost indistinguishable from our baseline, because actual net migration is small. The larger working age population in the favourable immigration scenarios decrease the projected imbalances. In the double immigration scenario, in 2047, looking only at the impact of demographic change (no growth and no discounting), the primary surplus would drop from €1.3 billion in 2017 to –€9.3 billion in 2047. In the no immigration baseline it falls to –€14 billion in the same time frame. Figure 21 shows the contribution of each age group to these primary balance figures in the double immigration scenario, which can be compared with Figure 6 for the baseline scenario.

Figure 21
Net government revenues distributed by age, 2017 and 2047, "double migration" scenario.



Source: Author's projections and Eurostat.

The fertility rate is not changed by immigration in our simulations. For this reason, like in the no migration scenario, Figure 21 shows that the net contribution for the schooling ages is smaller, due to lower spending on education. Immigration helps by increasing the working age population, allowing the (tax and contributions) revenues of that age class to remain roughly at the same level of 2017. The last two points, the lower number of children and the higher number of working age have a positive effect on the primary balance relative to the baseline scenario. However, since the mortality rate is unchanged in this scenario, the negative net contributions of the old remain large, in fact larger than in the baseline scenario as the size of these age groups increases due to the ageing of immigrants. The former positive effects are not enough to compensate for this large additional net spending.

We report the imbalance metrics in Table 11 under our different scenarios. The first column reports our main imbalance factor, as described in Section 4.

Note first that the scenario based on the 2017 values for migration (second row) predicts a higher imbalance than in our benchmark with zero net migration. The ageing of immigrants, aggravated by emigration in the working ages, leads to this result.

In the counterfactual scenarios where we shut down emigration, the imbalance factors decrease because, as explained, immigration improves revenues as more taxes and contributions can be collected from a larger active population. While there will also be more old people retiring in the future, implying higher spending, the effect is still substantial: implies an improvement of over 1% of GDP per year. With double immigration, the improvement goes beyond 2% of GDP.

Table 11
Sustainability imbalance factor under different migration scenarios

Migration scenario	θ_T
2017 Baseline (no migration)	1,22
2017 Net migration	1,24
2017 only migration	1,20
2x 2017 immigration	1,18

5.2 PENSIONS

Pensions are the largest of the expenditure items concentrated on the older ages, in terms of per capita average spending. Their importance in the government budget is such that old age pensions are already the largest single expenditure item, in aggregate terms (Table 3 in Section 3.1). As such, the evolution of pension payments is a critical determinant of the age profile of per capita spending.

While a constant structure of per capita expenditures is a useful benchmark, in the case of pensions the age distribution will certainly be different in the future, under current policies. First, because pensions paid today are the result of a combination of different rules that were in place over time, as benefits were first attributed to some current pensioners many years ago. Second, even those on the verge of retiring now will receive benefits calculated with a mix of old and current rules ("grandfathering"). As such, the age distribution of pensions would only reflect the contemporaneous legislation after many years of constant policies.

The social security system in Portugal can be quite complex, in particular, regarding retirement benefit concession rules. Issues such as the coexistence of multiple pre-existing systems (public servants system, bank employees' system) or the aforementioned grandfathering contribute to this complexity. For these reasons, accurately forecasting pension expenditure, let alone the future impact of pension reforms, is not easy, despite the availability of detailed demographic projections. Moreover, the credibility of policies also plays a role, as a no-policy-change projection fails if rules are changed later on, or if *ad hoc* policies are implemented – this has been the case of the last few years, with successive "extraordinary" pension increases.

Even so, we perform two exercises that attempt to introduce the eventual future implications of current legislation in our framework, so as to assess their impact in terms of our imbalance metrics. The results are presented in Tables 13 and 14 below.

Retirement age increase

One of the most significant changes in pension attribution rules is the periodic retirement age increases, triggered automatically in reaction to increases in life expectancy. We introduce this in our accounts in a simple way: we "shift" the age distribution of pensions forward over the projection period, in order to match the increases in retirement age that will take place in the future given current mortality projections (see Table 12). We also adjust the age profile of some other taxes and benefits for consistency (see Technical box 7).

Table 12
Qualifying condition for retiring

Year	2020	2030	2040	2050	2060	2070
Retirement age	66A/6m	67A/2m	67A/9m	68A/3m	68A/10m	69A/4m

Source: Instituto da Segurança Social.

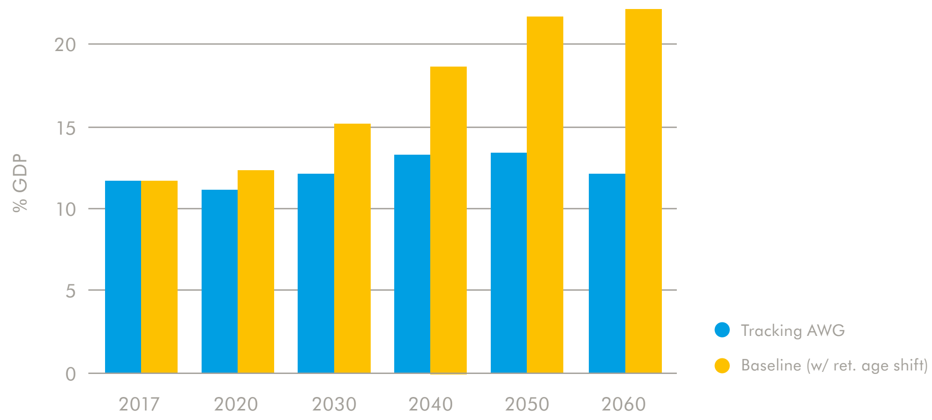
Tracking the Ageing Report forecast

The forecasts performed by the Portuguese Ministry of Finance for the European Commission Ageing Working Group (the "Ageing Report", henceforth AWG) are the most readily available and up to date long term pension forecasts. They are developed within a pension model that is meant to be consistent with current pension legislation. We use their results to adjust per capita pension spending in our projections, in order to approximate the pension cuts implied by legislation (see Technical box 8).

We assume the distribution of per capita expenditures changes in accordance with the legislated retirement age increases as described above. We then find the necessary adjustment (cut) to per capita average pension payments for all ages, such that the pensions-to-GDP ratio in our projection is consistent with the AWG report.

The AWG trajectory for old age, disability and survivor pension expenditure differs substantially from what our baseline projection implies. Figure 22 shows that if per capita benefits were kept constant (in growth-adjusted terms), the weight of public old age pensions would increase to 22% of GDP by 2050, then slowly rising to 25% over 2050-2100. In the AWG Report, by contrast, the same indicator peaks at 14% of GDP in the mid 2040s and then begins a gradual descent.

Figure 22
Pensions to GDP in the projection



Source: Own calculations and European Comission (2018)

Results

Retirement age increase

The retirement age increases described above have a significant impact on our results. Comparing with our baseline, the main sustainability metric is reduced by .05 (Table 13). If the retirement age were to increase twice as much until 2055, this would reduce a further .05, meaning that it would provide for half of the required adjustment towards sustainability.

Table 13
Imbalance factors with retirement age increase, 2017

Year	Pension Scenario	θ_T
2017	Baseline	1,22
	Retirement age 68 in 2036	1,17
	Retirement age 70 in 2036	1,13
	Retirement age 76 in 2036	0,98

Retirement age increases have a double positive effect for the budget. Not only do they mean people receive benefits for less time (as they only start receiving them closer to death), but they will pay social contributions, and usually higher income taxes, for a longer period of time. If the retirement age increased by five times as much, such that the normal retirement age reached 76 years old by 2036, this would more than close the imbalance, but this is likely not a realistic policy alternative.

Tracking the Ageing Report forecast

Adjusting our projection in line with the AWG Report pension spending closes the fiscal imbalance.[37] This is due to the fact that the reduction in average pension benefits (including old age, survivor and disability) implied in the AWG projections is large.

Table 14
Imbalance factor tracking AWG pensions expenditure, 2017

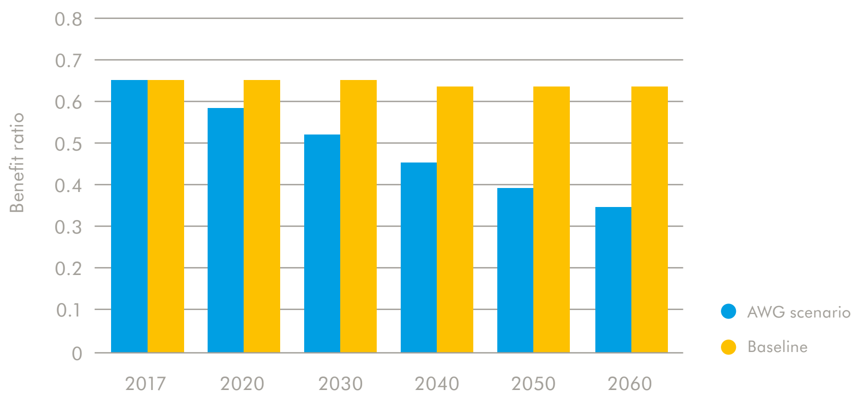
Ano	Pension Scenario	θ_T
2017	Baseline	1,22
	Retirement age 68 in 2036	1,17
	AWG tracking	0,95

In this scenario, the age-induced fiscal imbalances are avoided by containing expenditure growth. This is achieved with lower benefits. The reduction in pension generosity compensates for the increase of the weight of the retired ages in the population.

As stated in the AWG Report, this evolution implies a substantial fall of the benefit ratio,[38] a common measure of pension benefits generosity that compares the average pension to the average wage. This is plotted in Figure 23.[39]

37 This is consistent with the results of Berti *et al.* (2019)
38 In practice the definition of the *Ageing Working Group* computes the average wage as the wage bill divided by the working-age population, which we follow.
39 We cannot actually compute this directly, as we do not track individual workers/contributors or pensioners, but under some reasonable assumptions we find a similar result to the one given in the AWG Report.

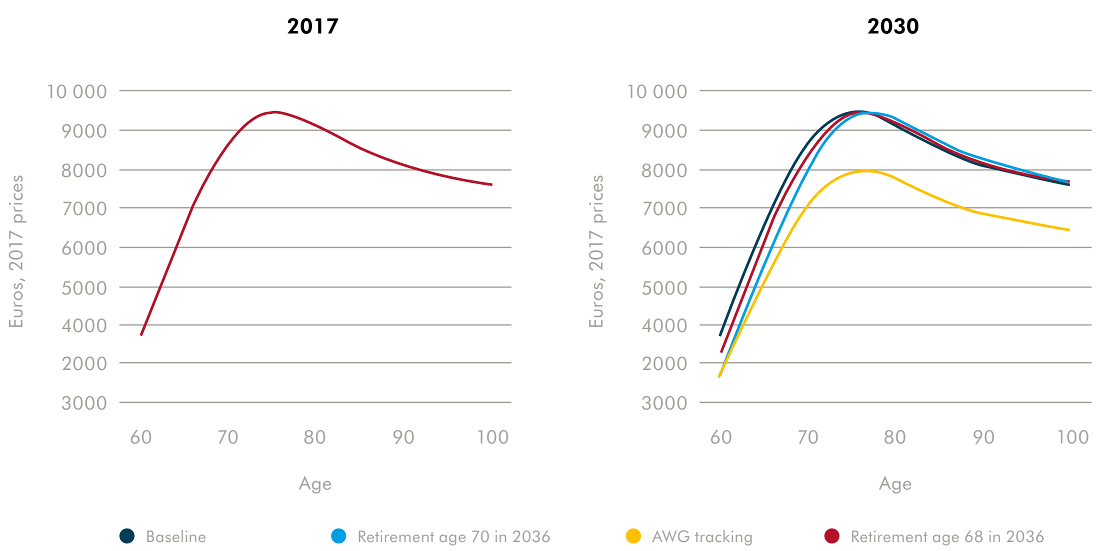
Figure 23
Pension benefit ratio in the projection



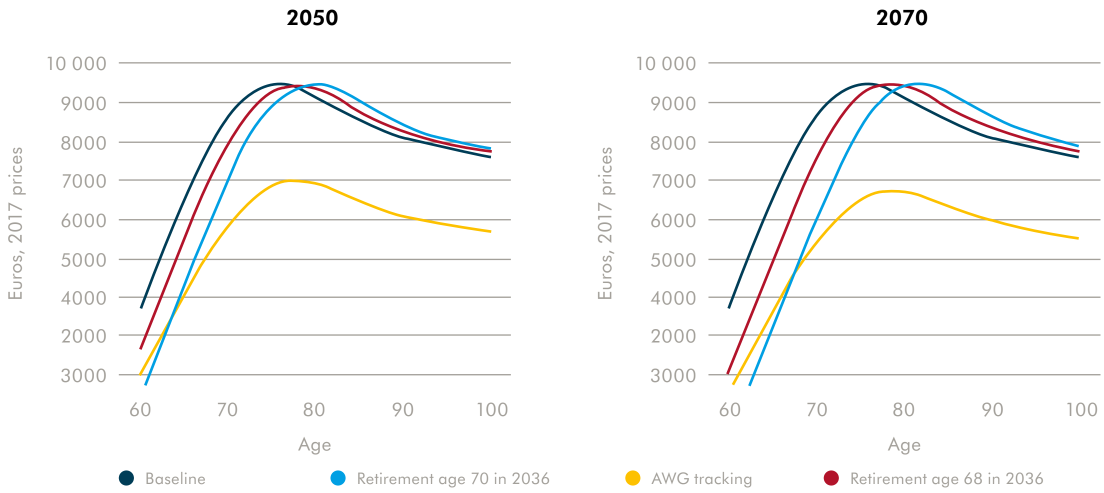
Source: Own calculations and European Comission (2018)

In our implementation, this implies a continual decline (with respect to the growth of GDP) of pension values for all ages, plotted in Figure 24, along with the age distributions of pension payments under the normal and accelerated retirement age increase scenarios[40]

Figure 24
Age profiles of average pension spending under different pension policy scenarios.



40 This is consistent with the pattern reported in the Portugal Country Fiche regarding pension projections in the Ageing Report.



Source: Own calculations and European Comission (2018)

To highlight the change in the relative age distributions and pension generosity, the values plotted are based on a projection with no growth, such that amounts in different periods are comparable. Figures in 2017 prices.

These projections imply a significant fall (in relative terms) of pension benefits, both on the intensive margin (amount of pensions) and the extensive margin (number of years receiving pensions).[41] The decline foreseen in the AWG report is so pronounced that it closes the large sustainability gap we found.

Portuguese legislation does not favour the reduction of existing pension entitlements ("grandfathering"), let alone pensions in payment.[42] It follows that these pension generosity reductions will have a differential impact across generations. This highlights the relationship between sustainability and generational balance: the measures required to restore fiscal sustainability have distributional effects across generations; in this case, for example, those retiring in the future will receive lower benefits. A rigorous appraisal of the welfare implications of this, and thus for intergenerational equity, requires an appropriate model and a judgment on how to weigh different generations. Both are beyond the scope of this study.

Under a high migration scenario, in the medium term (30 years horizon) revenues increase but not enough to compensate for the increased spending induced by ageing. In any case, given the projected mortality rate decline, unless the fertility rate changes, immigration will not be able to by itself generate a population structure compatible with long-term fiscal sustainability, given the current age profile of revenues and expenditures. This incompatibility generates primary deficits that are accumulated for all the periods of our projection, as such, the imbalance remains large.

41 The way we incorporate both retirement age increases and pension benefit reductions is highly stylised. Two examples of oversimplifications: i. the retirement age increases will change the shape of the age profile of pensions, as people react to such increases in their retirement decisions; ii. the decline of benefit generosity is phased in and applied through new retirees, rather than across the board. Our results do not permit, as such, to explore in detail which policies may be best suited to closing the sustainability gap, a question left for future work.
42 This point is reinforced by jurisprudence of the Portuguese Constitutional Court during the crisis.

If already enacted policies are fully implemented in the future, they imply much less generous pension benefits. The legislated mechanism for automatic retirement age increases will lead to lower lifetime benefits and higher tax payments. This by itself may allow to close a part of the future ageing-induced fiscal imbalances. The scenario outlined in the EU Ageing Report implies a cut in pension values across the board, that becomes relatively larger over time. This would fully resolve the sustainability issues we predict.

Technical box 7

Implementation of retirement age increases

Let $g^p_{\bar{t},a}$ be the pension received by age a in the base year $\bar{t}$. The pension reform can be approximated by a forward shift in the age distribution of pension payments using the conditions embedded in the law.

Given that the retirement ages in the law are expressed in years and months, we use an approximation. We interpolate linearly the age between different dates and round to integer years. The results are that for 2021-2035 the retirement age is 67, for 2036-2054 the retirement age is 68 and from 2055 onward the retirement age is 69. Using this, we proceed to shifting the age distribution forward, in the sense that for $t > 2020$, the average person aged a receives $g^p_{\bar{t},a-S}(1+\gamma^e)^{t-2017}$, for $t \in [2036, 2054]$, $g^p_{\bar{t},a-2S}(1+\gamma^e)^{t-2017}$ and $g^p_{\bar{t},a-3S}(1+\gamma^e)^{t-2017}$ for $t \geq 2055$, where S =1 for the base case where we mimic the retirement age increase predicted in the law (Table 12).

A simple counterfactual exercise that can be easily performed is to introduce larger retirement age increases as a multiple of those officially predicted (S > 1). E.g. with S = 2, we would have in 2021--2035 a retirement age of 68, for 2036-2054, 70 and from 2055 onwards, 72.

In these exercises we adjust forward in the same way as described above the distributions of other taxes and benefits, to ensure the exercise is conceptually consistent:

Disability and disease benefits

Their distribution appears to be dependent on the statutory retirement age, with average per capita payments increasing a lot in the few years before retirement.

Survivor benefits

Calculation of these benefits is done with respect to the old age pension to which the deceased was entitled to at the time of death.

Social contributions and personal income tax revenues

These must be adjusted since the retirement age increase means also that people will be working more years before retirement. In this case, however, it does not make sense to simply shift the whole distribution forward, as this would also entail the loss of revenues in the first years of adult life (as if people began to work later). In this case, the adjustment described above is performed only for the ages above 65, such that the profile of taxes paid remains the same up to that age, and such that the brackets right after 65 pay more, as they will contain increasingly more workers (and less retirees).

Quadro 8
Technical box 8: Tracking the Ageing Report forecast

We adjust per capita average pensions such that the ratio of pension spending to output follows the path projected in the AWG forecasts.

We assume that the age distribution of pension payments changes only in accordance with the legislated retirement age increases, and that the pension cut implied in the AWG has a uniform effect over the age distribution.

Then the adjustment to per capita payments can simply be computed at the aggregate level. In brief, we find a series of factors $\left\{\Gamma_t^p\right\}$ to adjust average per capita pensions such that:

$$\frac{\sum_a \Gamma_t^p g_{a,t}^p P_{a,t}}{Y_t} = \frac{G_t^{AWG}}{Y_t^{AWG}}, \quad \forall t \tag{5.1}$$

where $g_{a,t}^p$ denotes pension spending in year t for the average person aged a and Y_t, GDP. To compute this adjustment factor we collect[a] the series of real GDP growth γ_t^{AWG} and of pension spending G_t^{AWG} implied in the AWG projections. Then, from the above expression, we can obtain:

$$\begin{gathered}\Gamma_t^p \frac{\sum_a \tilde{g}_{a,\bar{t}}^p \left(1+\gamma^e\right)^{t-\bar{t}} P_{a,t}}{Y_{\bar{t}} \left(1+\gamma^e\right)^{t-\bar{t}} \Pi_{k=\bar{t}}^t \left(1+n_k^e\right)} = \frac{G_t^{AWG}}{Y_{\bar{t}} \Pi_{s=\bar{t}}^t \left(1+\gamma_s^{AWG}\right)} \Leftrightarrow \\ \Leftrightarrow \Gamma_t^p = \frac{G_t^{AWG} \Pi_{s=\bar{t}}^t \left(1+\gamma_s^{AWG}\right)^{-1}}{\sum_a \tilde{g}_{a,\bar{t}}^p P_{a,t} . \Pi_{k=\bar{t}}^t \left(1+n_k^e\right)^{-1}}, \forall t\end{gathered} \tag{5.2}$$

Recall that $\tilde{g}_{\bar{t},a}^p$ is the per capita pension spending, for age a, in the base year.

This adjustment factor is computed as the ratio between aggregate pension spending in the two scenarios, removing the effect of GDP growth (different between the two). This procedure is applied separately to old age, disability and survivor pensions.

[a] We employed a chart reading tool (Rohatgi, 2012) on Ministry of Finance (2018) documentation.

6.

EXPECTED AND REALIZED COHORT

NET PAYMENTS

Computing the net contribution to the government budget made by a generation over its lifetime would require mapping spending and revenues to ages over a very long period.

Survey micro data allowing us to obtain complete tax-benefit age profiles is only available from 1995.[43] In the previous decades, there were very significant changes to tax-benefit policies: e.g. many of the currently existing benefits were created between the 1960s and 1980s; VAT was only introduced in the 1980s; social contribution rates increased a lot. As such, although the macro data exists,[44] we cannot provide reliable estimates of generational contributions to the primary balance. For this, we would need data allowing to estimate tax-benefit profiles before 1995.[45]

Even so, our data and projections allow for a few informative exercises. The first two exercises explore what our baseline projections imply for the net payments over the life cycle of different generations. First we focus on the cohort born in 2017, to pinpoint the effect of increased life expectancy on lifetime net payments. Second, we look at the generational accounts – net payments over the remaining lifetime – associated with the different generations alive in 2017. Finally, we look at estimates of actually realized net payments within our data window (1995-2017); this compares net payments by different cohorts over particular "slices" of their respective life cycles.

6.1 PROJECTED LIFETIME NET TAXES FOR THE NEWBORNS OF 2017

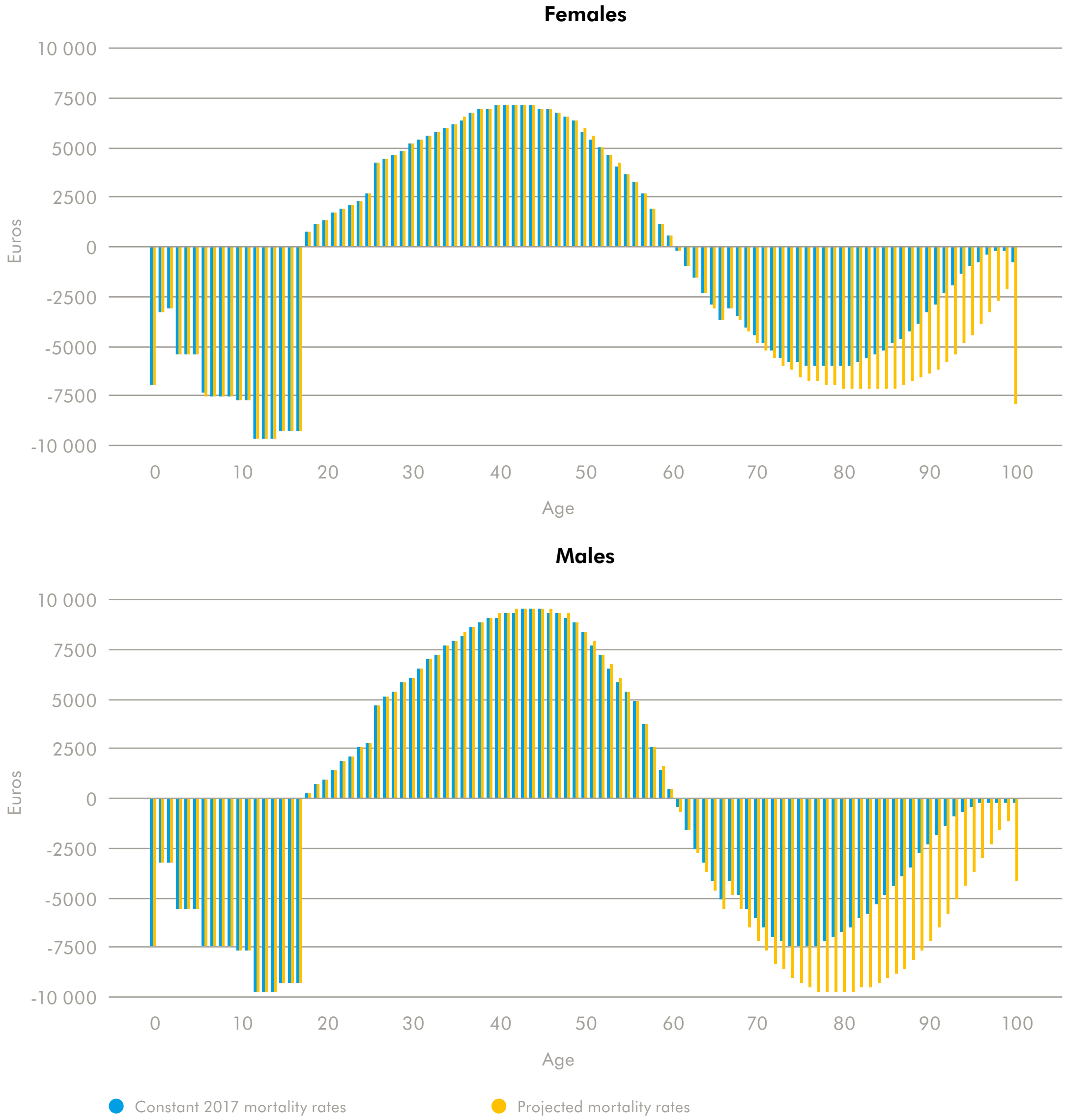
We first examine in detail the expected net payments for the cohort of newborns in 2017. In our baseline scenario, the average member of this cohort is expected to make negative net payments over a lifetime.

Figure 25 shows the expected net payments computed with the projected mortality rates. We also show the expected net payments computed using the mortality rates of 2017. The difference comes from the projected decrease in mortality (increase of life expectancy). To focus on the effect of mortality, in this analysis we abstract from GDP growth, so these net payments are solely a function of the 2017 age profile of revenue and spending and of population projections.

43 See Appendix for a full description on the data collection and treatment used in the exercises.
44 Though long data series exist, data before 1995 (when the European System of Accounts was implemented) is, in general, less reliable and comparable.
45 We leave the work of constructing such profiles – which could in principle be obtained from administrative data, or even constructed from a detailed analysis of legislation – as a suggestion for future research.

Figure 25

Expected net payments for the cohort of newborns in 2017 over its life cycle, with projected and 2017 constant mortality rates, no GDP growth.



In the baseline scenario, the expected spending attributable to a newborn in 2017 over the course of his or her life is greater than the revenue. The impact of ageing translates essentially into much higher expected net benefits in the ages above 70, as shown in the plot. To be clear, here we look strictly at the effect of the increased likelihood of attaining those ages.[46]

Table 15 shows the sum of the net payments plotted in Figure 25.[47] These figures should be interpreted as the lifetime net payment implied by the 2017 distribution of spending and revenue if it were applied to a full life cycle.

46 The plot shows a spike at the 100 years old age bracket. This is because this actually represents the ages of 100 and higher.
47 Recall this is a no growth scenario.

Table 15

Expected full lifetime net payments for the cohort of newborns in 2017, with projected and 2017 constant mortality rates, no GDP growth.

Mortality rates	Projected	Constant 2017
Female	-147.962	-84.067
Male	-143.718	-45.517

The left hand column shows the baseline result, with no productivity growth, under the evolution of mortality given by current population projections. The right hand column shows the result under constant fertility and mortality rates (at their 2017 values). Figures in 2017 prices.

Table 15 clarifies that the current age profile of spending and revenue implies, over a full lifetime, that the average individual is a net receiver. The first column shows this amount is close to €150,000 for both males and females under the actual projections for life expectancy. The second column shows that the corresponding amounts in the counterfactual scenario, where mortality rates do not change, are far smaller. It also shows that the increase in life expectancy favours males more than females.

The latter scenario measures the extent to which current tax-benefit profiles are inconsistent with the stationary distribution of population, i.e. with expected population ageing. The former shows how the future increase of life expectancy exacerbates that inconsistency.

This analysis could be extended to look at different income or wealth quantiles, to better understand how the perceived generational inequality may interact with income or wealth inequality. While this negative net contribution may be true for the "average" newborn, that might not be the case of a richer or poorer individual.

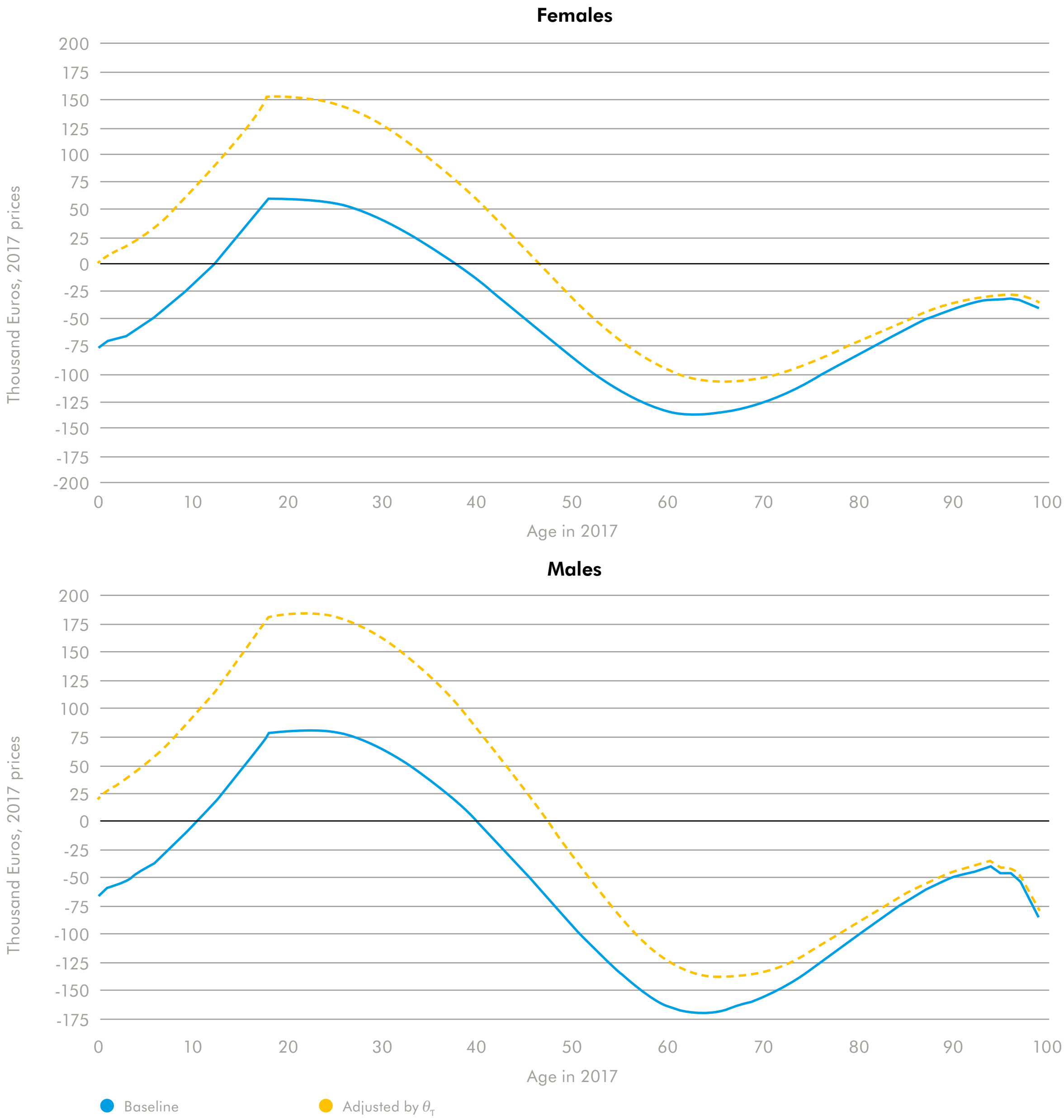
6.2 GENERATIONAL ACCOUNTS FOR CURRENT GENERATIONS IN 2017

In this second exercise, we project net payments from people of different generations over their remaining lifetimes. This looks at the question: how much, in net terms, is each living generation expected to pay, in euros, to fund the government? A tentative answer can be provided by decomposing the projections of Section 4.

Figure 26 shows that, under the baseline projection (blue solid line), most generations are expected to benefit more from spending than the revenue they will provide, i.e. lifetime remaining net payments are negative. This includes newborns and young children. Generations between late childhood to slightly below 40 years old expect a positive net payment over their remaining lives. Take the example of those in the beginning of their working lives, between 20 and 25 years old (born between 1992 and 1997). They expect a (per capita average) net payment over their lifetime of about 75.000€ (for males, somewhat lower for females – blue lines in the bottom and top panels, respectively). For generations older than that, the benefits (and spending) they expect to receive surpass the tax payments (and other revenues).

Figure 26

Lifetime remaining discounted net payments for current generations in 2017, baseline scenario, no adjustment and adjustment with revenue increase by θ_T = 1,22



The dashed blue line shows the effect of a hypothetical permanent increase in all revenues as described in Section 4, of 22% every year. Then, the lifetime remaining net payment would increase for all generations. The increase is larger for the younger ages, as most of the taxes (and all of social contributions) are paid in the working years. For the generations of 1992-1997, this more than doubles their lifetime remaining net payment, that would become close to 200.000€.

6.3 REALIZED NET PAYMENTS 1995-2017

The exercises we present in this subsection are completely different to the previous two. We use the data collected for the period between 1995 and 2017 to analyse realized net payments by different generations.[48] These are not generational accounts; they do not measure the life cycle contributions of cohorts to the budget. Instead, we now focus on limited "slices" of the life cycle, and compare different cohorts in the same ages (so at different points in time).

Actual net payments by different cohorts over the period 1995-2017

We look at net payments by different cohorts in five cases:

ages 0-10 – basically education, health (especially in the first year) and age-uniform benefits;

ages 20-30 – mostly university education spending and the small tax payments made in the beginning of the working ages;

ages 40-50 – the peak of the working life and, as such, of tax and social contribution payments;

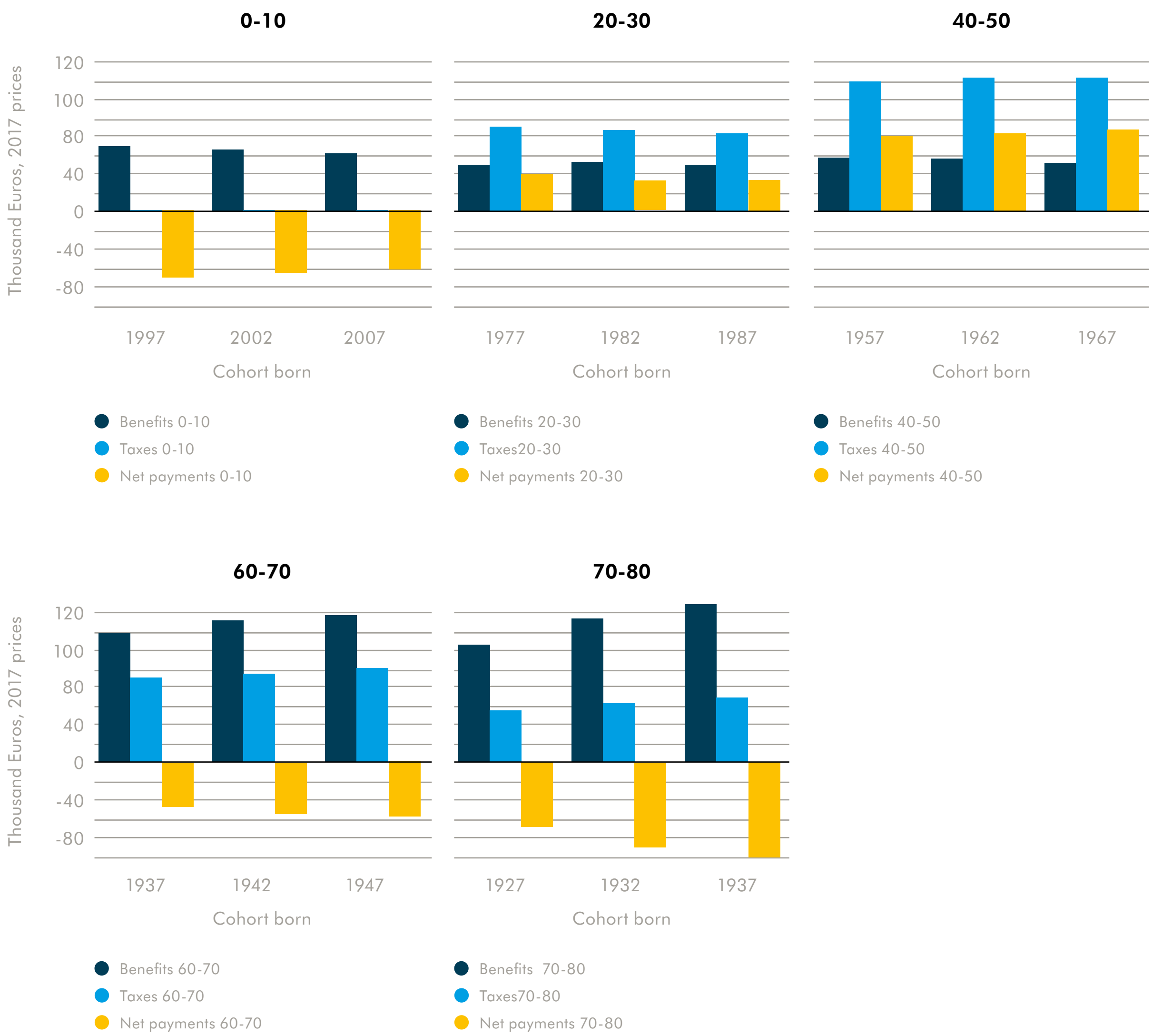
ages 60-70 – when many people begin to retire or request disability pensions, so benefits increase substantially;

ages 70-80 – almost everyone is retired and health spending also increases a lot.

48 This exercise is in part intended as a "proof of concept", to show how our methodology can be adapted to examine the life cycle contributions to the primary balance of different generations, if data spanning a longer period is available.

We observe net payments for the cohorts that reached the beginning of each of these age intervals in 1997, 2002 and 2007, and the end in 2007, 2012, and 2017 respectively. In each case, we look at the net payment made over this period by the average member of each cohort alive in the first year of the age interval. This takes into account life expectancy. For example, the average net payment for the 1937 cohort (60 years old in 1997) is smaller than the net payment of a member of this cohort that dies at 61, and higher than the net payment of one that survives to be 70. The results are plotted in Figure 27.

Figure 27
Net payments attributed to different cohorts over the same part of the lifecycle, estimates from actual data



Figures with 2017 prices.

Between the ages 0-10, the net spending declined slightly from the cohort of 1997 to the cohort of 2007, reflecting smaller per capita spending on education and age-uniform items. In the ages 20-30, the cohorts of 1982 and 1987 made smaller net payments than that of 1977, reflecting essentially smaller tax payments; this is consistent with lower labor market participation. In the ages 40-50, taxes per capita were roughly the same for the cohorts between 1957 and 1967, but benefit payments per capita were smaller. The average net payment in this part of the life cycle went from around 80,000 euros for the 1957 cohort to about 85,000 euros for the 1967 cohort.

In the retired ages, in contrast, benefits increased substantially over this period, leading later cohorts to receive more in benefits per capita. Over the ages 60-70, this was mostly compensated by higher taxes, such that net payments by the 1947 cohort were not very different from the 1937 cohort. But in the ages 70-80 the net benefit was much higher for the 1937 cohort compared to the 1927 one, going from just over 50,000 euros per capita to about 90,000 euros. Since we are comparing equally sized windows on the life cycle, this comparison is clean from the effect of life expectancy. It means that the 1927 cohort received much smaller net transfers in this period, which is consistent with both increasing social security coverage and higher healthcare spending.

The current age profile of spending and revenue would imply, for a full lifetime, negative net revenues of an amount around €150,000 for both males and females, under the actual projections for life expectancy. However, we find also that the permanent adjustment of Section 4 would imply an average positive net revenue of about €200,000 from the point of view of a generation entering its working life in 2017. Finally, we find, looking at our data window of 1995-2017, that different cohorts made similar average net payments in their peak working ages (40-50), slightly above 80 thousand euros. In contrast, the successive cohorts of children aged 0-10 in this period enjoyed a smaller net spending over time, while those aged 70-80 received higher net spending.

Technical box 9

Expected and realized generational accounts

We denote by $n^e_{t,a}$ the expected generational account for the generation aged a at time t. This represents the discounted sum of revenues minus expenditures attributable to the average person aged a at t, in the period between t and $t + J - a$ (the year that generation reaches age J = 100). These expected accounts are obtained using the revenue and spending profiles in $\bar{t}$, projected forward as explained previously, and taking into account the forecast of life expectancy: only a fraction of the members of the cohort aged a at t will survive each year.

Formally, we compute:

$$n^e_{t,a} = \sum_{s=0}^{J-a} s^a_{t+s} D^s \left(\tilde{\tau}_{\bar{t},a+s} - \tilde{g}_{\bar{t},a+s} \right), \ \forall a \tag{6.1}$$

where s^a_{t+s} denotes the unconditional probability of a person aged a at t surviving through to $t + s$.[a]

Figure 25 in Section 6.1 presents the components of the generational account computed for the newborns in 2017.

The chart gives the components of the sum given by the above expression, computed for a = 0, $t = \bar{t}$ = 2017. To clarify the impact of life expectancy, this is calculated with different sets of survival rates, and with D = 1 (no growth or discounting).

Figure 26 in Section 6.2 presents the expected generational accounts for the generations alive in 2017, i.e. the result of the above sum evaluated for a = 0, 1, 2, ..., with $t = \bar{t}$ = 2017 and D $= \frac{1.0342}{1.0458}$, consistent with our sustainability projection.

In Section 6.3, we evaluate the net payments attributable to different generations, but concerning only 10-year slices' of the life cycle. We do this exercise using actual (estimated) per capita revenue and spending streams, rather than projected ones. We denote these *realized* net payments $\hat{n}_{t,a}$ (for the generation aged a at time t). Here we use actual population data to compute the average contribution of a cohort member alive in the first year of the interval, instead of projected survival rates. $\{\tilde{\tau}_{t+s,a}\}, \{\tilde{g}_{t+s,a}\}$ are directly estimated from survey data and national accounts. In brief, Figure 27 presents results for the following sums:

$$\hat{n}_{y,a} = \sum_{s=0}^{10} \frac{P_{y+s,a+s}}{P_{y,a}} \left(\tilde{\tau}_{y+s,a+s} - \tilde{g}_{y+s,a+s} \right) \tag{6.2}$$

where y is the first year of the analysed 'slice' (1997, 2002 or 2007) and a is the first year of the age interval (0, 20, 40, 60 or 70). The cohort birth year is given by y - a.

[a] Therefore $s^a_{t+a} = \prod_{i=0}^{a-1} s_{i,t+i}$.

7.

CONCLUDING REMARKS

In this report, we assessed the implications of demographic change for public finances in Portugal. It was already well known that this demographic shock will have a strong impact on the government budget. Yet, with our analysis, we uncover facts that can inform both policy discussions and future research on the topic.

We find that the current primary surplus relies on the present age structure of the population. All else being equal, projected demographic trends would bring it down to a large – and permanent – deficit within a few decades, jeopardizing fiscal sustainability. Without changes to the tax-benefit age profiles, restoring sustainability would require a 22% permanent increase in revenues. This is not simply the temporary effect of a demographic transition. We show that the current age profile of taxes and benefits is structurally inconsistent with projected fertility and life expectancy. This result is invariant to alternative scenarios of economic growth.

In this context, restoring sustainability requires either changes in population dynamics or a recomposition of revenues and expenditures. A policy aiming at the former would be promoting immigration – emigration is a margin largely out of policymakers' control. Our findings suggest this could mitigate the fiscal impact of ageing in the medium run. But they do not resolve the structural incompatibility between the government budget of today and the long-run age distribution of population. This incompatibility makes policies that change the age profile of taxes and benefits unavoidable.

Due to its size and sensitivity to the age structure of population, social security is the government program where policies aiming to change the tax-benefit age profile can be most effective. In fact, we find that already enacted pension policies can close the sustainability gap. These include changes to pension attribution rules and automatic retirement age increases. Both lead to lower lifetime benefits and higher tax payments.

However, it is hard for such measures to avoid distributional effects between generations. This highlights how sustainability concerns are inseparable from generational imbalances. In this report, we refrain from making any judgment with respect to intergenerational fairness. Our definition of sustainability pertains to positive economics: it is defined as the financial solvency of the public sector. The choice of a policy mix to ensure sustainability, in contrast, entails a normative judgment. We avoid such prescriptions, left for future work.

In brief, with this project we delivered a clear, data-driven picture of what the ongoing ageing process implies for public finances in Portugal. We clarified the conditions for public finance to be consistent with current demographic trends. As they stand today, they are not. We also showed that migration, per se, cannot solve this structural issue, so changes to the age profile of taxes and benefits are unavoidable. Pension policies already in place today are sufficient to restore fiscal balance. The question of whether these are fair to different generations and politically sustainable – and, if not, what can be optimal alternative policies – remains open.

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DATA APPENDIX

DATA APPENDIX

Generational accounting is a data intensive methodology that requires a peculiar treatment of the data. On the one hand, it demands macro data on the fiscal aggregates and for the population by age and gender and its projections. On the other hand, in order to compute the age-gender profiles for each tax and expenditure with an age distribution, we need micro data that capture the relative age-gender distribution. While the first group of data is directly imported from Eurostat and no particular treatment is needed (with the exception of corporate income tax), the second group is not so straightforward and demands some assumptions.

MICRO DATA

The first issue concerning demographics regards the fact that, due to data privacy reasons, the *age* variable in survey micro data is top-coded: all the observations above a certain age are grouped in a single age-bracket. This is important since population projections indicate that these age strata will represent an increasingly higher share of the total population as time progresses.

Dealing with this feature of the data requires making assumptions regarding the age profile of taxes and transfers for these ages, since we are computing tax-transfer profiles for year-of-birth cohorts. Our choice was to attribute to each observation in this age-bracket a fictional age, in such a way as to mimic the age distribution of the population. The technique is simple: individuals in the top-bracket are randomly sampled, and an age is attributed by using the respective share of the population as a probability density. More precisely, p_a, the probability of being of age in the top-bracket is approximately given by

$$p_a = \frac{\mu_a}{\sum_{a=\tilde{a}}^{100} \mu_a} \; for \; a = \tilde{a}, \dots, 100$$

where $\tilde{a}$ is the minimum age in the top bracket and is the number of individuals of age a.

IRS

Personal income tax, called IRS in Portugal (*"Imposto sobre o rendimento de pessoas singulares"*) is calculated and payable at the household level.[49] As we want to know the contribution of each age-gender cohort, we must distribute tax payments among household members. We do so using a rule based on the income earned by the individual in the household income:

$$IRS_i = \frac{Income_i}{Income_{household}} IRS_{household}$$

where IRS_i is the allocated IRS to an individual in the survey, used to build the relative distribution.

This rule is solely applied to the years between 2007 and 2017. In the previous years we keep the relative distribution of 2007, due to data availability.

IMI

IMI (*"Imposto Municipal sobre Imóveis"*, corresponding to the Property tax) is payable by individual property owners. In practice, it is common that more than one household member shares property ownership (e.g. partners both owning family residence) and indeed the survey we use presents this data aggregated at the household level. Here we assume the payment is split uniformly among the household members (except individuals below 18 years old or non-working young adults below 30 years old):

$$IMI_i = \frac{1}{N_i} IMI_{household}$$

where N is the number of household members abve 30 years old or between 18 and 30 years old and working.

For the years 2004-2017, the distributions are derived using data on the IMI paid by the household, on EU-SILC.

For the remaining years, 1995-2003, we assume the distribution of 2004, due to the lack of data.

IVA

IVA (*"Imposto sobre o Valor Acrescentado"*, corresponding to the Value-Added Tax) distribution is computed using the consumption expenditure from IDEF - Inquérito às Despesas das Famílias, also provided by Statistics Portugal.[50] We implicitly assume a flat rate, which has some limitations, e.g. lower income households will face a lower average rate since the weight in the household budget of reduced rate items is higher. We believe this will not significantly affect results regarding the age-gender distribution. Furthermore, we only have access to the expenditure done by each household so we must assign a distributional rule to this category, as we have done for personal income tax or property tax. We follow a rule based on the share of income of an individual in the total household income. Compared with PIT it has a small difference that implies that every individual, including non-working individuals between 18 and 30 years old, have at least a part of the burden allocated:

49 Even though income tax from employees' wages or self-employed income is calculated and paid individually
50 The survey puts agents in an age-bracket, which makes the distribution having a ladder shape

$$IVA_i = \frac{\left(1 + \frac{Income_i}{Income_{household}}\right)}{\sum_{k=1}^{H} \left(1 + \frac{Income_k}{Income_{household}}\right)} Expenditure_{household}$$

where IVA_i is the allocated IVA to an individual in the survey and the number of household members above 18 years old.

IDEF, the survey where the data comes from, is available for 1995, 2000, 2005, 2010 and 2015. We assume the distribution of the closest year available for each year. In other words the survey of 1995 generates a distribution used is years 1995, 1996 and 1997; the survey of 2000 is used in the years of 1998, 1999, 2000, 2001 and 2002; the survey of 2005 in the years 2003, 2004, 2005, 2006 and 2007; the survey of 2010 for the years 2008, 2009, 2010, 2011, 2012; and the survey of 2015 for the years 2013, 2014, 2015, 2016 and 2017.

IRC

Our assumption for assigning IRC (*"Imposto sobre o rendimento de pessoas coletivas"*, corresponding to the corporate income tax) tax payments to ages requires additional discussion. IRC is paid by firms, not households or individuals, making it hard, even theoretically, to determine how the burden associated with this tax might be distributed across generations. A common assumption in the literature assumes that, since the taxation of a small open economy cannot impose a burden on internationally mobile capital, the economic burden of this tax will fall entirely on workers via lower wages (since labor is less mobile). As such, it would make sense to assign IRC tax payments to generations using the age distribution of labor income.

Our view is that while this is computationally convenient, it is an exceedingly strong assumption. We assume instead that, insofar as firm equity is held by residents (see note below), these will bear the burden of corporate income tax in Portugal. While general equilibrium, let alone capital movement, effects of capital taxation may surely exist, the first order effect will be on equity holders' wealth. For this reason, we choose to use, as an indicator of the generational distribution of IRC payments, data for the equity holdings by individuals, which we obtain from Household Finance and Consumption Survey data, provided by the European Central Bank.

Social benefits and Social Security contributions

The EU-SILC database includes, at the individual level, labor income, which we use to infer social contributions based on statutory rates (this implies a simplifying assumption[51] that details of the contribution rules are homogeneous across generations). We distribute both employee and employer contributions in this way, since it seems reasonable to assume that the economic burden of employer contributions is largely reflected on workers. All relevant transfer items are also included in the SILC individual data set: pensions (old age, survival and disability) and unemployment and sickness benefits.

51 This assumption is unrealistic: one key example of an additional detail on the rule is the exemption for firms hiring youngsters in their first job (currently a 50% "discount" for a maximum of five years, Law-Decree 72/2017) on employer contributions. In the impossibility of finding data for this, the hope is that this does not affect the age distribution significantly.

Note that attribution rules and agents' behavior lead to some of the age profiles having non-normal shapes. Disability benefits are fairly small until the 60 years old brackets, when they shoot up, peaking at 65 years old. This is not only because people tend to have greater health issues later in the working life, but also because there is some substitution between applying for these benefits and early retirement (due to the penalty the latter entails). These benefits cannot be accumulated with old age pensions, and as such reaching retirement age they go to zero.

As observed in Figure 3, the per capita average old age pension payment for 66 years old is lower the sum of old age and disability for 65. This may be a feature of the sample but it is also consistent with pension rules.

Health and education expenditure

For the health age-gender profiles we use the assumptions used for the Ageing Report 2018 (henceforth AWG).[52] For education age-gender profiles, we assume that only individuals between the age of 3 years old and 25 years old can receive this benefit. In order to proceed, we use the number of enrolled students in the public system by level of studies, from PORDATA, and the Eurostat total general government expenditure by type of education. For the types of education in Eurostat data that encompasses more than one level of studies, we distribute it according to the relative share of the number of students in the public system. This way we are able to get the age profile (gender in this case is not relevant as both genders receive the same from the Government in terms of education) for education.

Smoothing age distributions

To smooth the age distributions of taxes and transfers a lowess smoother function is used, which runs a locally weighted regression for each tax-transfer item (and gender) a la Cleveland (1979).

Summary of micro data sources

Data for most recent years comes from EU-SILC apart from IVA that comes from IDEF, IRC that is extracted in the HFCS, Health that uses the computations of the AWG and Education, that was computed as explained before. Some variables use the European Community Household Panel (ECHP) for older years, a EU-wide income survey that predated EU-SILC with similar objectives, however it is more limited in scope and does not have all the variables we required. As such, in some cases, we simply assumed the distribution of the closest possible year. The following table summarizes, for each fiscal category, the data source:

52 We are thankful to the European Commission DG ECFIN for having kindly provided this data.

Table 16

Summary of micro data sources

Fiscal Category	Source	Observations
IRS	EU-SILC	For the years 1995-2006, the distribution considered is the 2007 one.
IMI	EU-SILC	For the years 1995-2003, the distribution considered is the 2004 one.
IVA	IDEF	We use the date from the closest possible year, as IDEF is only produced every 5 years.
IRC	HFCS	We use the distribution of HFCS-2013 for all the years.
Contribuições Sociais	EU-SILC e ECHP	For the years 2002 and 2003, we use 2004 SILC. For the remaining years we use ECHP.
Pensão por invalidez		
Pensão por velhice		
Subsídio de doença		
Pensão de sobrevivência		
Subsídio de desemprego		
Despesas com educação	Pordata e Eurostat AWG	We consider the distribution used for the 2018 Ageing Report, developed by the Portuguese team of the Ageing Working Group. This refers to 2015.
Despesa com saúde		

MACRO DATA

A note on public debt and interest rates

Besides data on revenues and expenditures, the methodology also needs information about government wealth.

Auerbach et al. (1994) state that the initial stock of government (net) wealth in the generational accounts should "in principle, equal all government assets minus liabilities". This would then involve considering not only all of the public sector financial (general government public debt) and non-financial (not considered in the tax and transfer flows, such as arrears) liabilities, but also the current value of the government capital stock, including financial and non-financial assets.

Due to data limitations, in practice, applications of the generational accounting framework usually use some measure of public debt. In our exercise, we consider indeed general government gross debt.

Regarding interest rate, we compute an implicit rate. Countries have several types of public debt bonds with diverse rates and maturities. Therefore, we compute the interest rate of year as the ratio of the interest payments done in year and the total debt outstanding of the same year. This is the rate used for discounting.

A note on the IRC aggregate

We have chosen not to use the total value. Portugal had at the end of 2017 a negative net position in direct investment of 79.15 billion euros and a gross position of 161 billion euros. This is an indication that a large share of companies in Portugal are owned by non residents. We use firms' balance sheet data from the Bureau Van Dijk database. For 2017 we have in the database 367 271 corporations that declared IRC. 247 499 declared positive IRC and paid 5 416 456 thousand euros in total, out of 6 271 000 in the national accounts. We are able to assign 5 270 222 thousand euros to shareholders. We are able to identify 86 913 shareholders that are resident in Portugal and 193 131 that are not residents. The total amount paid by residents in Portugal is 2 570 613 thousand euros and the total amount paid by non resident in Portugal is 2 435 315 thousand euros. We also identify 264 295 thousand euros that we are not able to assign in terms of residency. Table 17 summarizes these numbers:

Table 17
IRC in thousand euro paid in 2017

Residency	IRC paid
Portugal	2,570,613
Rest of the World	2,435,315
unknown	264,295
Total IRC (Bureau Van Dijk)	**5,270,222**
Total IRC in national accounts	**6,271,140**

Source: Bureau Van Dijk e Eurostat.

The implication is that at least one-third of the IRC in Portugal is not paid by residents. In our age distribution of taxes, we only assign IRC paid by residents to ages, in accordance with the age profile of equity holdings as described above. We assume IRC paid by nonresidents has a neutral effect on the age distribution, so we distribute it uniformly by the adult population.

Summary of macro data sources

All the macro data is extracted from Eurostat. The following table summarizes the Eurostat variables used:

Table 18

Summary of macro data sources

Aggregate	Eurostat datasets/ variable codes	Observations
Demographic data		
Population	demo_pjan; proj_18np; proj_18naasmr	We use data from historical estimates (demo_pjan) up to 2017; projections from the EUROPOP2018 exercise (proj18_np for population and proj_18naasmr for the mortality and fertility assumption tables), which has scenarios with and without migration.
Fiscal data (all from the gov_10a_ggfa data set)		
IRS	D51A	
IMI	D29A	
IVA	D211	
IRC	D51B	
Social Contributions	D611+D612+ D613	
Disability pension	GF1001	As GF1001 includes both disability and sickness pensions, we consider here 82% of this aggregate, based on the relative size of these two items in the 2017 public accounts.
Old-age pension	GF1002	We consider here 18% of the aggregate (see note above).
Sickness allowance	GF1001	
Survivor pension	GF1003	
Unemployment subsidy	GF1005	

Education expenditure	GF09	GF09 includes all expenditure in the education sector. We only assign by age consumption expenditure, with capital expenditure assigned uniformly across ages.
Health expenditure	GF07	As for GF09, we only assign by age consumption expenditure.
Other macroeconomic variables		
GDP	CP_MEUR in nama_10_gdp	
GDP deflator	PD15_EUR in nama_10_gdp	
Net wealth	gov_10a_ggfa	