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Demographics and the welfare state - from one crisis to the next?*

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Abstract

Recent demographic projections point to lower fertility rates, and in most countries below the reproduction level. This is widely perceived to add further burdens to already strained public finances due to increasing longevity and ageing populations. The public finance implications of changes in fertility are analysed considering intergenerational linkages arising via age dependencies in expenditures due to childcare and education for the young, and healthcare and pensions for the old, being largely financed by taxes levied on the working-age population. Evidence is shown that support to both the young and the old is quantitatively important in most countries, and this makes the response of public finances to fertility generally ambiguous. A decline in fertility triggers a dynamic process as the youth dependency falls on impact followed by a later increase in the old-age dependency ratio. The former improves and the latter deteriorates public finances, and hence an important budget dynamics is released, and the long-run budget effects are in general ambiguous. It is shown how the structure of the intergenerational compact matters for these responses, and hence the effects are generally country specific. A quantitative analysis for Denmark shows that lower fertility improves fiscal sustainability.

Keywords: Fertility, intergenerational compact, public finances, welfare state.
JEL: D7, E60, H50, J11.

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1 Introduction

Ageing populations have for decades been a concern since increasing longevity and the implied rise in the old-age dependency ratio challenge the financial viability of pension systems and public finances. This has prompted lively economic policy discussions, in particular on the design of pension schemes and statutory retirement ages. Some countries have undertaken reforms, while others still face major challenges in coping with ageing populations, see e.g. OECD (2023) and European Commission (2024).

There is an ongoing debate about whether low fertility rates will alleviate or exacerbate these fiscal challenges. The decline in fertility has been attributed to increasing costs of raising children, changed attitudes towards parenthood and more intensive parenting norms than in the past, see e.g. Doepke et al. (2023), Goldin (2025), Kearney and Levine (2025), and OECD (2024). However, the decline is also seen in countries which have pursued "family friendly policies", see e.g. Hellstrand et al. (2020), and specific measures in countries like Japan and China have not been successful in changing the trend. This raises the question of whether a double demographic crisis evolves with low fertility rates adding to the fiscal challenges caused by increasing longevity, or whether it is a mitigating factor reducing the pressure on public finances[1], see e.g. Bloom et al. (2025). In policy debates and analyses, the answer to this question is not clear, since some find that lower fertility increases the pressure on public finances (see e.g. Darvas et al. (2024)), while others that it reduces it (see e.g. the Danish Economic Council (2024) and the Swedish Economic Council (2025)).

The starting point of this debate is the set of intergenerational interdependencies—or compacts—embedded in welfare state arrangements. Key provisions such as childcare, education, healthcare, and pensions are strongly age dependent, as they are concentrated on the youngest and oldest members of society. At the same time, the financing of these programs, through various forms of taxation, falls primarily on the working age population. Public finances are therefore highly sensitive to the age structure of the population. This issue has been extensively examined in relation to declining mortality and rising longevity, but far less attention has been given to the effects of changing fertility, changes that influence not only the size of the population but also its age structure.[2]. These budgetary implications are crucial, as they determine whether adjustments to the intergenerational compact are required in response to a permanent shift in fertility rates.

A permanent decline in fertility causes low frequency changes in the age composition of the population. First it decreases the number of children and young (and hence the youth dependency ratio), later the working age population decreases (which increases both youth and old-age dependency ratios), and

[1] The effects of demographic changes on growth are analysed in e.g. Jones (2022) and Maestas et al. (2023).

[2] Eventually for given fertility and mortality the population and its age composition would converge to a steady state level (disregarding migration), but the adjustment period is very long.

then the number of old (for unchanged mortality) declines (reducing the old-age dependency ratio). These changes will clearly be reflected in macroeconomic variables and public finances, and the effects triggered by changes in the dependency ratios imply that the public budget may at first improve and then deteriorate, thus leaving the long-run effect ambiguous.

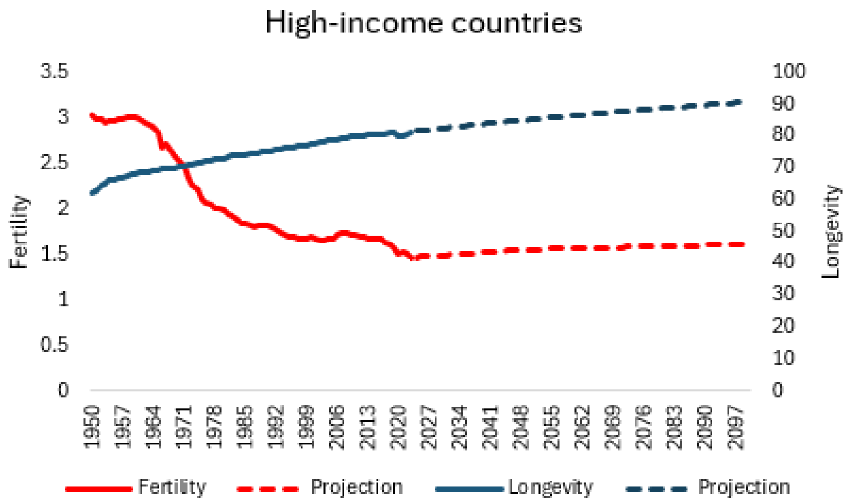
The aim of this paper is to clarify the implications of changes in fertility for the intergenerational compact embedded in the public sector (welfare state). The first part of the paper presents a simple theoretical framework capturing the essence of the demographic structure for public finances arising from age dependencies in public finances (both on the expenditure and revenue side). Since the intergenerational compact has both a forward part (support to the young) and a backward part (support to the old), a change in fertility has complicated effects on public finances, which change over time as the demographic effects of a permanent change in fertility unfold. It is shown how the long-run budget effects depend on whether expenditures on the young or the old dominate. If the former is the case, lower fertility improves public finances (for unchanged policies) in the long run, and vice versa. The public finance impliations of changes in fertility are therefore country specific. Second part of the paper quantifies the effects of changes in fertility using data for Denmark as an illustrative example of the effects. First, a simple mechanic quantification is presented, followed by a presentation of the results from a more elaborate model.

The paper is organised such that Section 2 provides a brief overview of demographic trends and the age dependencies in public finances. Section 3 presents a simple overlapping generations structure allowing an identification of the key routes by which fertility affects public finances, and Section 4 presents quantifications of effects of lower fertility for Denmark. Section 5 offers some concluding remarks.

2 Demographics and the intergenerational compact

Most countries experience similar demographic changes, see e.g. Bloom and Canning (2008) and UN (2024). Fertility has been declining and has fallen below the replacement level of 2.1 children per woman, see Figure 1, and recent developments suggest that projections may be adjusted downwards, see e.g. Kearney and Levine (2025). Simultaneously, longevity has been on an upward trend, which is expected to continue, see Figure 1 for high-income countries, although there is some discussion of whether or when the increases will level off, see e.g. Utkus and Mitchell (2025). Hence, in short, fewer children are born, but they live longer!

Figure 1: Fertility and life expectancy: High-income countries, 1950-2100



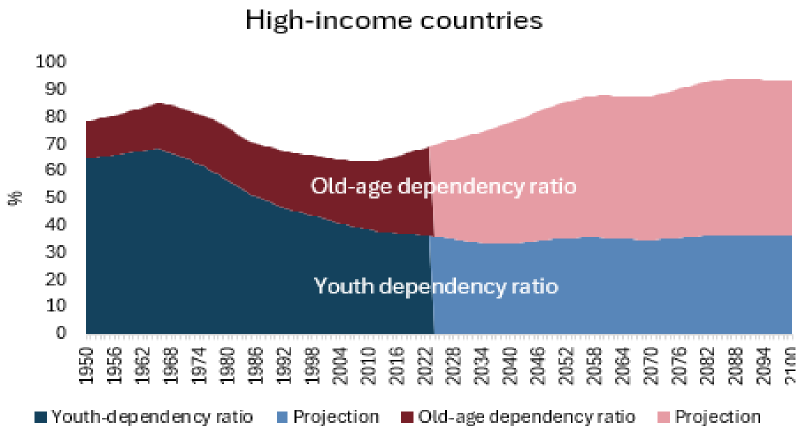
Note: Total fertility rate (live births per woman) and life expectancy at birth, both sexes (years).

Data source: UN, Population Prospects 2024, https://population.un.org/wpp/.

These developments imply significant changes in the demographic dependency ratios, shown for high-income countries[3] in Figure 2. The total dependency ratio (individuals aged 0-19 years and 65+ years, respectively, relative to the population aged 20-64) has been declining until recently. The decrease in the youth dependency ratio has dominated the increase in the old-age dependency ratio until around 2010, after which the increase in the old-age dependency is causing the total dependency ratio to increase and reach historically high levels.

[3] At a global level, the same trends exist, but the overall increase in the dependency ratio is less strong in the projection period.

Figure 2: Total and old-age dependency ratio: High-income countries, 1950-2100



Note: Youth dependency ratio: Age group 0-19 relative to age group 20-64. Old-age dependency ratio: Age group 65+ relative to age group 20-64.

Data source: UN, Population Prospects 2024, https://population.un.org/wpp/.

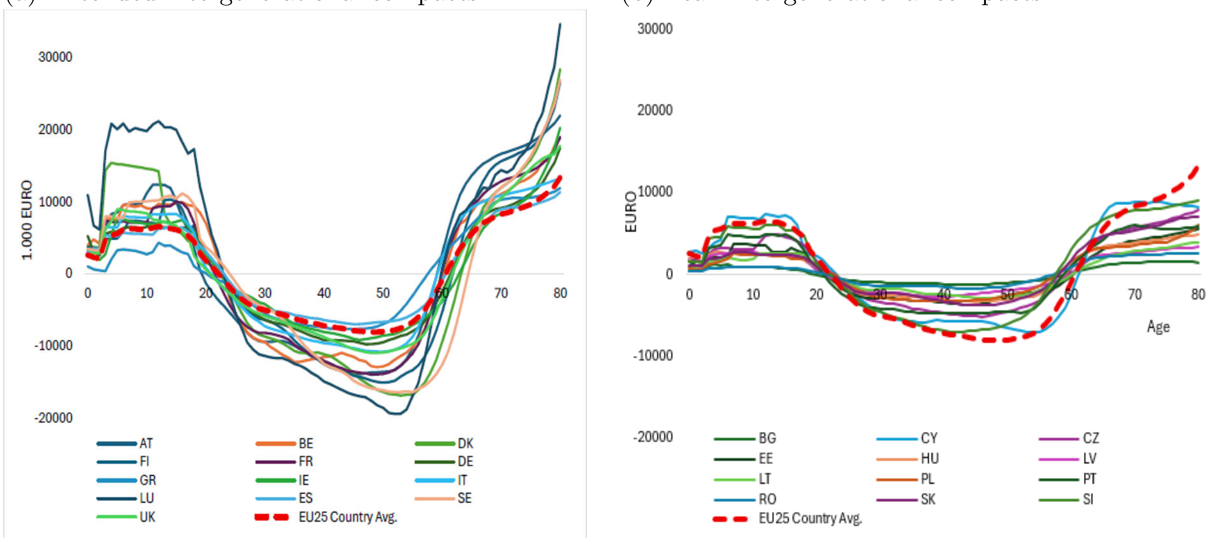
2.1 The intergenerational compact

These demographic changes affect public finances for the basic reason that there is a clear age dependency in both public expenditures and revenues. On the expenditure side, important items like childcare, education, healthcare, and elderly care are predominantly targeted the young and the old. The financing side rests mainly on people in the working-age population via various forms of tax payments. This age dependency is displayed in Figure 3 for EU countries, showing the average net transfers at a given age, defined as the difference between the value of the services and transfers received and taxes paid. The dotted line is the average across EU countries, and there is a clear pattern where the average person is a net beneficiary from birth to around the age of 20, then becomes a net contributor until about the age of 60, and then again becomes a net beneficiary. The more extended welfare arrangements are, the larger the age dependencies or the amplitude of the age-dependent net transfers. Figure 3.a shows the relationship for countries with a more extended intergenerational compact than the EU average, and Figure 3.b shows those with a more lean scheme. Even in the latter case, there is a clear age dependency.

The patterns shown here for EU countries is general, see also Lee and Mason (2011), and is also at centre of all projections of how demographic changes affect public finances, see e.g. IMF (2025), OECD (2023), and European Commission (2024). OECD (2024) shows that all countries have significant public expenditures on children (childcare and education) and the old (old-age care and pensions). Papanicolas (2020) shows that the larger part of public health expenditures are spent on the elderly part of the population. In all countries employment rates depend on age in a bell-shaped way, increasing from ages about 20 years and reaching a maximum in the age group 30-40 years, and then declining and reaching a low level at ages above 65 years, see e.g. OECD (2025).

Figure 3: Intergenerational compact - Age dependent net-benefits: Selected EU countries

(a) Extended intergenerational compacts (b) Lean intergenerational compacts



Note: The net benefits are defined on a per capita basis as the value of services received plus transfers less taxes paid. Data applies to 2010, see Istenič et al. (2016) for details on the construction of the data.

Data source: www.wittgensteincentre.org/ntadata.

This age dependency can be interpreted as an intergenerational compact tying different cohorts together since there, at a given point in time, is an overlap between different cohorts. Simplifying, the life cycle can be split into three phases: childhood, adulthood, and old age. The compact depends on adults working and contributing tax payments to finance childcare and education etc. for the children (below termed "education"), and health and old-age care etc. for the elderly (below termed "pensions").

The compact can thus be interpreted as having both a forward (supporting the coming generation) and a backward part (supporting the previous generation) by splitting the life cycle in two phases (around the age of 40, see Figure 3), see e.g. Andersen and Bhattacharya (2017). The average person first starts as a net beneficiary and then becomes a net contributor upon finishing education and entering the labour market. This may be interpreted as an implicit borrowing arrangement since the average person receives before later contributing (implicitly paying back). In the second life phase, the individual is first a net contributor, and with age and retirement becomes a net beneficiary. This is an implicit savings arrangement since there is first a contribution and later a benefit.

Before turning to an analysis of how the intergenerational compact is affected by changes in fertility, it is important to highlight several points about the nature of this compact that have been emphasized in the literature.

First, intergenerational compacts offer implicit rates of returns. A PAYG pension scheme where all in the working age contribute to a pension to all old has an implicit rate of return[4] given by the population growth rate (fertility) or the biological rate of return, as it was termed by Samuelson (1958). In a dynamic efficient economy, this return is lower than the market rate of return, and hence the PAYG pension scheme is return-dominated. This is the key argument made in the literature why PAYG pensions are detrimental to long-run welfare, see Aaron (1966). However, turning the argument around there is also an implicit borrowing rate, which in the simple setting is also the biological rate of return. Hence, the implicit borrowing rate, and thus the forward part of the intergenerational compact, is very favourable since it is below the market rate of return[5]. These arguments also hold in richer demographic settings, and the points on the implicit rates of return made above generalize, see Andersen (2025). A lower fertility rate is thus resulting in a lower implicit savings rate of return on the backward part of the intergenerational compact, but it is also decreasing the implicit borrowing rate on the forward part of the compact[6].

Second, the intergenerational compact can help alleviate capital market imperfections that limit young individuals' ability to finance education, and it can also internalize externalities e.g. in human capital accumulation and fertility decisions, see e.g. Boldrin and Montes (2005), Andersen and Bhattacharya (2017), Bishnu et al. (2021), and Bishnu et al. (2023). Hence, the intergenerational compact may be associated with efficiency gains.

Thirdly, a package considering both education and pension may be important for its political support. Importantly, the middle-aged may support education for the young. Although they do not benefit from it directly by receiving the education themselves, they benefit indirectly since the educational investment increases the income of the next generation, which in turn allows pensions to be higher, see e.g. Lancia and Russo (2016) and Bishnu and Wang (2017).

The following analysis takes the intergenerational compact as given and examines the financial implications of a change in fertility. This sheds light on how demographic developments may necessitate adjustments to the compact itself and potentially influence the level of public support for it.

[4]If all in the working-age population (size N^m) contribute T, and then all old (size N^o) can get a pension $b = \frac{N^m}{N^o}T = [1+n]\,T$, where $n \equiv \frac{N^m}{N^o}$ is the population growth rate. Seen from an individual perspective, T is paid when working and b is received as old, hence the implicit return is given as $\frac{b}{T} = 1+n$. In a more general scheme where the contribution is a proportion of wage income, the implicit return is the growth in the wage bill.

[5]Here implicitly the savings rate, and the market rate of borrowing is generally higher than the savings rate.

[6]In general the rate of return may also be affected by a change in the fertility rate, but still the net effect is to reduce r-n.

3 The basic arithmetics - public finances and demographics

The following develops some basic points on the interrelationship between demographics, the intergenerational compact, and public finances using a three-period overlapping generations setting with the life cycle split in three phases: childhood (y), adulthood or middle-aged (m), and old age (o), see discussion above. In each period t there is an overlap of cohorts being in different life phases. The intergenerational compact offers in period t education to the young (e_t), the middle-aged pay taxes (T_t), and the old receive pensions (b_t). Policies are here taken as exogenously given, and the labour market (production) is not made explicit, see discussion below.

The number of young in period t is $N_t^y = N_t$, given as the fertility rate[7] n_t times the number of middle-aged N_t^m $(= N_{t-1})$, where $N_t = [1 + n_t] N_{t-1}$. All young survive and become middle-aged, while there is a mortality risk for the middle-aged. The survival probability of a middle-aged in period t becoming old is π_t $(0 < \pi_t < 1)$. The number of old in period t (N_t^o) is thus determined by the number of middle-aged in period $t-1$ times the cohort-specific survival probability[8], $N_t^o = \pi_t N_{t-1}^m$. Hence, the youth-dependency ratio is $D_t^y \equiv \frac{N_t^y}{N_t^m} = \frac{N_t}{N_{t-1}} = 1+n_t$, and the old-age dependency ratio is $D_t^o \equiv \frac{N_t^o}{N_t^m} = \frac{\pi_t N_{t-2}}{N_{t-1}} = \frac{\pi_t}{1+n_{t-1}}$. For a constant fertility rate (n) and survival probability (π), it follows that the population growth rate is n and the youth and old-age dependency ratios are $D_t^y = D^y = 1 + n$, and $D_t^o = D^o = \frac{\pi}{1+n}$, respectively. A higher fertility rate increases the population size and changes its composition by increasing the youth dependency ratio and decreasing the old-age dependency ratio. These effects appear sequentially over time, with the effect on the youth dependency ratio appearing first, and then later the effect on the old-age dependency ratio materializes. In the empirically relevant case with a decline in the fertility rate, the population size shrinks, the youth dependency ratio declines, while the old-age dependency ratio increases. An increase in the survival probability (longevity) increases the population size and old-age dependency ratio.

The public sector budget balance (PB) in period t is

$$\begin{aligned} PB_t &= -N_t e_t + N_{t-1} T_t - \pi_t N_{t-2} b_t && (1) \\ &= \left[-D_t^y e_t + T_t - D_t^o b_t\right] N_{t-1} && (2) \end{aligned}$$

Both the population size and its age composition are important for the public budget. It is straightforward that a higher survival probability (longevity) has a negative effect on the budget. This is the essence of how longevity affects

[7] The fertility rate is here defined as the net fertility rate measured relative to the total population. In population statistics the fertility rate is measured as newborns relative to the female population (in relevant age groups).

[8] Since the length of old age is normalized to unity, the expected retirement period is $\pi_t < 1$, and hence the survival probability can in this simple setting be interpreted as (expected) longevity.

public budgets, and it is not discussed further. The following thus assumes the survival probability to be constant, $\pi_{t+j} = \pi$ for all j, to focus on fertility.

For given policies it follows straightforwardly that an increase in the size of cohort t worsens the primary balance when the cohort is young ($\frac{\partial PB_t}{\partial N_t} = -e_t < 0$), improves it when they are middle-aged ($\frac{\partial PB_{t+1}}{\partial N_t} = T_{t+1} > 0$), and worsens it when they are old ($\frac{\partial PB_{t+2}}{\partial N_t} = -b_{t+2} < 0$). Hence, the long-run effects are in general ambiguous. Note also that a change in fertility releases a dynamic adjustment pattern in a different way than an increase in longevity, which solely affects the retirement period.

For later reference, define the present value (PV) of the compact to an individual being young in period t as

$$PV_t^r \equiv e_t - \frac{1}{1+r} T_{t+1} + \frac{\pi}{[1+r]^2} b_{t+2} \tag{3}$$

where r is the market rate of return (assumed time-invariant for simplicity). The present value measures how the compact affects the lifetime income of the individual. Similarly, define the present value of the compact for a discount rate equal to the implicit return (n) in a PAYG scheme,

$$PV_t^n \equiv e_t - \frac{1}{1+n} T_{t+1} + \frac{\pi}{[1+n]^2} b_{t+2}$$

The following analyses how demographic changes affect both the budget and the attractiveness of the intergenerational compact.

3.1 Fertility and the public budget

To fix ideas and focus on long-run effects, assume that the fertility rate is time-invariant, $n_{t+j} = n$ for all j, in which case the budget balance can be written

$$\begin{aligned} PB_t &= N_t \left[-e_t + \frac{1}{1+n} T_t - \frac{\pi}{[1+n]^2} b_t \right] \\ &= N_t \left[-PV_t^n \right] \end{aligned} \tag{4}$$

The budget balance can thus be written as equal to the negative of the present value of the intergenerational compact to a person belonging to the period t cohort using the implicit (biological) rate of return (n) as the discount rate times the size of the period t cohort[9]. Expression (4) also points out that while the compact seen from the individual perspective is assessed in terms of its present value using the market rate of return (r) as the discount rate, see (3), the present value given the biological rate of return (n) is important for the financial balance of the compact. This shows that the compact may be valuable to the individual even if it satisfies a balanced budget requirement

[9] With a constant fertility rate, the population size will eventually converge to its steady state value.

($PV_t^n = 0 \nRightarrow PV_t^r = 0$), see below. The difference between the two rates of return is thus crucial, see below.

In a balanced-budget regime ($PB_t = 0$), the present value of the compact given the biological rate of return has to be zero ($PV_t^n = 0$). To elaborate on this, assume that the policy package is also time-invariant $\{e_{t+j}, T_{t+j}, b_{t+j}\} = \{e, T, b\}$ for all j. This case makes it possible to analyse the long-run or structural effects of changes in the fertility rate. In this case the budget balance is

$$PB_t = N_t \left[-PV^n\right] \tag{5}$$

where

$$PV^n \equiv e - \frac{1}{1+n}T + \frac{\pi}{[1+n]^2}b$$

The effect on this present value PV^n of a change in fertility is given as

$$\frac{\partial PV^n}{\partial n} = -\frac{1}{[1+n]^2}T + \frac{2\,[1+n]\,\pi}{[1+n]^4}b = \frac{1}{[1+n]^2}\left[-T + \frac{2\pi}{[1+n]}b\right]$$

The budget effect of a change in fertility for an initial situation with a balanced budget ($PB_t = 0$ and hence $PV^n = 0$ and $T = [1+n]\,e + \frac{\pi}{1+n}b$) is

$$\left.\frac{\partial PB_t}{\partial n}\right|_{PV^n=0} = N_t\left[\frac{1}{[1+n]}\left[\frac{\pi}{[1+n]^2}b - e\right]\right] \lesseqgtr 0$$

The term in the square brackets on the RHS of this expression is the present value as young of the expected pension given the implicit rate of return n in the PAYG arrangement less the education received as young. Hence, a higher fertility rate improves the primary balance if the present value of the expected pension using the implicit return as the discount rate exceeds the value of education, $\frac{\pi}{[1+n]^2}b > e$, while it worsens if $\frac{\pi}{[1+n]^2}b < e$. The budgetary effect thus depends on whether the forward or backward part of the intergenerational compact dominates (in present value terms using n as the discount rate). If the backward part "pensions" dominates, higher fertility improves the budget, and oppositely if the "education" part is dominating. Finally, the effect of changes in fertility is decreasing in the fertility rate, and hence a change in the fertility rate from an initial low level may have larger effects than for an initially high level.

Next, consider the effect of a change in the fertility rate from the perspective of the individual. Inserting the tax payment $T = [1+n]\,e + \frac{\pi}{1+n}b$ in (3), the present value of the compact is[10]

$$PV^r|_{PV^n=0} = \frac{r-n}{1+r}\left[e - \frac{\pi}{[1+r]\,[1+n]}b\right] \lesseqgtr 0 \tag{6}$$

[10] Observe that the difference between the present value discounted by the market rate and the implicit rate of return in general is given as $PV^r - PV^n = \frac{1}{1+n}T - \frac{1}{1+r}T + \frac{\pi}{[1+r]^2}b - \frac{\pi}{[1+n]^2}b = \frac{r-n}{1+r}\left[e - \frac{\pi}{[1+n][1+r]}b\right]$. Hence, in a dynamically efficient economy ($r > n$), the forward part of the compact contributes to making PV^r larger than PV^n, and oppositely for the backward part.

The present value of the compact is thus in general non-zero even though the scheme operates under a balanced budget (and therefore $PV^n = 0$). Two factors determine whether the compact has a positive or negative present value to the individual. First, the relation between the market rate of return (r) and the implicit rate of return (n). In a dynamically efficient economy, there is no overaccumulation of capital and $r > n$ (see the discussion above) - a condition which is generally found to hold empirically, see e.g. Rogoff and Schmelzing (2024). Subject to this condition, the forward (education) part contributes positively to the present value of the compact since the implicit borrowing rate (n) is lower than the market rate of return (r), see equation (6). Oppositely, the backward (pension) part contributes negatively to the present value since the implicit return to saving is lower than the market rate. The latter is a corollary of a fundamental result in the pension literature, stating that pensions in a dynamically efficient economy do not have a welfare rationale in steady state, see Aaron (1966). It should be noted that other reasons for having PAYG pension schemes are not considered here, including insurance (due to incomplete markets), behavioural decision-making, and redistribution. Hence, the present value of the compact depends on whether the forward or backward part of the compact is dominant, see Andersen (2025). Finally, notice that in a dynamically efficient economy ($r > n$), a positive present value of the compact to the individual ($PV^r > 0$) is a sufficient condition that an increase in the fertility rate worsens the public budget, $\frac{\partial PB}{\partial n}\Big|_{PV^n=0} < 0$.

The effect of a change in the fertility rate on the present value of the compact to the individual follows straightforwardly to be (using $T = [1+n]\, e + \frac{\pi}{1+n} b$)

$$\frac{\partial PV^r}{\partial n}\bigg|_{PV^n=0} = -\frac{1}{1+r}\left[e - \frac{\pi}{[1+r]\,[1+n]}b\right] + \frac{r-n}{1+r}\frac{\pi}{[1+r]\,[1+n]^2}b \lesseqgtr 0$$

The first term on the RHS arises via the effect a change in the fertility rate has on the return difference, $r-n$. The higher the fertility rate, the lower this difference, which decreases the present value of the compact if its forward part is dominating in the sense that $PV^r > 0$ (the implicit borrowing rate increases), and it increases if the backward part is dominating (the implicit savings rate increases). The second term on the RHS arises via the effect a higher fertility rate has on the financing of pensions. A higher fertility rate decreases the burden on the middle-aged of financing the pension (b) to all old, and this makes the backward part more attractive (less of a burden). This effect is the reason why the private return to fertility is lower than the social return in the presence of a PAYG pension scheme, see e.g. Cigno (1993).

To sum up, the effect of a lower fertility rate on the public budget is generally ambiguous. The decisive factor is whether the intergenerational compact is dominated by its forward part (education) or its backward part (pensions). If the forward part dominates, a decrease in fertility improves the budget balance; if the backward part dominates, the opposite holds. From an individual perspective, it is likewise unclear whether changes in fertility make the compact more or less attractive in present-value terms. The direct effect is that lower (higher) fertility raises (reduces) the attractiveness of the compact when it initially has a positive present value—that is, when the forward component is dominant. However, this direct effect is counteracted by the need to finance the backward component (pensions), making the overall impact ambiguous.

3.2 Intertemporal budget regime

Consider next the general case where the budget is not required to balance on a period-by-period basis, in which case a viable policy must satisfy an intertemporal budget constraint. The intertemporal budget constraint for the government can be written

$$\Gamma_t \equiv D_{t-1} + PB_t + \frac{1}{1+r} PB_{t+1} + \frac{1}{[1+r]^2} PB_{t+2} + ++ = 0$$

where D_{t-1} is the initial debt level. Inserting from (1), this expression can be rewritten as[11]

$$\Gamma_t = \widetilde{D}_t - N_t PV_t^r - \frac{1}{1+r} N_{t+1} PV_{t+1}^r - \frac{1}{[1+r]^2} N_{t+2} PV_{t+2}^r + +$$

where $\widetilde{D}_t = D_{t-1} + N_{t-1}T_t - \pi_t N_{t-2} b_t$.

The intertemporal budget constraint can thus be written in terms of an initial net-wealth variable ($\widetilde{D}_t$) and the (negative of) present value of the intergenerational compact to the individual, see (3), weighted by the size of the respective populations. The present value appears with a negative sign since a net transfer to the individual is a net expenditure for the state.

From a policy perspective, an important question is whether it is feasible to implement a policy package offering the same to all cohorts, $\{e_{t+j}, T_{t+j}, b_{t+j}\} = \{e, T, b\}$ for all j, such that the compact and its present value are the same for all cohorts, $PV_{t+j}^r = PV^r$ for all j. This may be interpreted as a policy which is intergenerationally fair in the sense that if offers the same to all individuals, irrespective of the cohort to which they belong. In this case the intertemporal budget constraint reads,

$$\Gamma_t = \widetilde{D}_t - N_t \frac{1+r}{r-n} PV^r$$

[11] This insight generalizes to a finer grid than the three-period overlapping generations model considered here. Let a denote age, $a = 0, 1....T$, $N_{t,a}$ is the number of people of age a in period t, and m_a is the age-specific net contribution are given as

$$PB_t = \sum_{a=0}^{T} N_{t,a} m_a$$

Let the number of people age a in period t be given as the number born in period $t-a$, B_{t-a}, times the probability of reaching age a, π_a, then $N_{t,a} = B_{t-a}\pi_a$

$$PB_t = \sum_{a=0}^{T} B_{t-a} \pi_a m_a$$

where $\widetilde{D}_t = D_{t-1} + N_{t-1}T - \pi_t N_{t-2}b$ and $PV^r = e - \frac{1}{1+r}T + \frac{\pi b}{[1+r]^2}$. Satisfying the intertemporal budget constraint requires, $\Gamma_t = 0$, and hence a policy package with the same present value for all cohorts PV^r is feasible iff

$$\widetilde{D}_t = N_t \frac{1+r}{r-n} PV^r \tag{7}$$

In a dynamically efficient economy ($r > n$), this requires that $\widetilde{D}_t > 0$ if $PV^r > 0$; that is, an initial net wealth (defined as $\widetilde{D}_t = D_{t-1} + N_{t-1}T_t - \pi_t N_{t-2}b_t$) is needed to ensure that the intertemporal budget constraint is fulfilled. This shows that a knife-edge condition must be satisfied for identical welfare entitlements across cohorts to remain financially viable, and a change in fertility would therefore require a policy adjustment.

Turning to the effect of a change in the fertility rate on the present value of net revenue, it follows that

$$\frac{\partial \Gamma_t}{\partial n} = -N_t \frac{1+r}{[r-n]^2} PV^r$$

which implies that

$$sign \frac{\partial \Gamma_t}{\partial n} = -sign\ PV^r$$

Summing up, in a regime without a requirement of period-by-period budget balance—though the intertemporal budget constraint must still hold—the effect of a fertility change on the present value of public net revenue depends on the present value of the compact for the individual. In the empirically relevant case of declining fertility, the long-run fiscal position improves when the compact is individually beneficial (PV > 0) and deteriorates when it is individually unfavorable (PV < 0). The underlying intuition mirrors the mechanism identified under the balanced-budget regime discussed earlier.

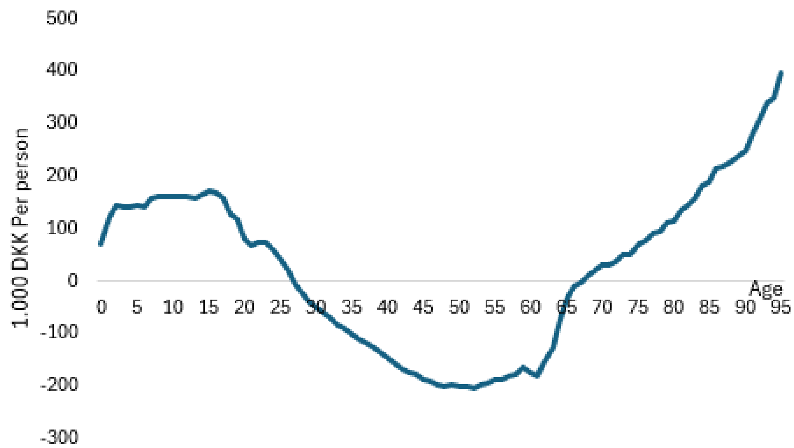
4 Quantification - budget effects of changes in fertility - Denmark

The setting above condensed the life cycle to three phases, which is an oversimplification, and allowing an annual time structure also makes it possible to capture the more rich age dependencies in net contributions. Figure 4 shows the average net benefit for given ages in the case of Denmark, where the net benefit is given as the difference between transfers and the value of welfare services[12] (childcare, education, healthcare and old-age care etc.) received and tax payments. To quantify the public finance implications of changes in fertility, it

[12] All public consumption expenditures, transfers and taxes are allocated across age groups. Public consumption expenditures are in national accounts split into collective public spending (e.g. defence, judicial system, police, state administration etc.) and individual public spending (e.g. care, education, health). For a precise definition and classification of different expenditure types, see

is important to capture these age dependencies, and the following first analyses the mechanic budget effects of a change in fertility and then reports the result from a richer model used for actual policy planning.

Figure 4: Intergenerational compact - Age dependent net-benefits: Denmark



Note: The net benefits are defined on a per capita basis as the value of services received plus transfers less taxes paid. Based on register data. Data applies to 2019.

Data source: Danish Ministry of Finance (2023).

Denmark has an extended welfare state belonging to the Nordic Welfare Model, and is among the countries with an age dependency above the average (Denmark is among the countries appearing in Figure 3 with an age dependency stronger than the EU average). The demographic changes in Denmark are very similar to the developments across high-income countries. Figure 5 shows how the dependency ratios develop in the medium- and low-fertility scenario in the UN population projection for high-income countries and Denmark, respectively. The fertility rate in the low scenario is 0.5 lower than in the medium scenario. Notice that the assumptions about mortality are the same in the two cases, and longevity is assumed to increase[13]. A lower fertility rate reduces the youth dependency ratio, which implies that the total dependency ratio remains roughly stable until the mid-2050s. After that point, it begins to rise and eventually reaches a higher level. As the smaller cohorts resulting from reduced fertility age, the size of the workforce declines. Consequently, the old-age dependency ratio increases more sharply than in the medium scenario, while the decline in

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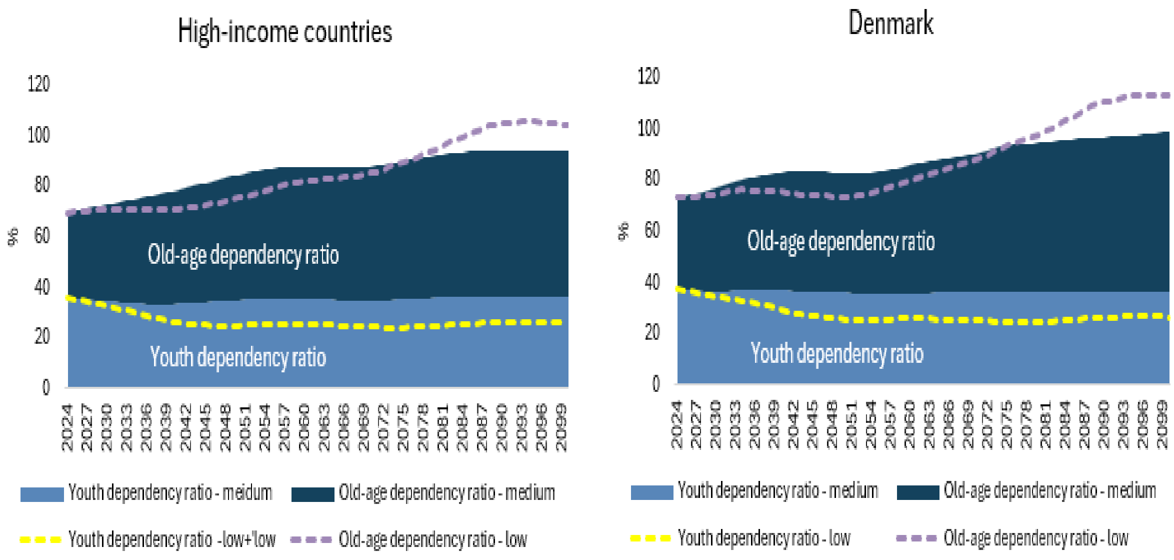
https://unstats.un.org/unsd/classifications/Econ/Download/COICOP_2018_draft_publication.pdf. Detailed register data available for Denmark makes it possible to attribute the individual public spending and tax payments to specific individuals and thus to allocate them across age groups, see Danish Ministry of Finance (2023). Collective public spending is distributed on a per capita basis in the computations of the net contributions.

[13] From about 81 years for a newborn man and 85 years for a woman in 2025, to 88 and 90 years, respectively, in 2069.

the youth dependency ratio tapers off. In short, a lower fertility rate reduces total dependency for four to five decades, after which it increases.

Figure 5: Dependency ratios, medium- and low-fertility scenario: High-income countries and Denmark



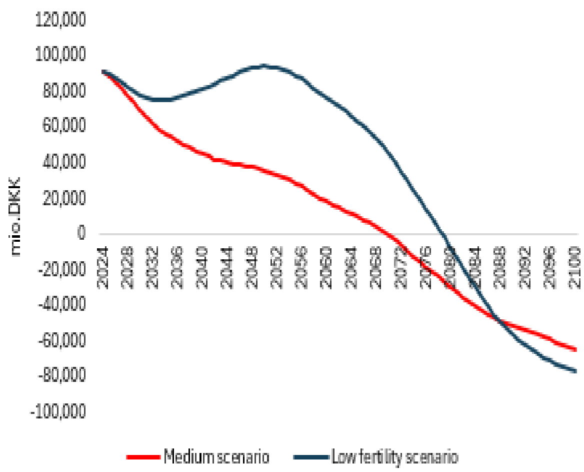
Note: Projected dependency ratios, medium- and low-fertility scenario (fertility rate 0.5 lower than in the medium scenario).

Data source: UN, Population Prospects 2024, https://population.un.org/wpp/.

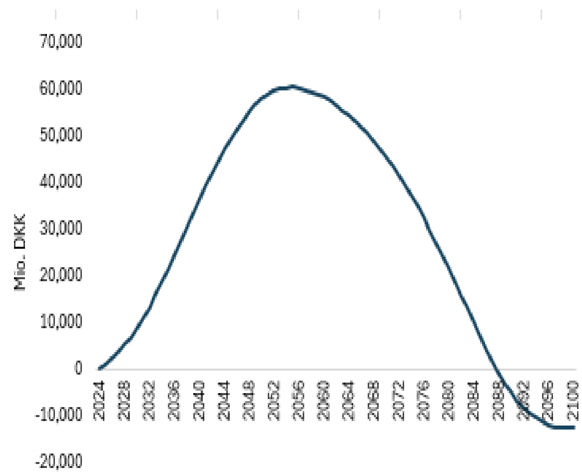
Given the age-dependent net contributions (Figure 4) and the population size of each age group (Figure 5), the aggregate net contribution (primary budget balance) is computed for each year in the forecasting period. The computation is made both for the medium- and low-fertility scenario, making it possible to observe the consequences of a decline in the fertility rate. Given the population forecast from the medium scenario, there is a trend decline in the budget balance which reflects the steady increase in the dependency ratio, see Figure 6a. Notice the compact is assumed time invariant, and hence there is no policy response to the changes in demographics, including the increasing longevity, see below. In the low-fertility scenario, there is first a u-shaped pattern since the lower number of children and young reduces total costs on these age groups, eventually the budget starts deteriorating due to a lower work force and an increasing total dependency ratio. In the very long run, public finances are adversely affected compared to the medium scenario.

Figure 6 Public finances (primary budget balance) and fertility: Medium- and low-fertility scenarios

(a) Primary budget balance



(b) Difference from medium scenario



Note: Own calculations based on formula, see footnote 9.

Source: Data reported in Figure 4 and 5.

The preceding gives the mechanic budget effects disregarding how demographic changes affect the economy, which in turn feeds back on the economy. The following reports on a quantification of a decrease in fertility using the DREAM-model for Denmark, see Andersen et al. (2023). The model is specifically constructed to analyse the long-term developments of public finances, including the effects of changes in labour market policies, pension legislation and demographics. It is a large scale structural overlapping generations model[14]. The model has a detailed modelling of the population, education and demographics (labour supply) as well as of the public sector (both on the tax and expenditure side). The behaviour of both firms and households is derived by optimizing behaviour, product prices are flexible, and the labour market has wage bargaining implying structural unemployment. The model is regularly used for analyses and quantifications of long-run issues in policy discussions in Denmark, see e.g. Danish Economic Council (2024), and as such it is a credible modelling framework.

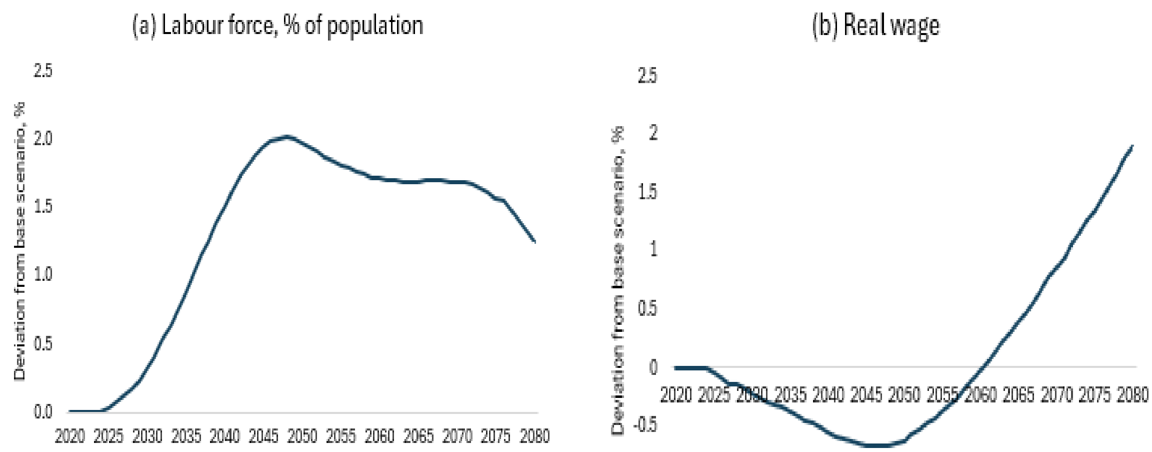
Specifically, the following reports a quantification of the effects of a change in the fertility rate from about 1.7 for the entire population to a level which converges[15] to 1.3 (for a short description of the base scenario, see Appendix A), see Andersen and Skaksen (2025). The results can thus be interpreted as

[14] For an introduction to the structure of the model, see https://dreamgroup.dk/publications/2008/april/dream-documentation

[15] Although a long-run model with evolving dynamics arising both from demographics and economic mechanisms, it is assumed that demographic variables are stationary from xx, and that the economy is in steady state after that. Especially for demographic changes, this assumption is raising issues when the population size and composition are not stabilizing within this period, and the discounting is not strong enough to make changes after the horizon inconsequential.

the "marginal" effects of a change in the fertility rate (a similar experiment with an increase in the fertility rate to 2.1 gives roughly the same but oppositely signed results). All figures below show the changes relative to the base scenario. The base scenario uses the latest official population forecast and considers the trajectory for key macro variables and public finances over time for unchanged policies. Fiscal policy is sustainable, see also Ministry of Finance, and Danish Economic Council (2024), and for the base scenario the sustainability indicator is 2.9% of GDP. The indicator shows that a permanent increase in public expenditure—or an equivalent tax reduction—amounting to 2.9% of GDP can be implemented without undermining fiscal sustainability. In other words, such a policy change would still satisfy the government's intertemporal budget constraint.

Figure 7 Labour force and real wages - effects of decline in fertility

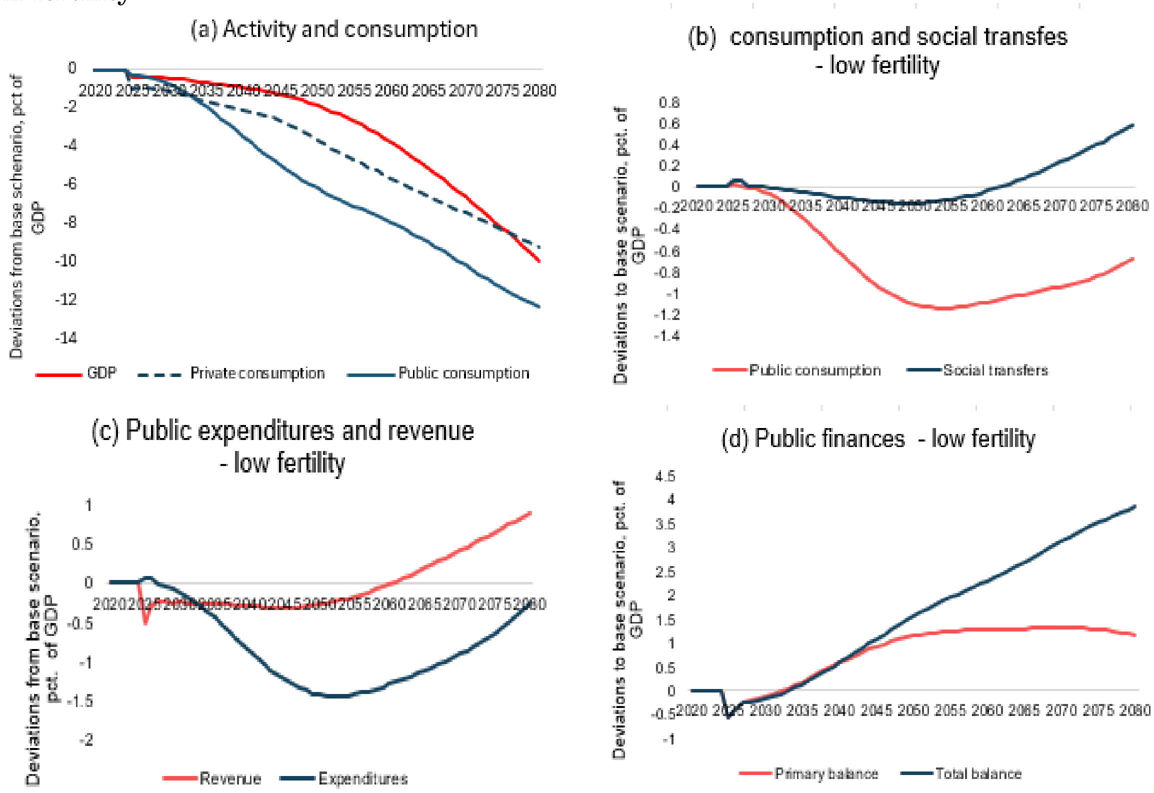


Note: The figure shows the effect of a decline in the fertility rate from 1.7 in the base scenario to 1.3.

Source: Andersen and Skaksen (2025), Andersen et al. (2025).

Lower fertility initially raises the labour force as a share of the total population—the mirror image of a falling youth dependency ratio—but this effect eventually reverses. Fewer births reduce public consumption targeted at children (see Figure 4), which lowers public-sector labour demand. This puts downward pressure on real wages and increases private-sector employment. Over time, however, the relative size of the labour force declines, pushing real wages upward and reducing employment and economic activity. In absolute terms, the smaller workforce lowers GDP (see Figure 8), and this negative effect grows over time as the reduced fertility rate gradually feeds into a smaller labour supply. Further ahead, lower fertility reduces the number of older people, which decreases public consumption and transfer payments such as pensions. Yet because GDP is also falling, transfer expenditures rise as a share of GDP in the long run. Public expenditures decline relative to GDP, but tax revenues first fall and then rise as a share of GDP due to higher real wages. Overall, the public budget strengthens, although the primary balance follows a hump-shaped trajectory—improving initially and then deteriorating—similar to the findings of the mechanical projection in Figure 6. Measured by the fiscal sustainability indicator, which captures the permanent adjustment to the primary balance (as a share of GDP) consistent with long-run budget balance, the effect is an improvement of 0.47% of GDP. This implies room for a permanent increase in spending or a tax reduction equivalent to roughly 0.5% of GDP. In sum, lower fertility significantly improves public finances, thereby expanding the scope for economic policy choices. This aligns with the conclusion in Section 2 that, under a front-loaded intergenerational compact, lower fertility improves fiscal sustainability.

Figure 8 Key macro variables and public finances - effects of decline in fertility



Note: The figure shows the effect of a decline in the fertility rate from 1.7 in the base scenario to 1.3.

Source: Andersen and Skaksen (2025), Andersen et al. (2025).

The quantification presented above uses a model that incorporates standard macroeconomic responses. Importantly, the underlying factors influencing fertility may have additional consequences not captured here—for example, lower fertility could increase labour supply if less time is devoted to childcare and this would have a positive effect on public finances. A more comprehensive analysis would be required to account for such mechanisms. Since the reasons underlying the decline in fertility are not well understood, see the introduction, it is difficult to assess the consequences of such responses. The purpose of the present assessment is therefore to illustrate the first order effects for public finances.

5 Conclusion

Declining fertility can influence society through multiple channels and may have substantial economic consequences. In many countries, public finances are already under pressure from population ageing, and it is often assumed that lower fertility would further strain government budgets. This analysis shows that the fiscal impact of changes in fertility is generally ambiguous and highly country-specific. The magnitude and direction of the effect depend on each country's welfare institutions and policy design. For Denmark, the results indicate that the structure of the intergenerational compact is such that lower fertility actually improves fiscal sustainability. While these findings cannot be directly generalized to other countries, they highlight an important point: the common assumption that declining fertility automatically worsens public finances does not hold universally. Instead, the outcome depends on the relative weight of welfare services and transfers directed toward the young compared with those directed toward the elderly.

The findings raise a number of policy questions. If lower fertility improves fiscal sustainability and thus creates some fiscal space, it becomes a question whether more should be spent or invested on each young person. This could potentially increase their income (and thus growth at the economy-wide level), which in turn increases the tax base and the scope for financing the burden following from an ageing population. However, from a political economy perspective, the development may go in the opposite direction since fewer young people also – over a substantial transition period – shift more political power to the more senior part of the electorate, making it more difficult to find support for "youth"-friendly policies, see e.g. Andersen (2025), Stiglitz (2016) and Vlandas (2023). It is an important issue for future research to analyse these opposing forces and how they would influence economic developments in economies with declining populations.

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APPENDIX

Base scenario

The following briefly describes the base scenario for the projection of public finances, see Andersen et al. (2024). The base scenario projects key variables - including for public finances - given unchanged policies (unchanged tax system, expenditures per capita etc.) and a demographic projection. The projected path for public finances is shown in Figure A-1. After an initial phase where expenditures rise and exceed revenue, a decline in expenditures and a rather steady revenue-to-tax ratio, implies a systematic surplus on the primary balance. This in turn implies a wealth accumulation for the public sector, and hence the total balance exceeds the primary balance. The sustainability indicator for this base projection is 2.9% of GDP; that is, a permanent deterioration of the primary balance as a share of GDP - via expenditure increases or tax reductions - would be consistent with satisfying the intertemporal budget constraint for the public sector. That public finances are sustainable with some margin is also the findings of the Ministry of Finance (2024) and the Danish Economic Council (2024). A key factor behind this finding is that the statutory retirement age in Denmark is indexed to the development in longevity, and it is targeting an expected retirement period of 14.5 years. The expected retirement is currently above this level; hence, over time, this target will be approached, which contributes significantly to making public finances sustainable.

Figure A-1: Base projection - public finances