The Sustainability of PAYG Pension Schemes: A Comparative Analysis (1993–2023)

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Abstract
The most common policy response to pension account deficit appears to be increasing age of retirement. Many countries with PAYG pension schemes have been experiencing this bitter reality. This paper brings to evidence some parameters of PAYG pension schemes neglected in short political cycles, but important from the long-term perspectives. We use data from the Czech Republic and Germany, two economies close geographically and by population structure, yet different in pension schemes tradition and economic development. By a comparative analysis we show in detailed parameters that a balanced family policy combined with macroeconomic policies may allow keeping retirement age fixed in a sustainable PAYG pension scheme.

Keywords: PAYG pension scheme; retirement age; aging population; total fertility; average age of the mother at birth; life expectancy.

JEL Classification: H55; H75; J32.

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1. Introduction

Pension scheme reforms are a resonant policy issue across European countries. Traditional pay-as-you-go (PAYG) pension scheme is seen in crisis under ageing population reality and policymakers thoroughly look for feasible solutions. A frequent outcome of any proposed pension reform consists in increasing retirement age. Generally, reforms tend to be limited on adjusting three basic parameters: the retirement age, the level of pension benefits and the rate of income tax. Increasingly also governments motivate capital pension savings. We argue that

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this narrow approach currently poses a significant risk to the sustainability of PAYG systems. This paper brings evidence that governments often make fundamental mistakes when considering reforms to pay-as-you-go (PAYG) pension schemes in the context of an ageing population. An example of how governments are approaching the sustainability issue is Germany, whose government has approved the intention to raise the retirement age in September 2024[1] and also the Czech Republic, where the legislative process to reform the pension system started in November 2024, plans to increase it gradually up to 67.

However, pay-as-you-go pension systems are sensitive to a number of other parameters that governments pay little attention to in the interest of the short-term political cycle. This approach is probably the result of the mistaken belief that demographic factors cannot be fundamentally influenced in a single electoral period. For this reason, governments focus primarily on easily measurable and quantifiable parameters whose impacts are relatively easy to plan and predict.

Timing plays a key role in the issue of pension reforms. The limited length of electoral terms leads to a situation where decisions on the current set-up of the PAYG system will have a major impact only decades from now. Although retirement age adjustments are usually planned with transition periods of 20-30 years ahead, governments are able to implement these legislative changes almost quickly. This is due to the administrative ease of passing the changes in the law itself.

A question to be asked is why governments do not pay enough attention to parameters that are as important as those traditionally addressed, and which - we assume - can be influenced by governments, even if not so easily. Among these parameters we can mention, for example, fertility trends, the average age of mothers at childbirth or quality of life. This paper focuses on these neglected aspects of pay-as-you-go (PAYG) pension schemes. It also discusses the impact of modern trends in medicine that can have a major impact on PAYG schemes. The issue is analysed through a case study using data from the Czech Republic and Germany.

We point out the existing time dichotomy as governments under political cycle of 4-8 years may not decide in an efficient way on issues with operation time well beyond this time period. Pay-as-you-go pensions continue to be among the most effective tools to provide for old age. We will offer a discussion on possible settlements of time dichotomy in decision-making.

The aim of this paper is to offer a more comprehensive view of ways to improve the sustainability of PAYG pension schemes. Particular attention will be paid to the impact of policy cycles on the feasibility of reforms and on the broader set of factors affecting scheme sustainability. We will analyse aggregate fertility development and maternal age at childbirth, attempting to identify the economic and social determinants of these parameters using the Czech Republic and Germany as a case study. The discussion will also include an analysis of current trends in medicine and their impact on pension, health and social systems. The paper further includes a comparative analysis of these factors between Germany and the Czech Republic, highlighting shared challenges and potential lessons for enhancing the sustainability of PAYG pension systems.

[1] See for example: https://www.reuters.com/world/europe/germany-approves-pension-reform-incentivize-later-retirement-2024-09-04/ [cited 11/10/2024]

2. Literature Review

Current research highlights that PAYG systems face mounting pressures due to demographic shifts, but strategic reforms such as raising retirement ages, implementing automatic balancing mechanisms, and engaging older workers' labour potential can bolster their sustainability. These efforts require balancing economic imperatives with social equity to ensure long-term financial and social viability.

PAYG pension schemes rely on contributions from current workers to fund pensions for retirees. This model faces significant strain due to demographic shifts, such as increasing old-age dependency ratios—where fewer workers support a growing number of retirees. Penas and Fernandez emphasize that the rising ratio of pensioners to contributors jeopardizes PAYG systems' financial sustainability, necessitating reforms to maintain equilibrium (Penas & Fernandez, 2017). Similarly, Andersen and Bhattacharya discuss the consequences of labour supply adjustments under the pressures of unfunded pensions, urging the creation of economic frameworks that address these issues effectively (Andersen & Bhattacharya, 2012).

One key strategy for addressing these challenges lies in adjusting retirement age policies. Fanti argues that raising the mandatory retirement age can enhance long-term income and the financial health of PAYG pensions, reducing financial strain on the system (Fanti, 2014). Both Knell (2016) and Vogt and Althammer (2016) build on this idea by suggesting that reforms linking retirement ages to increasing life expectancy can stabilize funds and directly tackle demographic challenges.

Reforms to PAYG systems also involve automatic mechanisms for maintaining financial sustainability. Godínez-Olivares et al. (2016) propose adjustments to contribution rates and retirement ages as a framework for optimizing PAYG systems under shifting demographics. This aligns with Cipriani and Fioroni (2019), who stress integrating demographic factors into policy-making to ensure the resilience of pension systems over the long term.

Beyond financial considerations, PAYG systems also affect the broader economy, particularly in areas like labour supply and human capital. For example, Erosa et al. (2012) highlight the role of government programs like pensions in influencing labour market participation, particularly among older workers. Extending working life can boost older individuals' economic contributions, relieving pressure on the pension system (Vögel et al., 2013).

The relationship between total fertility rates and the average age of mothers at birth offers critical insights into broader socio-economic trends and health outcomes. This literature review builds on recent findings, focusing on how maternal age impacts fertility behaviours and outcomes against the backdrop of changing societal structures.

Globally, the average age of mothers at childbirth is rising, correlating with declines in total fertility rates. Beaujouan et al. (2023) observe that as women delay first childbirth, completed fertility rates decline, leading to fewer children per woman across cohorts. Similarly, Zambon et al. (2018) explain how economic fluctuations and societal shifts, such as those seen in Greece, have contributed to both delayed childbearing and reduced fertility. These findings show the interplay between societal norms, economic pressures, and reproductive choices.

Advanced maternal age has multidimensional implications, influencing both fertility and health outcomes. Berg et al. (2021) find that women born to older mothers display lower fertility rates, revealing potential intergenerational effects of maternal age. Neal et al. (2018) and Moore et al. (2019) highlighted that increasing maternal age is linked to heightened risks like neonatal

mortality, especially when coupled with socio-economic disparities and limited healthcare access. Conversely, early maternal age is not without challenges—Gibbs et al. (2012) report that early childbirth significantly increases risks of adverse pregnancy outcomes, illustrating the dual risks of both early and late motherhood.

Socio-demographic factors such as cultural practices and education also shape reproductive behaviours. For instance, Iqbal et al. (2022) observe that consanguineous marriages often correlate with higher fertility, affecting the average maternal age in specific cultures. Augustine et al. (2015) identify maternal education as another vital factor, with higher educational attainment delaying childbirth and lowering fertility rates.

In conclusion, the relationship between total fertility rates and maternal age is shaped by complex socio-economic, cultural, and health factors. The rising age of mothers at childbirth results in both declining fertility rates and greater health risks, suggesting the need for targeted health and policy interventions to address these demographic trends.

The interplay between life expectancy, aging populations, and political cycles further complicates demographic challenges, particularly in the realms of fiscal policy and social welfare. With global life expectancy on the rise, the resulting population aging significantly strains government budgets, particularly regarding healthcare and pension systems.

Political cycles influence fiscal decisions in aging societies, where rising demand for social services presents unique challenges. For example, governments often increase spending before elections to secure voter support, a phenomenon known as political budget cycles (PBC). While this strategy can generate short-term voter approval, it may exacerbate long-term fiscal challenges and hinder the sustainable funding of programs like pensions (Gootjes et al., 2019; Hanusch & Keefer, 2013; Aaskoven, 2018). The tension between electoral incentives and aging-related fiscal needs tends to escalate in countries with older electorates, where political actors are pressured to prioritize pension benefits over broader economic reforms (Pástor & Veronesi, 2020; Philips, 2016).

The impact of PBCs varies depending on political institutions. Democracies tend to exhibit more proactive fiscal manipulation by politicians vying for re-election, whereas in autocratic regimes, the cycle may be less predictable, with decisions shaped more by individual authorities' interests than by public accountability (Klien, 2015; Chiripanhura & Niño-Zarazúa, 2015; Tsai, 2016). In aging societies, this behaviour intersects with shifting voter demographics, intensifying fiscal pressures to satisfy older individuals' preferences, such as expanded social safety nets (Bohn, 2018; Aaskoven, 2018).

As these political cycles shape fiscal governance under the influence of aging populations, they also risk resource misallocation and long-term economic instability (Doležalová, 2011; Philips, 2016). Policymakers must navigate competing priorities to address older voters' needs while ensuring sustainable fiscal policies for future generations.

In summary, the relationship between life expectancy, aging populations, and political cycles illustrates how demographic forces and political behaviours collectively shape fiscal policies. Sustainable solutions must balance electoral incentives with the need for fiscal discipline, ensuring that social welfare programs can meet the demands of aging societies without jeopardizing long-term economic stability. Within this broader context we will offer some new considerations on sustainability of PAYG system.

3. Methodology

This study aims to identify the socio-economic determinants of a pay-as-you-go (PAYG) pension system, focusing on key parameters that are often overlooked by the political representation. As the issue is examined over a 30-year time horizon in the context of the Czech Republic, there is insufficient data to apply econometric modelling to accurately quantify the results.

OLG (Overlapping Generations) models are commonly used in the literature (Kim & Lee, 2024), AR models (Kato, 2021) or OLS models (Lal et al., 2021). However, our analysis does not work with panel data that would lead to quantitative conclusions. Instead, we focus on a deeper, society-wide analysis that allows us to capture subtle country-specific economic and social causes. This distinguishes us from an approach based on econometric models which, while providing a useful statistical description, are not always able to fully reflect objective reality.

This study used data from several sources, including the Czech Statistical Office, the Czech National Bank, the Ministry of Education, Youth and Sports and others listed in the reference list. The sources include mainly demographic data, inflation, real GDP growth and wage growth. The chosen methodology is based on comparison and deduction, which allows us to examine the issue from a different perspective and to offer a more comprehensive insight into the issue.

4. The Impact of the Political Cycle on the Pension System - A Case Study on the Czech Republic

Decisions about the financing of a complex system such as pensions are closely linked to political decisions. However, we believe that a pension system should primarily reflect social practices and preferences. In the Czech Republic, the notion of state-guaranteed old-age provision with a minimum of self-responsibility is historically entrenched. This approach can be attributed to the influence of the socialist period (1948-1989), when the state was the main guarantor of living standards. However, this practice is gradually changing, especially among the younger generation, which is increasingly encouraged to invest individually and prepare for retirement without depending on the state. A key factor is the growing role of financial advice and the introduction of new investment instruments, such as the 'retirement investment product', which has been implemented by the government from 2024.

In November 2024, the Chamber of Deputies approved a pension reform that includes the abolition of the upper retirement age (65) and the introduction of a new mechanism for calculating the age limit. The reform also includes a slower growth of newly assessed pensions. The original formula for calculating the retirement age was based on the life expectancy of persons living to the age of 50. For example, life expectancy figures in 2024 were to be used for those aged 50, years, i.e. those born in 1974. If life expectancy were higher than the life expectancy at age 50 for the population born in 1965, there would be an increase in retirement. The calculation system assumed an average of 21.5 years spent in retirement. However, the government eventually decided to change the calculation. Under the proposed change to the

law, the retirement age for those born after 1965 will increase by 1 month for every year and the age will be capped at 67.

Despite these steps, political consensus on pension reforms in the Czech Republic has long remained problematic. The polarisation of the political representation into opposing camps and short-term electoral cycles make it impossible to adopt a reform that would be sustainable and politically acceptable in the long term. The opposition parties of the current government have already announced that they will abolish some changes, such as the increase in the retirement age, in the next parliamentary term. This cycle of political turnover, with populist governments reversing measures introduced by non-populist governments, has prevented the implementation of fundamental reforms for more than 25 years.

Another problem is the influence of populist governments, which often push through budget-irresponsible measures to retain the support of voters, especially seniors. [2] For example, between 2014 and 2021, pensions were indexed beyond the statutory formula, leading to an increase in the replacement rate to almost 50% of the average wage. This move, carried out during a period of economic growth, destabilised the pension account during the inflationary wave in 2022 and 2023, when the pension deficit approached EUR 4 billion per year.

The case of the Czech Republic illustrates how political cycles and changes of governments lead to delays in reforms and destabilisation of the pension system. This shows that leaving pension reforms entirely to the political representation is not always an appropriate solution. Increasing populism and manipulation of the electorate through disinformation campaigns may further deteriorate the sustainability of pension systems.

In these circumstances, the creation of an independent Pension Board to administer the pension system away from political influence should be discussed. This council should be enshrined in the constitution and its members elected by the legislature on the basis of mandates divided into three groups with overlapping terms of six years. This would ensure continuity and independence of decision-making from the political cycle. Without this constitutional guarantee, however, such a council risks lacking long-term stability and authority.

Causes and consequences of changes in total fertility over the last 30 years

Total fertility rate is one of the key demographic parameters that has a major impact on the future structure of the population. However, when making demographic forecasts, it is necessary to bear in mind that estimates with a horizon of more than 10 years are usually highly uncertain. As an example, population forecasts made at the turn of the millennium, more than 20 years ago, have proved inaccurate in many respects.

[2] We focus here on the view of the pension system and its setting, not on the social aspect, i.e. whether it is socially acceptable to valorise pensions beyond the valorisation formula. The fact remains that if there had been no indexations beyond the statutory limit between 2014 and 2021, the pension system would have been financially stable, and the government would probably not have had to reduce the indexation formula in 2023.

Table 1. Retrospective Total Fertility Projections from 2003

Year	Projected values of total fertility [3]			Reality
	Burcin & Kučera	CSO	UN	
	2003	1999	2002	
2010	1.34	1.32	1.23	1.49
2020	1.51	1.44	1.38	1.71
2030	1.57	1.50	1.63	--

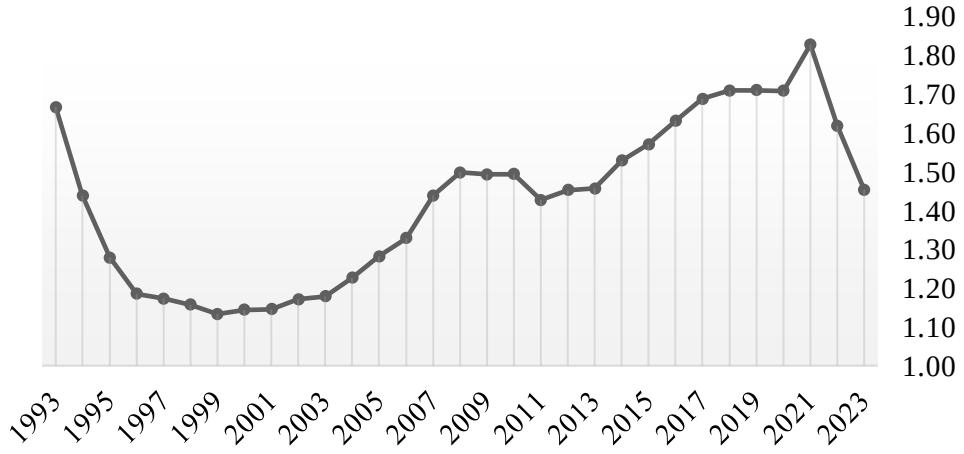
Source: Burcin, B. and Kučera T. (2003). DemoArt: Prague 2003 and Czech Statistical Office.

Deviations in demographic forecasts, such as those produced by the Czech Statistical Office (CSO) or the United Nations (UN), can have a major impact on future population estimates. These deviations are then reflected in the size of the population in the longer term, for example in 2050, when the generation born around 2020 enters reproductive age. To illustrate, the deviation in the fertility forecast for 2010 was 0.19 (compared to the average of the three declared forecasts), while for 2020 it increased by 0.267. With a hypothetical number of 100,000 mothers in 2020, this deviation would correspond to approximately 26,700 births.

These deviations show that fertility projections with a horizon of more than 10 years are not sufficiently accurate to draw concrete conclusions or to plan long-term reforms of the pension system. For this reason, total fertility tends to be a complicated and unclear factor for policymakers when deciding on structural changes to pension systems. However, it should be stressed that aggregate fertility is certainly a parameter that can be positively influenced by appropriate measures - which is the subject of the following analysis on the situation in the Czech Republic.

The following chart (***Figure 1***) illustrates the evolution of a key parameter of the pension system - total fertility. This indicator fundamentally determines natural reproduction and the age structure of the population, together with the number of mothers in the population, which contributes to the total fertility rate. Total fertility thus remains an absolutely crucial factor, regardless of fluctuations caused by strong or weak years.

Figure 1. Fertility trends in the Czech Republic 1993-2023



Source: own processing based on Czech Statistical Office data

[3] Total fertility rate (number of live births per woman aged 15-49)

Over the past 30 years, there has been both an increase and a decrease in total fertility. If we put this development in the context of the socio-economic situation, we must conclude that total fertility, i.e. the number of children born to mothers, can be influenced by appropriate national economic policy.

The first period: 1993-1999, the society was undergoing post-revolutionary changes, including a change in lifestyle and the emergence of the first generation of entrepreneurs and tradesmen. The relaxation of rules and the advent of democracy led to changes in lifestyle preferences. This period is characterised by several critical moments:

a) A period of high inflation (inflation averaged 25.8% per year in 1990-1995 and 10% per year in 1990-1999). The transition to a market economy led to a significant increase in the cost of living, which was felt especially by new families
b) Restrictive monetary policy of the CNB, which tried to slow down inflation (it succeeded only in 1999, when it was 2.1%)
c) Economic crisis in 1997-1998
d) The government's restrictive fiscal policy (so-called belt-tightening) even led to the fall of the then right-wing government (GDP fell, -0.6% in 1997 and -0.4% in 1998)
e) Stagnation or decline in real average wages (real average wages grew by only 1.33% in 1997 and even fell by 1.31% in 1998)

These macroeconomic but also social changes have led young families to have fewer children. These developments culminated in a decline in the total fertility rate to 1.1328 in 1999, when it was at its lowest level in the entire period of observation (since 1920).

The second period: 2000-2008 was characterised by an unexpected increase in total fertility to 1.50 in 2008, the second highest since 1993. The reasons for the increase in total fertility can again be linked to societal changes and the economic situation.

In 1998, a new minority (left-wing) government came to power, which, thanks to the opposition agreement, was assured of a stable 4-year term. The government succeeded in completing the privatisation of key enterprises, and during this period the banking sector was stabilised. This period is characterised by:

a) Disinflation (inflation fell from 10.7% in 1998 to 1.8% in 2002)
b) Real wage growth averaging 3.47% per annum
c) Low inflation (not exceeding 3% per year on average)
d) Real GDP growth averaged 4.17% per year
e) The Czech Republic joins the European Union
f) Increasing Consumer Confidence Indicator (the Consumer Confidence Indicator has been monitored since 2003, rising from 99.00 to 104.3 from 2003 to 2007)

All of these economic outcomes gave people confidence in economic stability and made it possible for them to afford to have more than 1 child more often. In 2008, the economic situation started to deteriorate (GDP increased by only 2.6%, inflation jumped to 6.3% and real wages increased by only 1.41%). In addition, there was negative news from the US about the collapse of the mortgage banks and the risk of a global crisis. This was also reflected in a decline in the Consumer Confidence Indicator, which fell from 104.3 in 2007 to 98.72 in 2008. Due to the prenatal period of 9 months, these factors were not reflected in the aggregate fertility rate until 2009, when the increase stopped, and the value dropped slightly to 1.49.

The third period: 2009-2013 is the period of economic crisis triggered by the US mortgage crisis and the subsequent stagnation and decline of the economy and the Consumer Confidence Indicator. This period was characterized by:

a) The decline or stagnation of GDP (the first decline was in 2009: -4.8% and the second decline in 2012: -0.80%)
b) The government implemented fiscal retrenchment to reduce the government budget deficit
c) Low inflation (fiscal restraint has kept inflation at an average of 1.8% per year)
d) Real wages stagnated in 2012 and even declined in 2013
e) The consumer confidence indicator fell from 94.77 in 2009 to 80.57 in 2012, before rising slightly to 91.75 a year later.

These social and economic circumstances led to a halt in the growth of the total fertility rate in 2009 and 2010 at 1.49 and a decline to 1.43 in 2011. In 2012 and 2013 it remained at 1.45 and 1.46 respectively. The period of uncertainty and low confidence associated with restrictive fiscal policy has led young families to postpone having children or having more children.

The fourth period: 2014-2020 represents economic expansion and growth not only for the Czech Republic but also for most countries in Europe. It was a period that brought:

a) Resumption of stable real wage growth (averaging 3.64% per annum)
b) CNB exchange rate commitment in 2013-2017 (artificial depreciation of CZK, to CZK 27/ 1 EUR)
c) Stable economic GDP growth (excluding the impact of the 2020 COVID, average growth over this period was 3.57%, however, in 2020 GDP fell by 5.3% due to the lockdown)
d) The Consumer Confidence Indicator is rising to 113.02 in 2019. With the advent of the coronavirus pandemic, this indicator has fallen to 100.86 in 2020.
e) Stably low inflation (average inflation was 1.71% per year during this period)
f) Very low interest rates on mortgage loans and availability of mortgages

These aspects have had a positive impact on the development of the total fertility rate, which has started to rise from 1.46 in 2013 to 1.71 in 2020. The standard of living in the Czech Republic has increased significantly over this period and combined with low interest rates, has enabled young families to access housing, which was the only obstacle in the previous growth period, i.e. in the period 2000-2008.

The fifth period: 2020-2023 is characterized by two key events that have had a major (opposing) impact on total fertility:

1. 2020-2021 Coronavirus pandemic and associated movement restrictions, blanket closure of the economy, etc.
2. 2022-2023 a period of high energy price-induced inflation, which has permeated the entire economy as cost inflation linked to the war in Ukraine.

The first event affected fertility in an unprecedented way. Due to restrictions on movement, people were forced to spend most of their time together at home, which created space for biological reproduction. As a result, fertility rose to a value of 1.83 in 2021, the same as in 1991 (1.83). It was therefore the highest in 30 years.

The second event, which began to manifest itself at the end of 2021 with the accelerating rate of inflation, the beginning of the energy crisis due to the collapse of several energy suppliers in

the Czech Republic in the autumn of 2021, and with the deepening of the energy crisis due to the war in Ukraine, began to have a negative impact on the decline in aggregate fertility.

In general, this period is characterized by:

a) The high level of interest rates, including interest on mortgages
b) State budget consolidation and negative development of the pension account
c) High inflation rates (15.1% in 2022 and 10.7% in 2023)
d) Significant decline in real wages (5.92% per year on average)
e) A fall in the Consumer Confidence Indicator to 79.87 in 2022 followed by a slight increase to 89.33 in 2023.

If we add to these factors the stable high property prices, which have gradually increased in the previous period, the affordability of housing for young families will decrease significantly after 2021. In addition, there has been a temporary increase in the price of building materials, rising interest rates, and energy prices, which have affected some households whose price fixing period has just ended. These aspects have led to fertility rates dropping significantly to 1.45 in 2022 and 2023, the level of 2012 when similar fiscal retrenchment was underway.

In the previous paragraphs, we tried to outline which factors may influence the level of total fertility, or the willingness of parents to have children or more children. Parents in the period (2021-2023) are likely to have decided to postpone having a first or additional child. It is therefore possible that the fertility decline will stop in 2024 and may even increase in 2025.

Let's summarize the hypothetical impulses that positively or negatively influenced fertility in the Czech Republic.

The following factors were found to have a positive effect on total fertility:

a) Stable low inflation
b) Stable real GDP growth
c) Low mortgage interest rates and housing affordability
d) Stable real wage growth
e) Lockdown and forcing residents to remain in their place of residence, including working from home
f) Policies contributing to a positive mood in society, which is reflected in a rise in the Consumer Confidence Indicator

Conversely, the following factors had a negative effect on total fertility:

a) High inflation and rising cost of living (this negative relationship has manifested itself in all three critical periods (1993-1999, 2009-2013 and 2021-2022))
b) Restrictive monetary and fiscal policies were always present in periods when fertility was declining
c) GDP stagnation or decline
d) Stagnating or falling real wages
e) Unaffordable housing for the young, caused by high mortgage rates, high property prices (real estate bubble) and even high energy prices
f) Policies contributing to a negative mood in society manifested by a decrease in the Consumer Confidence Indicator

For an effective policy aimed at increasing aggregate fertility while at the same time ensuring the sustainability of the PAYG pension system, it would be crucial for governments to formulate a long-term economic strategy. This strategy should include maintaining public finances in

balance during economic boom periods to avoid difficult fiscal consolidation processes during crises - which recur cyclically on average every 10-12 years.

Over the past 30 years, the Czech Republic has experienced three major economic crises that have highlighted the need for a long-term macroeconomic strategy. Such a strategy should contribute to stabilising the economy and at the same time emphasise family policy in a broader context. Family policy should not be limited to tax benefits or social benefits for young families. Stable incomes, affordable housing and sufficient services for young families, such as pre-school capacity, remain key barriers to larger families.

Family policy therefore affects many areas of the national economy, and its strategic design can have a positive impact not only on the promotion of fertility through aggregate fertility, but also on the stability of the pension system. If governments approached the issue from a broader perspective, it would probably be possible to avoid radical changes in the PAYG pension system or going beyond reasonable values of its key parameters.

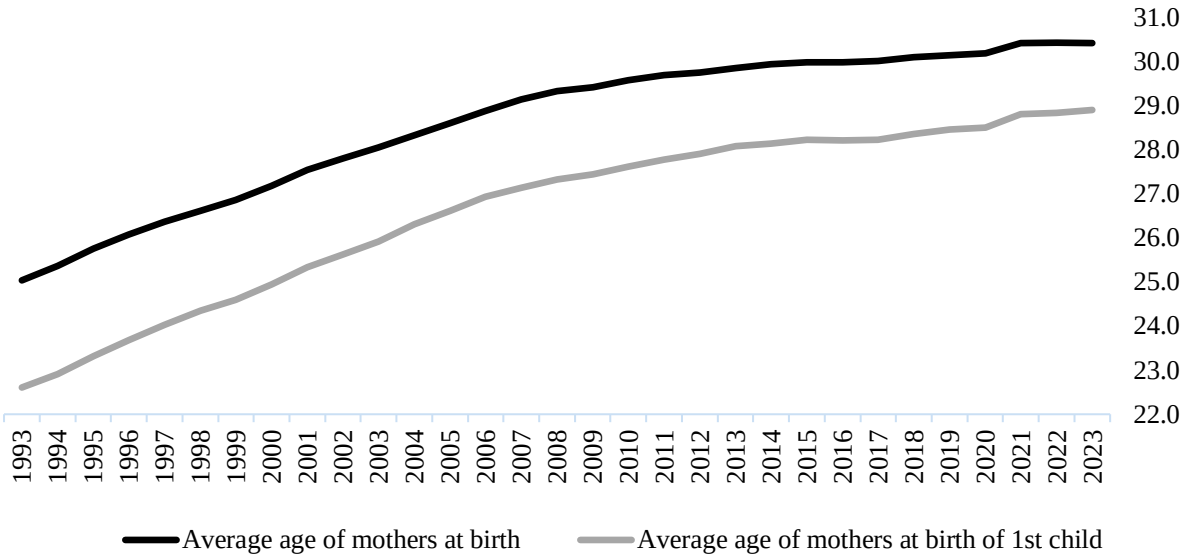
Causes and consequences of changes in the average age of mothers at childbirth

The third key indicator that determines the future sustainability of the pension system is the average age of mothers at childbirth, or the average age of mothers at the birth of their first child. In the Czech Republic, between 1960 and 1990, the average age of mothers at childbirth was 25.0 years and remained almost unchanged (for the first child, it was 22.5). With the advent of democracy and social change, the average age of mothers at childbirth has shifted significantly. Between 1990 and 2010, this age increased from 24.8 to 29.6 years (i.e. by 4.8 years). In the period 1994-2003 (the first 10 years of the study period), only mothers with the birth year 1969-1975 gave birth, i.e. only 7 years. In the next 10 years (2004-2013), mothers born in the period 1976-1983 gave birth, i.e. only 8 birth years. It was not until the next decade (2014-2023) that mothers born between 1984-1993, i.e. 10 birth years, gave birth. In the first two periods, only 15 birth years of mothers (instead of 20) participated in the birth of offspring. As a result, we can estimate the decline in the number of births over these 20 years at approximately 500,000 children.

In the last 3 years (2021-2023), the age of mothers at birth has stabilized at 30.4 and it can be assumed that it will not increase substantially. It has shifted by 0.8 years in the last decade, which can be considered as a stabilisation of this key parameter. On the basis of the average age of mothers, the time between generations has increased by 5.6 years (the average age of the mother at the birth of her first child has increased by 6.4 years). There will no longer be 4 generations in a century, but only 3.

For the entire national economy, this means a fairly substantial parametric change in the population decline of an estimated 500,000 individuals. These 500,000 unborn children between 1990 and 2010 have been missing from the labour market since 2018, when the number of job vacancies in the country exceeded the number of jobseekers for the first time, and since then the labour market situation has not been able to be fundamentally reversed. The economy was not prepared for such a large drop in the population among the new entrants to the labour force, and we are likely to face this drop until 2030, before the generation born after 2010 enters the workforce.

Figure 2. Evolution of the average age of the mother at birth (1st child)



Source: own processing based on data from Czech Statistical Office

The most significant postponement of childbearing was in the first 20 years after the transition to democracy and a market economy. Young people had more freedom, freedom of movement, and there was a boom in higher education. In 2000 there were approximately 190,203 students studying at universities in the country, while in 2010 there were already 395,982 students.[4] The doubling of the number of students represents one of the main determinants of the shift in the age of the mother at the birth of the child. Other reasons may be a change in life preferences in favour of travel and starting a career. Furthermore, there has been a quite fundamental change in lifestyle, or in attitudes not only to study but also to career and travel.

The age of the mother at the birth of the child is a parameter that governments can influence, e.g. through affordable housing for people aged 30 and over. However, in recent years it has become increasingly possible to hear the voices of the youngest generation, who will be entering adult life, saying that they do not want their own home and do not want to go into debt. This generation can therefore influence, by changing their priorities and preferences, what the lifestyle of this generation will look like in 5- or 10-years' time, which will have an impact on when they are likely to start families.

However, it may happen that a change in lifestyle can surprise, and the age of mothers at the birth of the child may even decrease. If they want to live in rented rather than owned accommodation, they may not wait to buy a house or flat and therefore delay having a child. In this respect, the future and circumstances of family formation are uncertain. The rising generation has a very different background than their parents had, with different social skills and preferences, having grown up on digital technologies.

[4] https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fdsia.msmt.cz%2Fvystupy%2Ff2%2Ff21.xlsx&wdOrigin=BROWSELINK [accessed: 11/10/2024]

Causes and consequences of changes in life expectancy at age 65

The fourth key parameter that fundamentally influences the functionality of the pension system is the expected average life expectancy, however, it should be noted that the life expectancy of people over 65 is crucial for the pension system, as the average life expectancy is also influenced by infant mortality, which has decreased from 10.8% (1990) to 2.2% (2023) in the Czech Republic. It has improved significantly over the last 40 years, statistically extending life expectancy. The middle-age mortality rate in the Czech Republic has remained at 10.7% for a long time, with a 2-p.p. increase in the COVID-19 period (12.7%). It has returned to 10.4% in 2023.

The life expectancy for men aged 65 has increased by 5.08 years since 1990 and was 16.7 years in 2023. For women, the life expectancy at age 65 has increased by 5.16 years since 1990 and is 20.43 years in 2023, and it can be noted that men and women still maintain the same gap. On average between 1990 and 2023, the gap in life expectancy at age 65 was 3.52 years. While the evolution of life expectancy is a useful parameter, it is retrospective and does not consider how the population is now living in middle and young age. Life expectancy at age 65 is the result of the lifestyle of those born before 65. However, it can be assumed (given the stable mortality rate of the middle-aged population) that the increase in life expectancy is more likely to be due to improvements in medical care. Can we expect that the quality of life in retirement will also improve?

Current knowledge about ageing in the medical field may give us the answer. In 2019, the WHO classified ageing as a disease (under the codes MG2A - Ageing associated with a decline in intrinsic capacity and XT9T - Age-related diseases)[5] , which has generated quite widespread opposition and much debate, especially among gerontologists and geriatricians see (Banerjee et al., 2021; Mendoza-Núñez & Mendoza-Soto, 2024). The reactions of several geriatricians and gerontologists have been very aggressive, and the classification of ageing as a disease by the WHO has been described as ageism (as a type of discrimination characterised by stereotyping, prejudice, stigmatisation and rejection of old age and old people - see (Butler, 1969). The reaction of this group of specialists is perfectly logical. If research in the field of ageing were to be oriented more towards ways of treating ageing, it is very likely that this particular group of professionals will not find in the future the kind of application they have today. In addition to these opposing views, there are several scientists who take the opposite view, as they consider the WHO move to be pivotal in the field of anti-aging research and anti-aging medicine, see (Bulterijs et al., 2015; Calimport & Bentley, 2019; Khaltourina et al., 2020).

There is a very large body of research on ageing, and over the last 30 years, the way scientists and doctors look at ageing has undergone a fundamental change. Part of this research includes research on cellular ageing, which was awarded the Nobel Prize in Physiology or Medicine in 2009 (Elizabeth Blackburn, Carol W. Greider and Jack W. Szostak). The scientists discovered a relationship between telomere (chromosome ending) loss and cell aging, as well as telomerase, an enzyme that restores telomeres as cells divide. In recent years, studies have examined the effect of telomeres and telomerase in areas other than aging (Deng et al., 2016; Epel et al., 2010)such as stress, mental disorders. Such research may contribute to improve the quality of life in older age.

[5] https://icd.who.int/browse/2024-01/mms/en [accessed 11/10/1/2024]

In addition to the effect of telomere loss in cells, there are other features associated with aging that have been defined by e.g. (López-Otín et al., 2013, 2023). Currently, we can talk about 12 interrelated factors of aging that can be influenced. The aforementioned authors report that since 2013, when they first introduced 9 of these aging factors at the cellular level, over 300,000 additional studies have been published (López-Otín et al., 2023). Thus, it is clear that anti-aging research has been a significant area of interest for research organizations, as well as the anti-aging medicine sector, in recent years.

Several studies have shown that quality of life in older age can be treated through prevention. Prevention can include habits that provide the body with so-called hormesis (a state of exposing our bodies to stressful situations such as: physical exercise, exposure to alternating heat and cold, intermittent fasting, low-protein eating habits, a higher proportion of plant-based diets, etc.). It includes:

a) Physical activity (contributes to an increase in NAD - nicotinamide adenine dinucleotide in cells, which research shows decreases with age and thus worsens cellular resistance to disease, see (Lundt & Ding, 2024; Rajman et al., 2018);
b) Consumption of smaller portions of food, inclusion of fasting or intermittent fasting (Zhang et al., 2013);
c) Reduction of animal protein consumption and the increase in plant-based diet (Budhathoki et al., 2019; Jayedi et al., 2024; Lamberg-Allardt et al., 2023; Wu et al., 2016; Zhong et al., 2020);
d) exposing the body to changes in temperature, e.g. hardening and sauna or cryotherapy. (Laukkanen et al., 2015; Strandberg et al., 2018).

Research in recent years has shown that these lifestyle changes not only have a positive effect on life expectancy but are also essential for improving quality of life.

In addition to these general rules, it appears that certain substances may contribute positively to slowing ageing or improving quality of life after the age of 65. One of the most well-known is the drug for type 2 diabetes mellitus, metformin, which counteracts cellular ageing, and in recent years it has been shown that people have a better quality of life in old age as a result of taking this drug, with a lower incidence of cardiovascular disease or cancer (Shmerling, 2024). Due to the many years of use of this drug, metformin is the first, and most importantly, the most proven adept for an anti-aging drug. Its only drawback is that it is not suitable for people with reduced kidney function (it can cause lactic acidosis).

In addition to this drug, research is also focusing on other substances, such as resveratrol (Baur & Sinclair, 2006), NR (nicotine riboside) and NMN (nicotinamide mononucleotide) (Rajman et al., 2018), apigenin (Alam et al., 2021; Hogan et al., 2019; Kramer & Johnson, 2024), quercetin (Aghababaei & Hadidi, 2023; Ding et al., 2020; Liu et al., 2017; Perdicaro et al., 2020; Rauf et al., 2018; Yao et al., 2019; Zheng et al., 2024) and a number of others that have shown promising results in model organisms (most commonly rodents). If these agents are shown to be effective in slowing cellular aging, we can expect to see increasing demands on the pension system. Research in the field of anti-ageing is aiming to reduce the cost of conventional health care through improved quality of life after the age of 65. Currently, medicine is not prevention-oriented, and the side effect is that it can prolong life (reducing mortality) but has not been successful in reducing morbidity (Crimmins, 2015) which is key to quality of life.

If we continue to extend life expectancy, contemporary medicine should focus its attention on anti-aging research in particular, so that, in line with increasing life expectancy, healthy life

expectancy increases. However, this can be started by each individual on his/her own without waiting for the results of research on cell-age retarding substances. Each individual can increase the proportion of physical activity, reduce food intake, especially limit animal protein and fat, take less industrialized foods, stop smoking and increase the proportion of plant-based diet. Research confirms that these steps contribute to a longer *healthy life* expectancy.

As the number of people aged 65+ will increase, the financial demands not only on the pension system, but also on health care and, most importantly, on social care, or care services and others, will grow. Therefore, the ageing population should become a key component of the national economic strategy not only in the Czech Republic, but also in the rest of the developed world, where we are experiencing an ageing population. To maintain a functional health system, it is essential that the government and use economic and non-monetary incentives leading to a greater preference for prevention. Such steps include, for example, partial charging for health care. Introducing fees in the health sector will increase the cost of care and offset the cost of prevention. This issue is related to the degree of time preference, as prevention creates costs in the present and its benefits are in the future, while neglecting prevention has benefits in the present and costs in the future. The time mismatch stems mainly from impatience in consumption, which is addressed in the studies (Rotschedl, 2022; Rotschedl & Mitwally, 2021). It turns out that time impatience also changes with age. The introduction of fee-for-care will increase individuals' health care costs and increase the value of prevention benefits. Targeted anti-aging support and education is another avenue. Lower stress levels, physical exercise, not overeating or fasting and a range of other activities need to be clearly and visibly promoted in national prevention plans, which are not given much attention.

5. Cross-national Assessment of the Sustainability Determinants of the PAYG System in the Czech Republic – A Comparison with Germany

Pay-as-you-go pension systems are the most prevailing old age support systems among the European countries. Especially within the last 30 years all European countries have reformed their systems to adapt to sustainability threatening determinants of the PAYG pension system (Hinrichs, 2021). If the previous discussed sustainability determinants of political cycles, maternal fertility, age of motherhood at birth and change in life expectancy at age 65 are of similar significance in other countries, it can be distinguished between national trends of Czech Republic and cross-country wide trends. If the challenges faced by Czech Republic are unique in its characteristics, it indicates that sustainability determinants stem from domestic factors. Whereas parallels to other countries open the possibility to evaluate previous made reforms and adopt them successfully to domestic factors. Assessing whether the challenges faced by the Czech Republic are unique enables the efficient allocation of governmental resources by avoiding redundant expenditures on pension reforms that could benefit from tested and proven solutions implemented in other countries like Germany.

The German pension system is highly comparable to the Czech pension system, as both are fundamentally based on the pay-as-you-go principles, wherein contributions from the current workforce finance the pension entitlements of retirees. Moreover, both countries operate within the framework of a multi-pillar system, setting them apart from other nations with PAYG-based systems that lack this structural diversification.

The impact of political cycles on pension sustainability – a recent example from Germany

In early 2021, the liberal party (FDP) proposed the "Aktienrente," a pension reform based on economic research (Werding & Läpple, 2021) aimed at establishing an equity-based capital stock to mitigate future pension costs. The capital stock is exclusively designated for balancing the pension system and grows through two mechanisms: annual variable contributions from the government budget and returns generated from investment dividends and rising stock prices. The accumulated surplus is intended to offset the fiscal impact of demographic challenges, characterized by a shrinking workforce and increasing pension liabilities from an aging population.

Following the federal election at the end of 2021, the liberal party (FDP) not only secured parliamentary representation but also succeeded in forming a coalition government with the Green Party (Bündnis 90/Die Grünen) and the Social Democratic Party (SPD). The proposed pension reform, "Aktienrente," was incorporated into the coalition agreement, with its implementation progressing steadily between 2021 and 2023. However, during this period, the opposition, led by the centrist party—which had been part of the government from 2005 to 2021—successfully challenged the use of general funds in the Constitutional Court, specifically concerning the pension reform. Consequently, the government was required to reallocate resources, resulting in significant budget cuts. Among the first casualties of these fiscal adjustments was the "Aktienrente" itself, despite its aim to enhance the sustainability of the German PAYG system. The pre-allocated capital stock of EUR 10 billion was liquidated and the reform was abandoned without a replacement. In response to the ongoing sustainability challenges of the German PAYG system, the government has shifted its approach, proposing a gradual increase in the retirement age starting in September 2024.

In 1994, Sweden demonstrated an effective approach implementing pension reforms within a political framework characterized by a governing coalition and a strong opposition, ensuring the sustainability of the PAYG system. The government successfully secured opposition support for the reform, resulting in a broad parliamentary consensus with approximately 85% of votes in favor (Lundberg, 2020). The reform's framework explicitly embedded the principle that maintaining support for the pension agreement is a fundamental responsibility of the contracting parties, extending beyond political cycles.

This example illustrates how political cycles can adversely affect efforts to ensure the sustainability of the PAYG pension system, a challenge observed in both the Czech Republic and Germany. However, proven solutions may be drawn from successful approaches implemented in other European countries, such as Sweden.

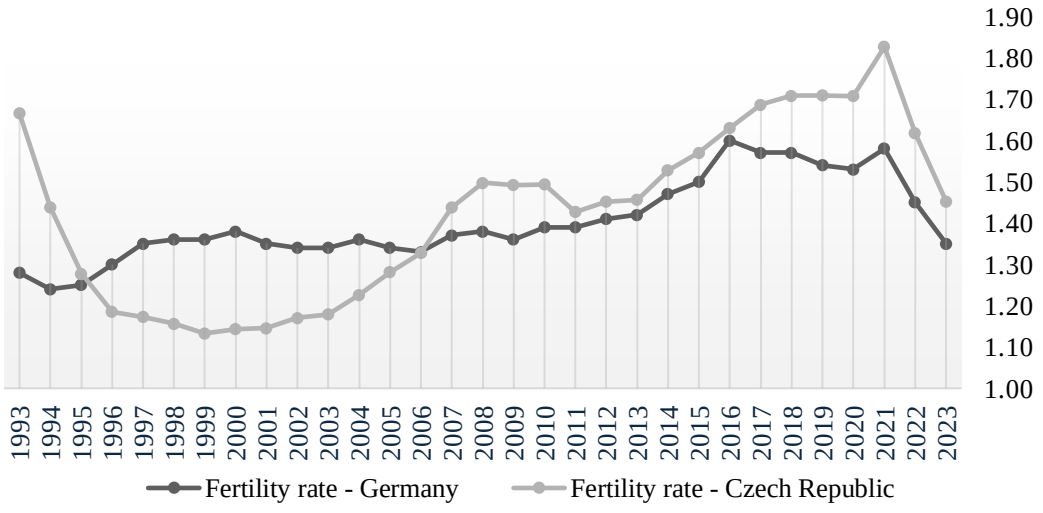
The development of maternal fertility and its impact on pension sustainability

The significantly lower fertility rate in Germany until 1995 can be attributed to the political and economic transformations following German reunification in 1990. In 1990, the fertility rate among women in the former East Germany stood at 1.5 children per woman. However, this figure plummeted by over 46% to 0.8 children per woman by 1994, primarily due to economic uncertainty during the transition period. The crisis period is followed by and adaption period (Conrad et al., 1996). By 2000, the fertility rate of women living in former East Germany had recovered to 1.4 children per woman, nearly reaching its pre-reunification level. Data indicates that this recovery in Germany's overall fertility rate by 2000 was driven entirely by the increase among women in the former East Germany, while the fertility rate in the former West Germany remained relatively stable at 1.2 children per woman.

Macroeconomic factors provide a compelling explanation for the divergence in fertility rates between Germany and the Czech Republic during the 1990s. The Czech Republic experienced a period of persistently high inflation, averaging 25.8% per year between 1990 and 1995, and remaining elevated at 10% over the entire decade from 1990 to 1999. In contrast, Germany entered a phase of consistently low inflation, starting at 4.5% in 1993 and declining further to 0.5% by 1999, with deflationary pressures emerging as early as 1991 following the inflation spikes associated with German reunification. These contrasting inflationary environments likely influenced economic stability and individual decision-making, contributing to the differing fertility trends observed in the two countries during this period.

Between 2000 and 2008, the fertility rate in Germany remained relatively stable, with a slight decline at the beginning of the period attributable to the economic repercussions of the dotcom bubble burst. This event triggered a rise in inflation from 0.25% to 2.5% within two years and resulted in negative GDP growth of -0.2% in 2002 and -0.7% in 2003, followed by a swift recovery prior to the global financial crisis of 2008. In contrast, as outlined in Chapter 3, the Czech Republic experienced a period of robust economic growth during this timeframe, contributing to an increase in its fertility rate. This economic divergence led to the Czech Republic closing the fertility rate gap with Germany, ultimately reversing the trend. Although the pace of divergence slowed in subsequent years, the Czech Republic established a consistent positive fertility rate gap relative to Germany.

Figure 3. Total Fertility Rate in the Czech Republic and Germany (1993-2023)



Source: own processing based on German and Czech Statistical Office data

Between 2009 and 2013, the aftermath of the global financial crisis culminated in the sovereign debt crisis within the Euro Area. In response, Germany and France spearheaded the establishment of two European monetary rescue mechanisms, providing crisis-affected countries with access to financial aid to avert insolvency. These measures contributed to an increasing debt-to-GDP ratio for Germany and rising inflationary pressures. The European Central Bank's (ECB) quantitative easing policies played a pivotal role in alleviating pressure on the Euro Area, effectively preventing severe economic downturns in Germany. However, the implementation of new fiscal regulations, including stricter debt limits for EMU member states, coupled with heightened political and economic uncertainty, contributed to a modest decline in fertility rates during this period.

Between 2014 and 2020, Germany and the Czech Republic experienced stable GDP growth, consistently low inflation, low interest rates, and high consumer confidence. These favourable macroeconomic conditions supported relative debt reduction, creating fiscal space for future opportunities. The Czech Republic successfully decreased its debt-to-GDP ratio from 41.55% in 2014 to 29.55% by 2019, prior to the onset of the COVID-19 pandemic. Similarly, Germany achieved a substantial reduction in its debt-to-GDP ratio, declining from 74.5% in 2014 to 58.7% in 2019. In this context of economic stability, fertility rates in the Czech Republic increased, supported by positive economic conditions. In contrast, Germany experienced a notable decline in fertility rates until 2016, nearly closing the gap with the Czech Republic, although this convergence was short-lived.

The period from 2020 to 2023 was defined by the COVID-19 pandemic, which caused a systemic shock to the global economy. Extensive government spending to mitigate the pandemic's effects resulted in sharply rising inflation rates in both Germany and the Czech Republic, accompanied by an increase in insolvency rates due to prolonged lockdown measures. Initially, the pandemic appeared to have a positive impact on fertility rates; however, the economic repercussions materialized with a time lag of over a year, contributing to ongoing weak economic performance and subdued recovery trajectories.

It can be concluded that fertility rates are responsive to economic policy measures, a relationship evident in both Germany and the Czech Republic. A comparative analysis suggests that lower volatility in macroeconomic indicators, such as inflation and GDP growth, is associated with reduced fluctuations in fertility rates, thereby contributing to more stable birth cohorts. In contrast, the Czech Republic exhibits greater macroeconomic volatility, resulting in higher cyclical impacts of fertility rates on the sustainability of the PAYG pension system. This cyclicality leads to fluctuating birth cohort sizes, which particularly strain the system during periods of low fertility. The notably reduced birth rates between 1995 and 2005 have intensified pressure on the PAYG model by narrowing the contributor base within the workforce. The results are in line with the literature (Karaman Örsal & Goldstein, 2010), supporting the findings of pro-cyclical behaviour of the fertility rate from the 1990s to 2008 with no trend reversal till 2023.

Changes in the age of mothers at childbirth and consequences for pension sustainability

Between 1993 and 2023, the average age of mothers at childbirth in Germany increased by 0.11 years annually, equivalent to approximately 40.15 days per year. As a result, mothers in 2023 are, on average, 3.3 years older than those in 1993. A key driver of this trend, also observed in the Czech Republic, is the rising enrolment of women in higher education. In Germany, the number of female university students grew from 699,096 in 1993 to 1,241,830 in 2023, reflecting a significant increase of 77.6%. However, this growth is less pronounced than in the Czech Republic, where female university enrolment surged by 108.2% between 2000 and 2010. This disparity contributes to the steeper rise in the average age of mothers in the Czech Republic, despite both countries exhibiting a similar overall trend in delayed motherhood.

Further insights from the comparison of female labour force participation (ages 15–75) highlight distinct trends between the Czech Republic and Germany. In the Czech Republic, female labour force participation remained relatively stable, with 52.3% of women participating in 1993 and 51.9% in 2023. This stability supports the convergence of the average age of mothers at childbirth above 30 years. Between 1993 and 2010, there was a decline in female labour force participation in the Czech Republic, followed by a reversal and steady increase until 2018, after which the rate stabilized.

In Germany, female labour force participation showed a consistent upward trajectory, rising from 47.6% in 1993 to 56.5% in 2023. This steady increase aligns with the continuous rise in the average age of mothers at childbirth over the 30-year period.

The data suggest a stabilization of the average age of mothers at childbirth in the Czech Republic, a key parameter for the sustainability of the PAYG pension system. However, no similar stabilization process is evident in Germany. It can be anticipated, however, that in the Czech Republic, female labour force participation may begin to increase again, particularly during periods of economic downturn. This potential rise in labour force participation could lead to a further increase in the average age of mothers at childbirth, introducing additional volatility to the sustainability of the PAYG pension system.

Figure 4. Average age of mother at birth in the Czech Republic & Germany (1993-2023)

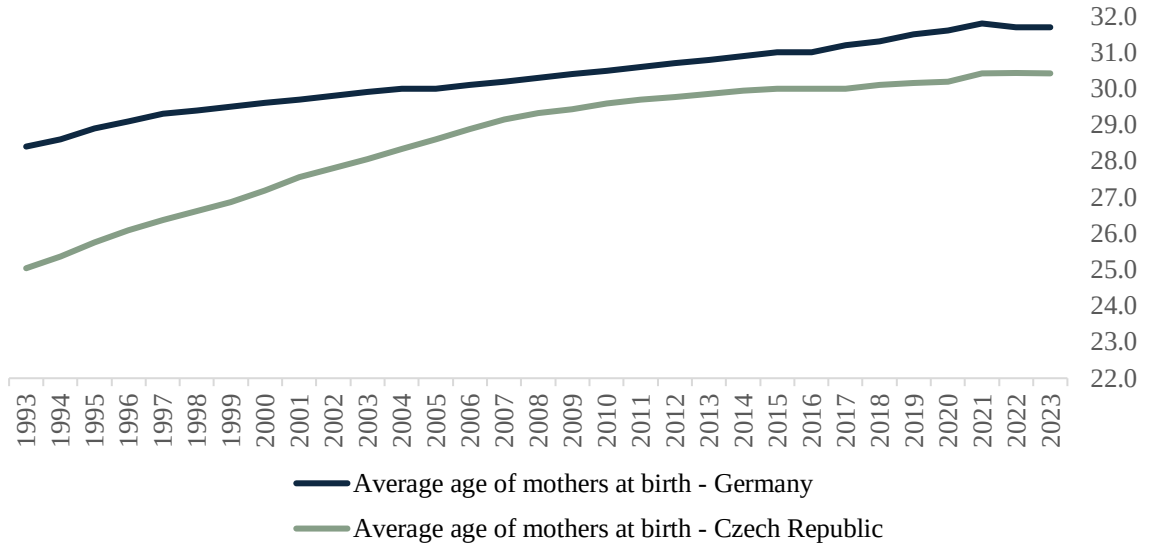
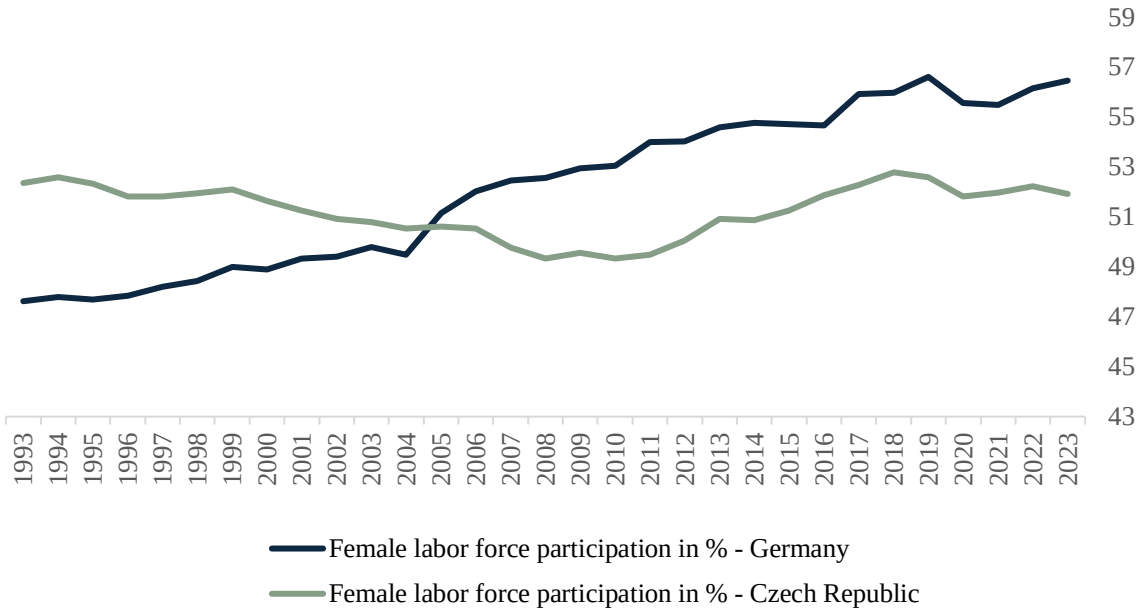


Figure 5. Female labour force participation in the Czech Republic & Germany (1993-2023)



Source: own processing based on German and Czech Statistical Office data

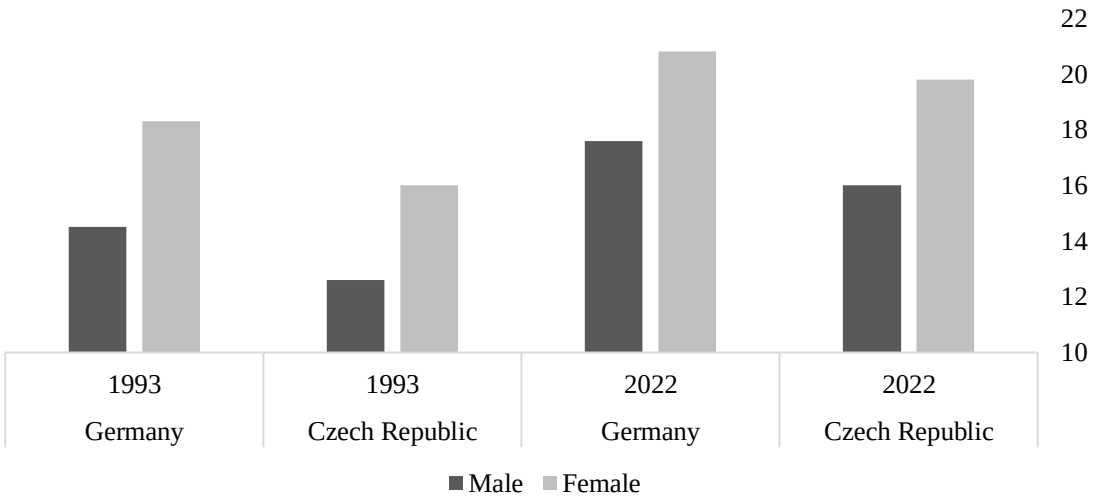
Changes in life expectancy at age 65 and its impact on pension sustainability

Life expectancy at age 65 plays a critical role in determining the sustainability of the PAYG pension system, as a longer post-retirement lifespan translates into an extended period of pension payouts. Combined with lower fertility rates and higher maternal ages at childbirth—both of which adversely impact the funding base of the PAYG system—rising life expectancy exerts dual pressure on the system by increasing outflows while straining inflows.

Germany and the Czech Republic exhibit similar trends in life expectancy at age 65, driven by shared improvements in living standards, heightened health awareness, and advancements in medical research and preventative care. In Germany, the life expectancy at age 65 for men increased by 3.1 years, from 14.5 years in 1993 to 17.6 years in 2022, reflecting a growth of 22.4%. For women, the increase was more modest, rising from 18.3 years in 1993 to 20.8 years in 2022, an increase of 13.7%. Despite the smaller relative increase for women, the gender gap in life expectancy at age 65 narrowed over this period, starting from a higher initial value for women.

In the Czech Republic, life expectancy at age 65 for women increased from 16.0 years in 1993 to 19.8 years in 2022, reflecting a growth of 23.8%. A similar trend is observed for men, whose life expectancy rose from 12.6 years in 1993 to 16.0 years in 2022, marking the largest increase across genders and countries at 26.9%. This significant progress highlights a convergence toward Germany's higher initial life expectancy levels, suggesting that the catching-up process in the Czech Republic is likely to continue, thereby exerting additional pressure on PAYG expenditures. While the sustainability of Germany's PAYG pension system remains more fragile due to its already high life expectancy levels at age 65, the rapid growth rates in the Czech Republic place increasing strain on its pension budget. This faster-paced restriction underscores the need for proactive fiscal planning in the Czech Republic to account for the accelerating demands on its PAYG system as life expectancy continues to rise.

Figure 6. Life expectancy at age 65 (1993, 2022) in Czech Republic and Germany



Source: own processing based on OECD data

Germany's life expectancy at age 65 in 1976 was equivalent to that of the Czech Republic in 1993, implying that the pressure on the sustainability of Germany's PAYG pension system began 17 years earlier. However, the increase in life expectancy for retirees has not been accompanied by a proportional improvement in quality of life, as age-related illnesses such as dementia and cancer have become more prevalent. This dynamic imposes risks not only on the pension system but also on Germany's public health system.

The COVID-19 crisis further exacerbated these challenges by triggering unexpected expenditures that significantly depleted the cash reserves of public health insurance providers. Concurrently, ongoing inflation, rising minimum wages, and supply chain disruptions have compounded financial pressures. Research indicates that the Long COVID Syndrome will impose substantial long-term costs on Germany's health and pension systems (Gandjour, 2023). As a result, contributions to public health insurance are set to increase as early as 2025, while contributions to the pension system are not expected to change in the near term.

6. Discussion of Results and Recommendations

A comparison of different periods between 1993 and 2023 in relation to aggregate fertility led us to similar conclusions that are confirmed by studies on panel data. Research on panel data from OECD countries (Kato, 2021) examined aggregate fertility in terms of four factors: the labour market, the macroeconomic environment, policy instruments and demographic conditions. Analyses showed the effect of unemployment or female labour force participation rates to be significant. We did not assess this issue, as unemployment in the country and the overall labour market has been struggling since 2018 due to a shortage of skilled labour despite the war in Ukraine, which has increased the influx of immigrants able to participate in the labour force. The authors of the research concluded that economic growth is positively correlated with aggregate fertility, a conclusion we have also observed in the Czech Republic setting.

Other research (Hondroyiannis, 2010; Lal et al., 2021; Ozbay Das, 2020) has determined, in addition to the determinants already mentioned, for example, that contraceptive prevalence is negatively correlated with aggregate fertility or with urbanization rates (but here only at a lower significance level of p=.10). We did not address issues such as urbanization, democracy, or the impact of contraception in this study, and this represents an area for further research.

Important to mention that our analysis does not include technological progress. Technological progress and digitalization, which will hit some professions hard and can be expected to affect unskilled labour in particular. Study (Kim & Lee, 2024) showed, based on common observations across all types of pension schemes (pay-as-you-go, fully funded and modified fully funded), that low-skilled households are most vulnerable to the effects of ageing. This area is therefore a challenge for more in-depth analyses that would contribute to the design of the necessary national economic policies.

Another area is health in relation to ageing. A study by Kim & Lee (2024) showed that the impact of increasing longevity on all three types of pension system is more pronounced than the impact of declining fertility rates. The reason given by the authors is that fertility fundamentally affects only some types of pension systems, while longevity and aging affect all pension system models. It is also shown in other studies, e.g. Tur-Sinai & Gottlieb (2024) that extending the retirement age in the context of extending life expectancy is an effective tool for improving sustainability. We agree with this conclusion, but it should be added that the issue of

intensive preventive medicine must be addressed in parallel with extending the retirement age, which will lead to a reduction in healthcare costs for the ageing population and, more importantly, will contribute to improving quality of life after 65. In the current situation, where health care is oriented towards treating diseases that have already arisen, health care will become financially unsustainable. The same developments can be expected in social care, nursing care and, in particular, the financing of care for people affected by dementia (e.g. Alzheimer's dementia), which is on the increase as a result of ageing. A greater emphasis on prevention of individuals and on preventive medicine may solve these problems.

However, in addition to extending the retirement age and the governments' focus on promoting preventive medicine, the government must not neglect the other parameters mentioned above that determine the sustainability of the pension system, such as acting through appropriate instruments on aggregate fertility and thus affecting total fertility. The PAYG system can then be sustainable in the long term, albeit with occasional fluctuations that will have to be financed from other sources.

The comparison with Germany highlights that the Czech Republic encounters similar sustainability determinants for its PAYG pension system, albeit with varying degrees of significance over time. The data indicate that Germany has historically faced higher life expectancy at age 65, an increasing age of mothers at childbirth, and lower fertility rates earlier than the Czech Republic. This provides the Czech Republic with a unique opportunity to analyse Germany's efforts and reforms aimed at ensuring the sustainability of its PAYG pension system. By leveraging the time lag and shared challenges, the Czech Republic can draw valuable lessons from Germany's experience. Evaluating the efficiency and outcomes of Germany’s pension policies allows the Czech Republic to design more effective reforms, thereby minimizing the required governmental expenditure to sustain its PAYG pension system while maximizing reform efficiency.

7. Conclusions

This study addressed the key issues related to the sustainability of a pay-as-you-go (PAYG) pension system and analysed the factors that play a crucial role using the Czech Republic as a case study. We focused on the impact of the political cycle on changes in the pension system and the risks associated with the growing influence of populist parties. Our results support the conclusion that short electoral periods and frequent changes of government make it impossible to implement stable and sustainable pension reform in the long term. As a solution, we have proposed the creation of a "Pensions Council" whose members would have a mandate overlapping with those of the governments, ensuring continuity and independence of decision-making. This council would be responsible for the parametric setting of the system and its financing.

The analysis also showed that the pension account shows surpluses in some years and deficits in others, and the current system does not allow for the effective accumulation of surpluses to cover future deficits. Therefore, the pension account should be separated from the state budget and transferred to an independent budgetary fund that could stabilize the financing of the pension system. To ensure its effectiveness, this budget separation must be legally secured beyond legislative periods, preventing capital outflows from the pension account being

redirected to ease government spending constraints, as occurred in Germany with the "Aktienrente."

Another key theme was the analysis of the determinants of total fertility. Using data from 1993-2023, a period of fertility decline and increase was identified, and the analysis showed that macroeconomic factors such as the availability of mortgages, low interest rates, stable real wage growth, low inflation and positive economic sentiment have a greater impact on aggregate fertility than family policy. The recommendation therefore aims to develop a long-term national economic strategy that would encourage a preference among parents to have more children.

We also discussed changes in the age at which women have their first and next child. This average age of mothers at childbirth has increased and has gradually stabilized at 30.4 years over the last 10 years in the Czech Republic. Over the 30-year period, on average, only 15 women have given birth, which we estimate represents a decline in the total fertility rate of approximately 500,000 unborn children over this period. This fertility gap is already showing up in the labour markets today.

As of 2018, there is an excess of labour demand from firms over labour supply from the economically active population. Given that an estimated 300,000 fewer babies were born in the 1990s due to the shift in the average age of the mother at birth, it is these labour market shortages post-2018 that have led to the country's abnormally low unemployment rate (one of the lowest in the world).

The issue of raising the retirement age was also a major topic. This is not possible without fundamental changes in the approach to medicine. Modern medicine is extending life, which has led to an increase in the retirement age in most countries. However, an ageing population increases the demands of health, social and care services, for which the Czech neither German economies are not sufficiently prepared, either in terms of capacity or financially. A key step should therefore be to focus government priorities on preventive medicine and to introduce financial and non-financial incentives, such as partial charging for healthcare.

At European level, the issue of pension systems is increasingly linked to the issue of private savings. For example, the European Commission's 2020 Capital Market Union Action Plan includes the creation of a Pension Dashboard and a Pension Tracking System (Dimitrov & Hadad, 2022). These tools can contribute to better transparency and efficient management of pension systems. Given that the pay-as-you-go (PAYG) pension system is the predominant model in the social security frameworks of European countries, including Germany, similar challenges are prevalent across nations. Evaluating the outcomes and efficiency of pension reforms implemented in other countries can provide valuable insights to optimize future pension reforms in the Czech Republic.

In conclusion, the present study does not cover all aspects related to the sustainability of a pay-as-you-go pension system. For example, we did not address geopolitical influences on migration, which can significantly affect the demographic and labour structure of the population. Nor have we analysed technological changes that can have a major impact on employment and the status of unskilled workers. These areas, along with other issues, represent a promising direction for future research that could enrich existing knowledge on the sustainability and adaptation of pension systems in the context of changing social and economic conditions.

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