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The Role of the Labor Market in Ensuring the Sustainability of the Pension System

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Abstract

The sustainability of the pension system is a key fiscal and social challenge that is exacerbated in the Czech Republic and other developed countries by demographic trends such as population aging, declining birth rates, and increasing life expectancy. These factors are putting increasing pressure on public finances and calling into question the stability of pay-as-you-go financing. The aim of this article is to comprehensively analyze the role of the labor market in ensuring the sustainability of the pension system and to identify key variables and their interrelationships. The analysis uses system dynamics methodology and a causal loop diagram (CLD) created in Stella Professional software. This diagram visualizes the complex system dynamics and feedback loops between key variables such as the number of workers, retirement age, system revenues and expenditures, and the influence of external factors. The results show that the sustainability of the system depends on a fragile balance that can be influenced by political interventions aimed at adapting the labor market. These include measures to support the employment of older workers and incentives to stay in employment longer. It is also crucial for long-term stability to take into account new trends such as flexible forms of employment, migration, and the impact of automation. Furthermore, it is necessary to emphasize the social acceptability of reforms and their accompanying measures in order to ensure not only financial stability but also intergenerational fairness and political acceptance.

Key Words: Causal Loop Diagram, Stella, Expenditures, Labor Market, Pension System

JEL Classification: H55, J26, J14, C63

Introduction

The sustainability of the pension system is one of the key challenges facing fiscal policy in the Czech Republic and other developed countries. An aging population, declining birth rates, longer life expectancy, and a declining ratio of economically active people to pensioners are putting increasing pressure on public finances and calling into question the long-term stability of the pension system. (Bloom et al., 2010; Chybalski & Marcinkiewicz, 2016; OECD, 2023; Valls Martínez et al., 2021). The International

Monetary Fund (IMF, 2025) defines a sustainable pension system as one that is capable of meeting its obligations to pensioners in the future, even in the face of demographic and economic challenges. According to the IMF, the key factors for sustainability are financial stability, social justice, and economic efficiency. While in the past it was possible to maintain the pension system through partial parametric adjustments, today's demographic and economic trends require deeper structural reforms to ensure its long-term stability and fairness across generations. Further studies (Bloom et al., 2014) show that longer life expectancy in good health usually leads to later retirement, but with elasticity less than one. Moreover, over the last century, it appears that rising incomes have encouraged early retirement, outweighing the impact of longer life expectancy. Other authors (Mao et al., 2014) point out that initial salary levels and salary growth rates also play an important role in determining the optimal retirement age. Initial consumption levels and interest rates are also important, but to a lesser extent. Furthermore, the combination of support sources varies depending on the institutional environment and how the population is aging. New ways to make pension financing more efficient are constantly being sought (Eggleston & Mukherjee, 2019).

The sustainability of pension systems has been addressed in a number of studies, which can be divided into analyses based on the Overlapping Generations (OLG) model and other prognostic models focused on individual countries, and comparative studies classifying countries using indicators or synthetic indices. Research based on the Overlapping Generations model has been ongoing for a number of years (Boldrin & Montes, 2009; Börsch-Supan et al., 2006; Fanti & Gori, 2010; Fougère & Mérette, 1999; İmrohoroglu et al., 1995; Krpan et al., 2022; Razin & Sadka, 1999). Other studies (De La Fuente & Doménech, 2013) have taken a different approach based on estimating the impact of the reform by breaking down pension expenditure relative to GDP and monitoring the "generosity" ratio. A similar methodology was used by the European Commission and other authors (Chybalski, 2016; Chybalski & Marcinkiewicz, 2016; Krpan et al., 2022; Skuflic et al., 2020), and other authors who consider pension expenditure as a percentage of GDP, as monitored by Eurostat, to be the main indicator of sustainability. Next studies (Peksevim & Ercan, 2024), emphasize the importance of cash funds, pointing out that pension funds significantly reduce financial stress in both crisis and non-crisis times.

In the Czech Republic, total pension expenditure accounts for approximately 9% of GDP. (Ministry of Finance of the Czech Republic, 2025). The pension system reform, which will take effect in 2025, represents an effort to balance the system's income and expenditure sides. However, its long-term impact will also depend on the labor market's ability to adapt to demographic changes.

1. Methods of Research

The aim of this article is to comprehensively analyze the key factors and their interrelationships that influence the long-term sustainability of the pension system in the context of an aging population, with a particular emphasis on the adaptability of the labor market. Using a Causal Loop Diagram (CLD) created in Stella software, the system

dynamics are visualized and positive and negative feedback mechanisms are identified that can strengthen or weaken the fiscal stability and intergenerational fairness of the pension system. The chosen methodology is based on the principles of system dynamics, which allows for the examination of complex socioeconomic systems through modeling, simulation, and analysis of behavior over time (Sterman, 2000). This approach is particularly suitable for examining long-term macroeconomic processes such as population ageing, labour market participation trends or the sustainability of the pay-as-you-go pension system, where there are delays, feedback loops and non-linear interactions between individual variables.

Simulations and visualizations were performed using Stella Professional, a specialized software designed for modeling levels and flows, which allows for intuitive visualization of the dynamic behavior of systems (ISEE systems, 2025). A Causal Loop Diagram (CLD) was used to identify key variables, their interrelationships, and types of feedback loops. The main variables included in the model are the number of economically active persons, the participation rate of older workers, the number of pensioners, the average retirement age, the average wage, the unemployment rate, the average pension amount, and the system's income and expenditure. The resulting CLD provides an overview of the mechanisms that affect the stability of the pension system and allows for the identification of potential intervention points that fiscal and labor market policies can target in the search for ways to ensure its long-term sustainability.

2. Results of the Research

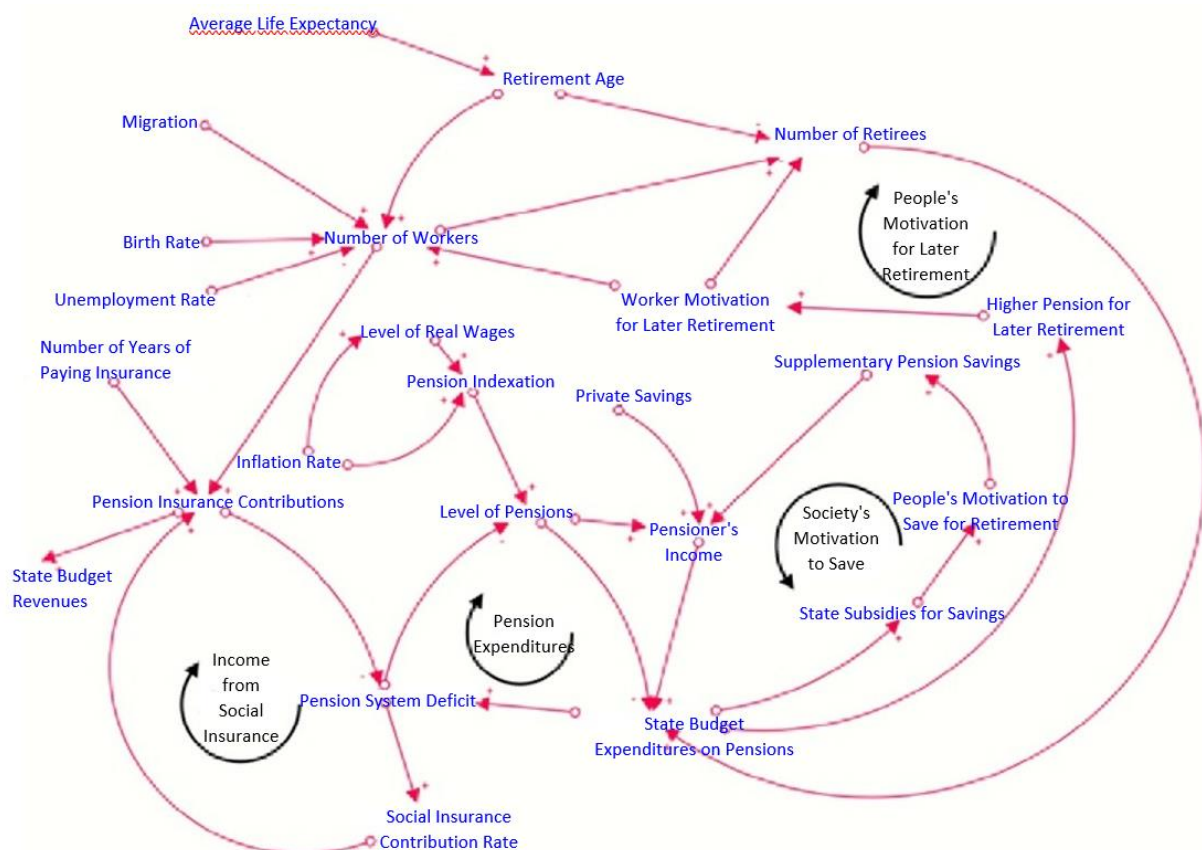
The analysis of the pension system is based on the creation of a causal loop diagram (CLD) that maps the interrelationships between key variables affecting the stability and sustainability of the system. This diagram serves as a basic structure for understanding the dynamics of the pension system, which in the Czech Republic operates on the principle of pay-as-you-go financing – that is, the currently working generation finances the pensions of the retiring generation. The basic and central variable of the entire system is the number of workers. It is this number that has a direct impact on pension insurance revenues and thus on the overall state of the national budget. The number of workers is influenced by several factors, the main ones being the birth rate, migration, the unemployment rate, the retirement age, and people's motivation to postpone retirement. A high birth rate contributes to the growth of the workforce in the long term, while an increased unemployment rate has the opposite effect. In addition, migration also has a significant impact on the number of workers, as it can supplement the workforce in the short term, especially in a situation of an aging population (Karlová, 2025).

Motivating people to remain economically active for longer and retire later is another key factor. This motivation is often stimulated by higher pensions for those who retire later, which creates a positive feedback loop: more people in work means higher revenues for the pension system and lower demands on its expenditure. The retirement age is often adjusted to demographic developments, specifically the increasing average life expectancy. On the revenue side, the amount of social insurance paid by workers and the length of time for which this insurance is valid play an important role. These revenues

constitute a significant part of the state budget revenues allocated to pensions. Increasing revenue from pension insurance helps reduce the pension system deficit, which is desirable. However, if the deficit is high, the state can respond in several ways – for example, by increasing the insurance rate or reducing expenditure, i.e., pensions themselves. State budget expenditure on pensions is influenced by a valorization mechanism that responds to growth in real wages and inflation. This system ensures that pensions do not lose their purchasing power. However, high valorization can increase the burden on public finances over time, especially in periods of high inflation. Pensions are the main source of income for most seniors, but increasing emphasis is also being placed on individual provision, for example in the form of supplementary pension savings and private savings. These components are supported by state subsidies, which aim to increase people's motivation to provide for their own financial security in old age.

The causal diagram (see Fig. 1) clearly shows that the sustainability of the pension system depends on the balance between the number of workers, the amount of their contributions, and the amount of pensions paid out. Political decisions, demographic developments, and economic conditions form an interconnected and dynamic whole that needs to be analyzed as a system, not as a set of isolated measures.

Fig. 1: Causal Loop Diagram of Labor Market Dynamics and Pension System Sustainability



Source: authors' own calculations, based on (Karlová, 2025)

3. Discussion

The results of the analysis confirm that the sustainability of a pay-as-you-go pension system is fundamentally influenced by labor market dynamics, demographic developments, and the parameters of the system. The presented results of the analysis, based on system dynamics methodology and visualized using a causal loop diagram (CLD), confirm and further expand on the findings presented in the introductory section of this article. While a number of previous studies focus on individual parametric adjustments or prognostic models (e.g., within the *Overlapping Generations model*), our analysis emphasizes the complexity and dynamics of the entire system. The causal loop diagram (CLD, Figure 1) illustrates the central dynamics between the number of workers, contributions, pension expenditures, and the resulting reinforcing (R) and balancing (B) loops. It highlights the key feedback mechanisms that determine the long-term stability of the system. Positive feedback, such as the motivation to stay in the labor market longer due to higher pensions, can strengthen fiscal sustainability. This conclusion is consistent with Bloom et al. (Bloom et al., 2010, 2014) who show that longer healthy life expectancy leads to later retirement. At the same time, the analysis highlights the key role of policy decisions and economic conditions, which can strengthen or weaken these feedback loops.

Reinforcing loops underscore the multiplier effects of measures that promote employment, migration inflows, and wage growth—these not only increase contributions but also strengthen confidence in the pension system and extend working life. Balancing loops, on the other hand, capture mechanisms such as pension indexation or spending cuts that stabilize budgets in the short term but can reduce incentives and deepen intergenerational inequality. For example, indexation during periods of high inflation, although necessary for social justice (IMF, 2025) can undermine fiscal stability. Together, these mechanisms illustrate the fundamental trade-off between sustainability and fairness and confirm that neither of these dimensions can be secured in isolation and that a political compromise is necessary.

Furthermore, integrating migration, automation, and flexible forms of work into future models could significantly reshape the existing loops. Migration inflows can reinforce contributions (R) and mitigate demographic pressures (B). Automation can increase productivity and contributions, but may simultaneously reduce labor demand, weakening the reinforcing employment loop. Flexible work can extend labor force participation, reinforcing system stability, but if under-regulated, may also reduce contribution levels, creating balancing effects. These interactions highlight the need to treat labor market transformation as an integral part of pension system modeling. An interesting finding is the role of supplementary savings and private savings as a complementary balancing mechanism. Supporting these instruments with state subsidies creates a loop that reduces dependence on the pay-as-you-go system and strengthens the financial independence of seniors. This finding corresponds to the work of Peksevim et al. (Peksevim & Ercan, 2024) which emphasizes the importance of pension funds in alleviating financial stress.

In the context of the Czech Republic, pension expenditure accounts for less than 9% of GDP (of which old-age pensions account for 6.9%). However, despite being below the EU average, the recently adopted reform will only be successful if it manages to combine parametric changes, such as raising the retirement age, with measures to support the employment and productivity of older workers. Adjustments to the retirement age alone are not sufficient without

parallel steps in the labor market. Another finding is the lack of consideration of the impact of work under DPP ([agreements on work performance](#)) and other forms of flexible employment. Their growing importance requires their inclusion in the system's income prediction models. The social acceptability of reforms is also crucial – raising the retirement age may place a disproportionate burden on low-income groups and physically demanding professions ([Blundell et al., 2016](#)). Blundell et al. (2016) also analyzed evidence on modeling incentives for couples and joint decision-making. Political acceptance, transparent communication, and accompanying measures ([retraining, flexible transition to retirement](#)) are essential for successful implementation.

From a methodological perspective, it is necessary to acknowledge the limitation of the CLD approach: while it helps visualize and identify feedback structures, it does not provide quantitative simulation. This means that the strength of relationships and the magnitude of their impacts cannot be directly measured in this study. Future work should therefore combine CLD with quantitative system dynamics models to enable scenario testing.

Overall, the reform represents a step in the right direction, but it requires a broader strategy combining demographic, economic, and social tools ([Barr, 2012; Börsch-Supan et al., 2020; Börsch-Supan et al., 2006](#)). The latter study ([Börsch-Supan et al., 2020](#)) found that for both men and women, an increase in employment rates coincides with a reduction in incentives for early retirement.

Conclusion

The sustainability of the pension system in the Czech Republic and other developed countries is a complex problem that cannot be solved by isolated measures. This study used system dynamics methodology and visualization through a causal loop diagram (CLD) to demonstrate that the stability and long-term sustainability of the system depend on an interconnected network of factors, with the labor market playing a key role. The fundamental and most important link in the system is the dynamic between the number of workers, the amount of their contributions, and the number and amount of pensions paid. Feedback loops, such as incentives to remain in the labor market longer, can have a stabilizing effect. On the other hand, demographic trends such as population aging and declining birth rates represent external pressures that can lead to destabilization if not offset by the labor market's ability to adapt.

To ensure long-term sustainability, it is necessary to implement policies that not only regulate the parameters of the pension system itself, but also promote flexibility and adaptability in the labor market. This includes measures to promote the employment of older workers, improve their qualifications, and support intergenerational solidarity. To reduce the vulnerability of the system, it is essential to strengthen individual savings and other pillars that relieve the pay-as-you-go system. Future research should focus on how migration, automation, and flexible work interact with the identified feedback loops. Migration may strengthen reinforcing mechanisms by boosting contributions; automation may alter both reinforcing and balancing dynamics by raising productivity but potentially reducing employment; flexible work may extend careers but also create balancing pressures if contributions are lower. Explicit modeling of these interactions will be essential for accurate forecasts. In the context of the ongoing pension reform in the Czech Republic, it is therefore essential to monitor not only its direct fiscal impact, but above all its impact on labor market dynamics. Future research could focus on quantifying these

links and simulating the impacts of different policy scenarios. A combined use of CLD with quantitative simulations would allow testing the strength of different feedback mechanisms and their long-term impact on system sustainability.

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