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Pensions and Subjective Wellbeing

A Causal Mediation Analysis for 18 Advanced Countries

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Academic paper

Pensions and Subjective Well-being—A Causal Mediation Analysis for 18 Advanced Countries *

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Abstract

This study examines how national pension systems affect subjective well-being, emphasizing the mediating role of perceived financial security in old age. Using causal mediation analysis, we compare pay-as-you-go (PAYG) and funded pension structures across 18 advanced economies and individual-level data from 2,241 respondents in 9 European countries. We find that private pension funding enhances well-being by strengthening financial security, while PAYG systems are linked to lower security and reduced well-being—especially in ageing societies where demographic pressures heighten the relevance of pension design. Robustness checks—including fixed effects analysis and WHR covariates—confirm that pension diversity contributes to well-being beyond standard predictors.

JEL classification: H55, I31, J26

Keywords: pensions, subjective well-being, financial security, causal mediation analysis, pay-as-you-go, funded pensions

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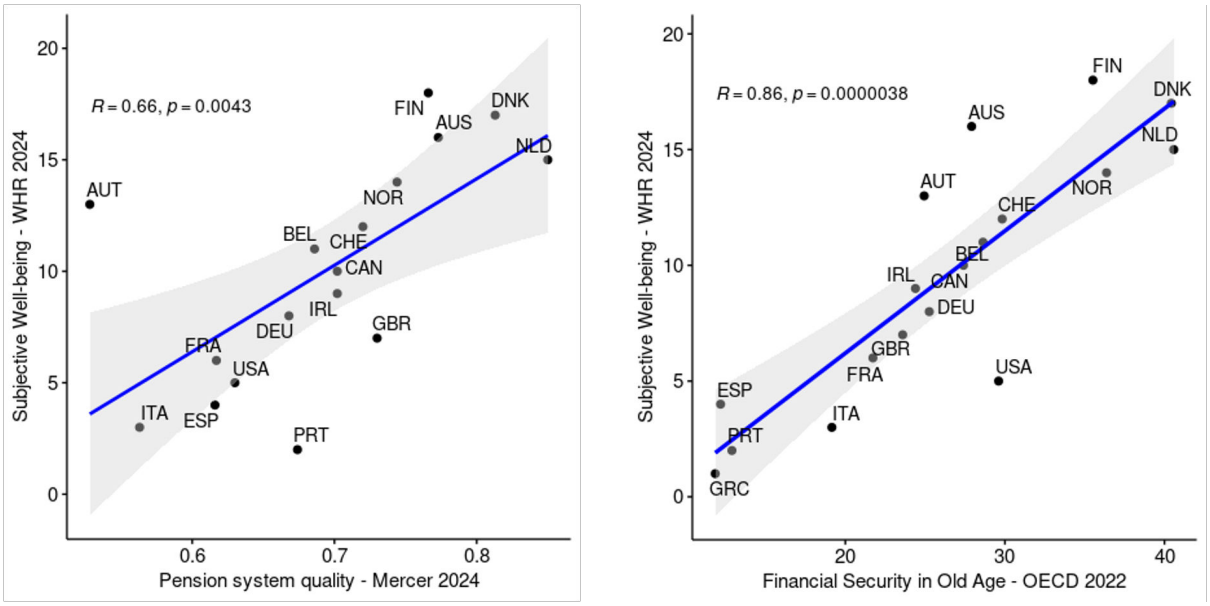
1 Introduction

Countries vary in their measured levels of subjective well-being. Factors such as per capita income and mutual trust play a significant role in explaining these differences. This study explores the impact of national pension systems on well-being.

Diagram (a) in Figure 1 illustrates a strong correlation between the well-being index from the annual published World Happiness Report WHR (Helliwell et al., 2024b) and a Pension system quality index (Mercer, 2024) for 18 developed countries. Ensuring financial security in old age is a fundamental objective of pension systems worldwide. Diagram (b) of Figure 1 shows that the WHR well-being index is positively correlates with perceived or expected financial security in old age (OECD, 2022).



(a) Diagram: Pension Quality

(b) Diagram: Financial Security

Figure 1: Relationship between well-being and quality of pension systems (Diagram a) and between well-being and perceived financial security around old age income (Diagram b)

Is there also a causal relationship between these observations? Does a well-structured pension system enhance financial security in old age and, in turn, contribute to higher well-being at the national level?

This study investigates the impact of national pension systems on subjective well-being, proposing that the relationship is mediated by individuals' perceived financial security in retirement. To test this hypothesis, we apply causal mediation analysis (Dippel et al., 2020), focusing on the causal link between the financial structure of national pension systems—particularly the mix of pay-as-you-go and funded components—and well-being outcomes. The analysis draws on two complementary datasets: a country-level dataset covering 18 advanced economies, compiled from publicly available sources, and an individual-level dataset based on survey responses from 2,241 individuals across 9 European countries.

It is plausible to assume that pension institutions influence well-being. These institutions are designed to help individuals to plan their finances throughout their lives. In many developed

countries, workers contribute a significant portion of their wages (20 to 30%) to pension systems, including government programs and private institutions such as pension funds and insurers. For most retirees, pension income from these sources serves as their primary, if not sole, means of income until the end of their lives.

Many countries are expected to experience significant population ageing in the coming decades, raising concerns about the long-term sustainability of their pension systems and the adequacy of future retirement incomes. Pay-as-you-go (PAYG) schemes, in particular, face mounting pressure as old-age dependency ratios—defined as the population aged 65 and older relative to those aged 25–64—are projected to double or more in many countries in the coming decades. This demographic shift may lead to benefit cuts and increases in the statutory retirement age.

Although funded pension systems are less directly affected by demographic financing pressures, they are not immune. As more individuals grow older and accumulate savings, the capital–labour ratio rises. This can reduce the marginal product of capital and, in turn, lower investment returns, thereby affecting the performance of funded pensions.

Rational, forward-looking individuals may anticipate demographic trends such as population ageing and adjust their expectations accordingly. This "ageing discounting" can lower perceived financial security in retirement. However, institutional trust may serve as a key moderating factor. When individuals have strong confidence that governments or pension institutions will uphold their commitments or adapt in fair and transparent ways, this "confidence effect" can mitigate—or even offset—the negative impact of ageing on perceived pension security.

National pension systems, as currently structured, are likely to persist for decades to come. Most of these systems, particularly in European and Anglo-Saxon countries, were shaped by political and economic decisions in the 1950s and 1960s, and these historical choices continue to define their institutional design. A central feature of pay-as-you-go (PAYG) financing is its Pareto efficiency: once established, it cannot be replaced by a funded system without imposing costs on one or more generations (Breyer (1989)). Downsizing a PAYG scheme typically requires a double burden on current workers—who must finance both existing retirees and their own future benefits—or benefit reductions for retirees. Consequently, countries with extensive PAYG systems face substantial obstacles in shifting toward prefunding. Their main reform avenue lies in parametric adjustments, such as raising the retirement age, lowering benefit levels, or modifying indexation rules. We argue that the expectation of such measures erodes perceived financial security in old age, which in turn adversely affects subjective well-being.

Although many studies in the well-being literature report correlations with various factors, demonstrating causality has proven difficult. To our knowledge, this is the first study to analyze the causal relationship between national pension systems and well-being. We employ a causal mediation analysis (Dippel et al., 2020), which integrates instrumental variable (IV) techniques with traditional mediation analysis, to identify and estimate the assumed causal pathway from pension characteristics to subjective well-being. The results of our causal mediation analysis

provide substantive support for a causal interpretation. We also that within-country variation in pension generosity will have impact on well-being levels as well, as identified with a fixed effect model.

We also observe that pension savings as a component of national pension systems is largely ignored in the well-being literature. When pensions are considered, the focus is typically on public pension spending, particularly in studies examining the impact of welfare state expenditures on well-being (Easterlin and O'Connor, 2025; Olivera and Ponomarenko, 2017; O'Connor, 2017). Our findings, however, suggest that pension savings play a crucial role in shaping well-being. In general, pension systems should receive greater attention in research examining international differences in subjective well-being.

The paper is set up as follows. We begin with a literature review, outlining the main explanations for cross-country differences in well-being. This is followed by a definition of our research problem. Next, we describe the key characteristics of national pension systems, with particular attention to differences in pension financing. We then explain how we apply causal mediation analysis to investigate the relationship between pensions and well-being. This method is implemented using both country-level and individual-level datasets. Finally, we present robustness checks and conclude with a discussion of our findings.

2 Literature Review on Subjective Well-Being and Pensions

The literature identifies three components of subjective well-being (Layard and De Neve, 2023; Nikolova and Graham, 2021). The first component, the affective dimension, relates to emotions and moods. The second component, economic well-being, focuses on fulfillment and the realization of life goals.

Our study concentrates on the third component, the cognitive dimension, which is evaluative in nature. It involves individuals assessing their overall life satisfaction, typically through survey questions such as: "All things considered, how satisfied are you with your life as a whole?" A common tool for measuring this is the Cantril ladder, where respondents place themselves on an 11-step scale ranging from 0 to 10. The World Happiness Report (WHR) applies this approach in its annual survey across nearly 200 countries, with approximately 1,000 respondents per country. Notably, the measured national well-being levels and the ranking of countries in the WHR studies has remained remarkably stable over time. Other institutions that publish well-being indices, such as the OECD (2020) and the World Values Survey (WVS) (Inglehart et al., 2008), also use this methodology.

Much research has been devoted to understanding international differences in well-being. Comprehensive overviews are provided by Helliwell (2003); Stutzer and Frey (2012); Nikolova and Graham (2021); Easterlin and O'Connor (2025). A key explanatory factor is national income. In general, higher per capita income is associated with greater life satisfaction. However, this relationship is nuanced by the so-called Easterlin paradox (Easterlin, 1974), which holds

that while happiness rises with income both across and within countries at a given point in time, the relationship weakens—or even disappears—over time. Despite sustained economic growth and rising average incomes, average happiness levels often remain flat. One explanation lies in the importance of relative income: individuals tend to evaluate their well-being in comparison to others, rather than based solely on absolute income levels (Clark et al., 2008). If all incomes rise proportionally, relative positions remain largely unchanged, limiting the overall impact on happiness. The paradox thus suggests that well-being is shaped by more than material prosperity alone, pointing to the relevance of additional economic, social, and institutional factors.

A second main factor is social capital or socio-cultural capital. Putnam (2000) defines social capital as: "... connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them." Numerous studies highlight interpersonal trust as a key determinant of international differences in happiness levels. However, trust is also closely linked to other explanatory factors. Trust correlates strongly with Hofstede's cultural dimensions (Hofstede, 1984), particularly uncertainty avoidance and individualism, both of which are closely tied to levels of mutual trust. Taken together, Putnam's social capital theory and Hofstede's cultural dimensions provide complementary explanations for the determinants of subjective well-being. Rather than acting in isolation, social and cultural factors form an interrelated cluster, playing a significant role in understanding international differences in happiness.

Third, welfare state institutions also play a crucial role in shaping well-being by influencing factors such as income inequality, social cohesion, and access to education and healthcare (MacCulloch, 2018). While a strong welfare state is often assumed to enhance well-being, empirical findings on this relationship are mixed. Some studies have found little or no evidence to support this claim (Veenhoven, 2000; Bjørnskov et al., 2007), whereas a more recent study by O'Connor (2017), covering over 100 countries, found that more generous welfare-state policies are positively associated with higher well-being. Additionally, Easterlin and O'Connor (2022) find that an increase in welfare state generosity over time is associated with an increase in well-being levels. However, in many countries, pension systems include both PAYG and funded components, yet the role of funded pensions is often overlooked in these studies.

A fourth category for explaining differences in well-being is the quality of institutions. Beyond the welfare state, institutional quality extends to factors such as the rule of law, which enhances stability and reduces precariousness, thereby contributing to greater happiness levels (Porta et al., 1998). Strong institutions also foster trust in governance, which has been shown to correlate positively with subjective well-being (Helliwell and Huang, 2008).

The WHR team has developed an own set of variables to explain international differences in well-being (Helliwell et al., 2024a). While we acknowledge their approach, we opt to use our own set of variables, incorporating pension-related factors, to better assess the causal link between pensions and well-being. However, we apply a robustness check to validate our findings with the WHR covariates. We find that pension finance diversity provides additional explanatory power in accounting for well-being variance, beyond the WHR covariates.

Despite the significant role of pensions in an individual's life course, pension systems receive little attention in discussions on well-being and the related literature. This gap is evident in comparative country studies on well-being, such as those conducted by the OECD (2022) and WHR (2024). The academic literature also largely overlooks the relationship between well-being and national pension systems, as seen in overview studies by Helliwell (2003), Dolan et al. (2008), Clark (2018), Clark and Ward (2019), Layard and De Neve (2023). Even in The Handbook of Well-Being by Diener et al. (2018), a nearly 1,000-page volume, the term pensions is not mentioned at all.

We found only one study which explicitly examines the potential relationship between pension systems and happiness. Analyzing data from over 18,000 respondents across 18 European countries, Olivera and Ponomarenko (2017) establish a significant negative relationship between pension insecurity—measured through expectations of downward reforms in PAYG pensions—and life satisfaction. Their findings suggest that greater uncertainty about future pension benefits negatively affects happiness.

Our study focuses on a specific institutional determinant of international well-being differences: the structure of national pension systems, particularly the balance between pay-as-you-go and funded financing. To our knowledge, no study has systematically analyzed this relationship in the context of subjective well-being.

3 Problem set

This contribution addresses the following two main questions. 1. What explains the differences in pension institutions between countries? 2. Is there a relationship between pension institutions and well-being in countries, and can this be said to be causal?

We propose three hypotheses, which are presented below with their motivation.

H1 Countries experienced varying levels of inflation during the interwar period. Those with high inflation tended to adopt postwar PAYG financing, whereas low-inflation countries favored a greater reliance on funded pension systems.

Countries experienced different levels of inflation during the interwar period. In the postwar decades, those with high inflation tended to adopt PAYG pension financing, while countries with more stable inflation histories gave a greater role to funded systems. These choices, made primarily in the 1950s and 1960s, continue to shape the structure of contemporary pension systems (Perotti and Schwienbacher, 2009). Transitioning from PAYG to a funded system remains difficult due to the so-called double burden problem: during such a transition, workers must simultaneously contribute to the pensions of current retirees and save for their own future retirement (Breyer, 1989; Feldstein, 2005).

H2 Pension system diversity influences well-being, but the relationship is indirect, operating through experienced or expected financial security in old age.

We do not expect individuals to directly associate the structure of their country's pension system with their own well-being. Instead, the relationship between pension institutions and well-being is likely indirect, with perceived or expected financial security in retirement acting as a key mediator. Every individual develops expectations about the financial security their retirement income will provide. For those who have not yet retired, these expectations are shaped by the experiences of retired peers, including family members, neighbors, and former colleagues, who serve as reference points. For pensioners, expectations are primarily based on their own income situation. In addition, the public debate on pension sustainability influences perceptions of pension security. This effect is particularly evident in countries where PAYG systems dominate. In such systems, concerns about the long-term sustainability of pensions often create uncertainty. As populations age, individuals increasingly recognize that pension entitlements may not be fully guaranteed, prompting them to anticipate higher retirement ages and potential benefit reductions.

H3 Greater reliance on funded pensions will enhance financial security in old age and thereby increase well-being, whereas a greater reliance on pay-as-you-go (PAYG) systems will reduce financial security and, in turn, lower well-being. The impact of pension financing methods on well-being is expected to be stronger in countries with more advanced population ageing.

We hypothesize that individuals evaluate their financial security in old age not solely on the basis of expected pension income, but also on the perceived credibility and sustainability of these entitlements. This perception is shaped by both the institutional design of pension systems and the demographic context in which they operate. In particular, we expect that funded pension systems, which are backed by accumulated financial savings and often safeguarded by strict regulatory frameworks, provide individuals with a stronger sense of financial security than PAYG systems, which depend on intergenerational transfers and are more exposed to political and fiscal risks. The long-term promises of PAYG schemes may appear vulnerable to downward reforms, especially in ageing societies where benefit levels become increasingly difficult to sustain. Conversely, the tangible nature of funded savings tends to provide reassurance, even if investment returns are uncertain. Building on this, we hypothesize two key mechanisms through which demographic and institutional factors jointly affect financial security:

First, the "ageing discount effect" - Individuals in ageing societies may discount the value of generous pension promises—whether public or private—due to expectations of future benefit cuts or declining returns. In PAYG systems, ageing threatens fiscal sustainability, prompting anticipated reforms. In funded schemes, population ageing may depress capital market returns. In both cases, the perceived real value of future entitlements declines, reducing feelings of financial security.

Second, the "confidence effect" - Institutional trust can mitigate the ageing discount effect. If individuals believe that governments or financial institutions will uphold pension promises or adapt systems in a fair and sustainable manner, this confidence can stabilize or even enhance perceived financial security despite demographic pressures.

4 Main Findings

We find that greater reliance on private pensions—reflecting a higher degree of capital funding—enhances financial security, which in turn contributes to higher levels of subjective well-being. This relationship is consistently supported by both country-level and individual-level analyses. Together, these results provide robust evidence of a causal pathway in which funded pension structures bolster financial security, and improved financial security translates into greater life satisfaction. Conversely, a stronger dependence on PAYG systems is associated with reduced financial security and lower well-being outcomes.

The impact of pension financing methods on financial security is stronger in countries experiencing more advanced population ageing. Trust mitigates ageing concerns in funded pensions, likely because these are backed by savings and operate under strict financial regulation. PAYG pensions appear less sensitive to trust, possibly due to their political nature and path dependency. This highlights the vulnerability of PAYG systems in ageing, low-trust societies.

The causal relationship between pensions and subjective well-being remains robust across various model specifications. Including WHR covariates in the model does not alter the main conclusions; notably, pension variables continue to provide additional explanatory power beyond this commonly used set of covariates. Furthermore, the findings remain consistent when pension system design is represented by pension assets as a percentage of GDP, rather than by the mix of PAYG and funded replacement rates.

5 Dataset Country-level

We construct the country-level dataset using public sources. The dataset, table 2, consists of 144 observations, covering 18 countries over 8 time points between 2009 and 2023 (2009, 2011, .., 2023). The biennial structure aligns with the OECD's Pensions at a Glance publication cycle, which appears every two years. The starting year, 2009, coincides with the first release of the World Happiness Report (WHR).

For several variables, we have only one observation per country. This applies to the cultural indicators uncertainty avoidance (Hofstede, 2001) and interpersonal trust (Inglehart et al., 2008), as well as to financial security (OECD, 2022), average historical inflation during the interwar period 1919–1940 (Jordà et al., 2019; Muller et al., 2025), and population ageing, measured by the projected increase in the old-age dependency ratio between 2020 and 2080 (OECD).

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Table 1: Descriptive Statistics Database Country Level

Statistic	Mean	St. Dev.	Min	Max	N
Subjective Well-being WHR	6.89	0.65	4.72	7.79	144
Total ReplacementRate	63.80	13.34	36.77	95.71	144
Public ReplacementRate	48.37	18.63	10.47	95.71	144
Private ReplacementRate	17.37	16.69	0.00	44.86	144
Pension Assets as % of GDP	61.17	62.49	0.00	229.40	144
log GDP per capita	10.75	0.25	9.91	11.68	144
Welfare Spending (excl. pensions)	9.06	3.90	3.30	17.38	144
Retirement Age	64.79	1.61	60.00	67.00	144
Dependency Ratio	31.73	4.02	23.73	41.52	144
Poverty	10.45	5.98	3.00	25.70	144
Healthy Life Expectancy	70.4	1.5	65.6	73.3	144
Inflation 1919-1940	3.00	4.12	−1.18	11.19	18
Financial Security Old Age (perceived)	26.24	8.52	11.85	40.58	18
Uncertainty Avoidance	63.89	24.14	23	112	18
Trust Interpersonal	40.42	13.71	17.29	68.11	18
Financial Architecture	0.10	0.80	−0.75	2.03	18
Protestant Fraction	28.82	29.97	0.10	87.30	18
Trust Residual	0.00	9.70	−10.55	19.92	18
Welfare Residual	0.00	2.78	−4.41	7.12	18
Uncertainty Avoidance Residual	0.00	16.66	−33.66	27.69	18
Financial Architecture Residual	0.00	0.69	−0.88	1.55	18

Note: Subjective well-being (SWB) is taken from the World Happiness Report (Helliwell et al., 2024a). Pension indicators, GDP per capita, dependency ratio, ageing projections, and welfare state spending are sourced from OECD's Pensions at a Glance (OECD, 2023). Data on interpersonal trust are drawn from the World Values Survey (WVS), while uncertainty avoidance is based on Hofstede's cultural dimensions. The Protestant population share (1960–2023) is obtained from the Cline Center. The country's averages of historical inflation (1919–1940) are based on Jordà et al. (2019), with exceptions for Austria and Greece. For these countries, inflation estimates are derived from Muller et al. (2025). Germany's inflation is calculated for the period 1924–1940, explicitly excluding the hyperinflation episode of 1920–1923. Healthy life expectancy is taken from the World Happiness Report. The variable *Ageing* captures the projected change in the old-age dependency ratio between 2020 and 2080 (OECD). To control for potential endogeneity and overlapping variance with our instrument historical inflation, we construct orthogonalized versions of several controls—*Trust Residual*, *Welfare Residual*, *Financial Architecture Residual*, and *Uncertainty Avoidance Residual*. These residuals are derived by regressing each original variable on historical inflation and retaining the uncorrelated component. As detailed in Section 7.4, these residualized controls serve to isolate their unique explanatory power while preserving the exogeneity of our instrument.

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6 Pension Institutions

6.1 Bismarck and Beveridge

In most advanced economies, pension systems are designed to fulfill two core objectives: (1) preventing old-age poverty, and (2) helping individuals smooth income over their lifetime to maintain stable consumption. While these goals are universally recognized, their institutional implementation varies significantly across countries.

In Western European and Anglo-Saxon countries, the structure of today's pension systems is largely shaped by political decisions made in the 1950s and 1960s, often in collaboration with private sector representatives, including social partners.[1] Broadly, pension systems can be classified into two primary models: the Beveridge model and the Bismarck model. These models are schematically illustrated in figure 2. In both pension models, the government administers a basic pension system based on a pay-as-you-go (PAYG) structure, primarily aimed at preventing poverty among retirees. However, the specific design and generosity of these PAYG pensions vary across countries.

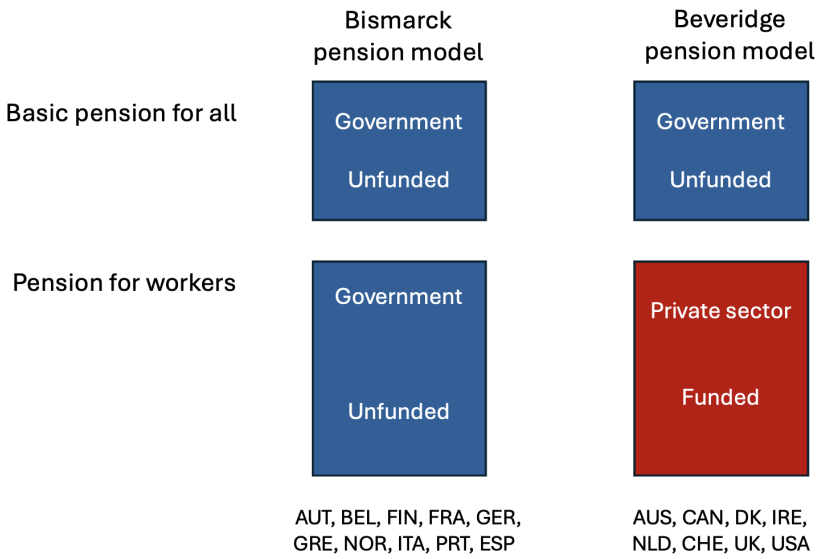


Figure 2: Pension models in the Bismarck tradition and in the Beveridge tradition

Notes: The figure compares the Bismarck and Beveridge pension models. The Bismarck model links pensions to earnings and uses PAYG financing, while the Beveridge model provides a flat-rate PAYG pension with funded supplements.

In Beveridgean welfare states, such as the Netherlands and Denmark, the basic pension is universal and uniform, providing all retirees with a flat-rate benefit deemed sufficient to ensure a dignified standard of living in old age. In contrast, Anglo-Saxon countries, which also follow the Beveridge model, provide a more modest basic pension, functioning primarily as a safety net for those without adequate private savings. Bismarckian countries, by comparison, provide a means-tested basic pension, with benefits that decline as income or wealth increases.

[1] This characterization does not apply to most Eastern European countries, where pension systems were shaped under different institutional and political regimes and underwent major restructuring only after the 1990s.

Beyond the basic pension, most countries also have employee pensions, but their structure differs significantly. In Bismarckian countries, these pensions are state-administered and PAYG-financed, meaning that current contributions fund the pensions of retirees. The final pension benefit is typically linked to an individual's earnings and years of employment, creating a direct relationship between career-long contributions and pension income.

In Beveridgean countries, including the Netherlands, Denmark, Switzerland, and Anglo-Saxon nations, employee pensions are funded rather than PAYG-based. These pensions are typically managed by social partners (via pension funds) or financial institutions. The final pension benefit depends on accumulated pension assets, which are derived from individual contributions and investment returns over time.

6.2 Institutional Characteristics

Table 3 presents key pension system characteristics for 18 advanced economies for 2023, categorized into Beveridge and Bismarck models and listed alphabetically. Columns (2), (3), and (4) display replacement ratios, illustrating the relative importance of pay-as-you-go (PAYG) and funded pensions by country. These figures are sourced from the 2023 OECD report Pensions at a Glance (OECD, 2023). The replacement rate is defined as the ratio of pension benefits to the last earned wage before retirement. In Bismarckian countries, pension provision primarily relies on public pay-as-you-go (PAYG) schemes, meaning that the total replacement rate is largely shaped by government-managed systems. By contrast, Beveridgean countries display a more balanced structure, with approximately half of retirement income typically derived from public PAYG pensions and the other half from private, funded arrangements.

Columns (6), (7), and (8) present evaluative indicators of quality related to national pension systems. Column (7) provide assessments of pension system quality, based on annual evaluations by pension professionals (Mercer, 2024). Column (8) measures financial security, reflecting the degree of perceived financial security in retirement, derived from OECD (2022). Column (6) reports subjective well-being levels, as measured by the World Happiness Report (WHR, 2024).

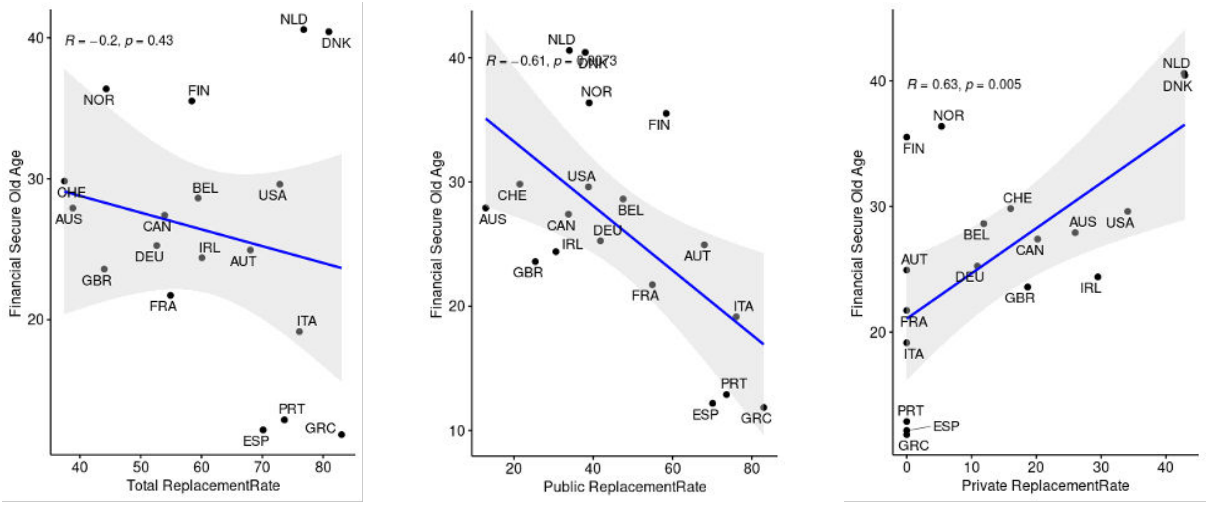
The average values for these indicators suggest that Beveridge countries tend to receive higher ratings for pension system performance, exhibit greater financial security in old age, and report higher overall well-being levels compared to Bismarck countries.

Figure 3 provides a graphical overview of the relationship between replacement ratios and financial security. While there is no significant correlation between overall pension generosity and financial security (see Diagram 3a), the financing mix plays a crucial role. A higher public replacement rate is negatively correlated with financial security, whereas a higher private replacement rate shows a positive correlation.

Table 3: Pension Characteristics and Quality

	Pension Characteristics in 2023					Evaluative criteria		
	Public (1)	Private (2)	Total (3)	Public/Total (4)	Pension Assets/GDP (5)	Subjective Well-being (6)	Mercer (7)	Financial Security (8)
Bismarck								
AUT	68.0	0.0	68.0	1.00	6.9	7.02	52.3	24.9
BEL	47.5	11.9	59.4	0.80	39.6	6.94	68.6	28.6
FIN	58.4	0.0	58.4	1.00	90.2	7.70	76.7	35.5
FRA	54.9	0.0	54.9	1.00	14.3	6.56	61.7	21.7
DEU	41.8	10.9	52.6	0.79	7.6	6.79	66.8	25.3
GRE	83.0	0.0	83.0	1.00	0.9	5.90	–	11.8
ITA	76.1	0.0	76.1	1.00	17.3	6.25	56.3	19.2
NOR	39.0	5.4	44.3	0.88	13.6	7.25	74.4	36.4
PRT	73.4	0.0	73.4	1.00	26.7	5.95	67.4	12.9
ESP	70.1	0.0	70.1	1.00	12.0	6.46	61.6	12.2
Average	62.1	2.0	64.2	0.96	22.8	6.59	66.0	21.9
Beveridge								
AUS	12.8	26.0	38.8	0.33	139.0	7.45	77.3	27.9
CAN	33.7	20.2	53.9	0.63	175.9	6.84	70.2	27.4
DNK	38.0	42.9	80.9	0.47	192.3	7.50	81.3	40.4
IRL	30.6	29.5	60.1	0.51	26.7	6.82	70.2	24.4
NLD	34.0	42.8	76.8	0.44	150.7	7.25	85.0	40.6
CHE	21.4	16.0	37.5	0.57	158.5	6.97	72.0	29.8
GBR	25.4	18.7	44.0	0.58	88.1	6.66	73.0	23.6
USA	38.8	34.1	72.9	0.53	148.2	6.52	63.0	29.6
Average	29.3	28.8	58.1	0.51	134.9	7.00	74.0	30.5
Total	47.1	14.4	61.4	0.75	72.7	6.82	69.3	26.4

Note: Pension characteristics are derived from OECD Pension at a Glance (2023), subjective well-being from WHR (2023), financial security from OECD (2022), and pension system quality from Mercer (2024). Columns (1)–(3) report public, private, and total replacement rates, respectively. Column (4) presents the public share of the total replacement rate, calculated as Column (1) divided by Column (3). Column (5), total pension assets over GDP, is expressed in percentages. Averages are unweighted.



(a) Diagram: Total RR (b) Diagram: Public RR (c) Diagram: Private RR

Figure 3: Financial security and Replacement Rates

Notes: The figure displays three diagrams: the first (a) represents the total replacement rate, the second (b) the public replacement rate, and the third (c) the private replacement rate. Each diagram highlights the relationship between replacement rates and financial security per country.

7 Methodology

7.1 Causal mediation analysis

This study investigates whether there is a *causal mechanism* from pensions to subjective well-being, with experienced financial security in old age as *mediating* variable. Broadly, there are two primary approaches to examining causality: the Instrumental Variable (IV) approach (Angrist and Krueger, 1991) and mediation analyses (Baron and Kenny, 1986). While both methods provide insightful findings, each has inherent limitations due to their methodological structure. The IV analysis allows for the identification of a true causal effect, but it cannot provide insight into the precise causal channel of how pensions affect well-being. The inherent limitation of mediation analyses approach lies within the assumption of exogeneity which is barely realistic. Multiple factors can be discerned that may bias the mediation pathway. Dippel et al. (2020) effectively address these shortcomings. They propose a causal mediation analysis that integrates the strengths of both the IV and mediation approaches.

7.2 Framework

Effectively, the mediation analysis by Dippel et al. (2020) involves a three-stage framework. This is depicted in Figure 4 which illustrates the causal pathway from pensions to subjective well-being, with financial security as a mediator.

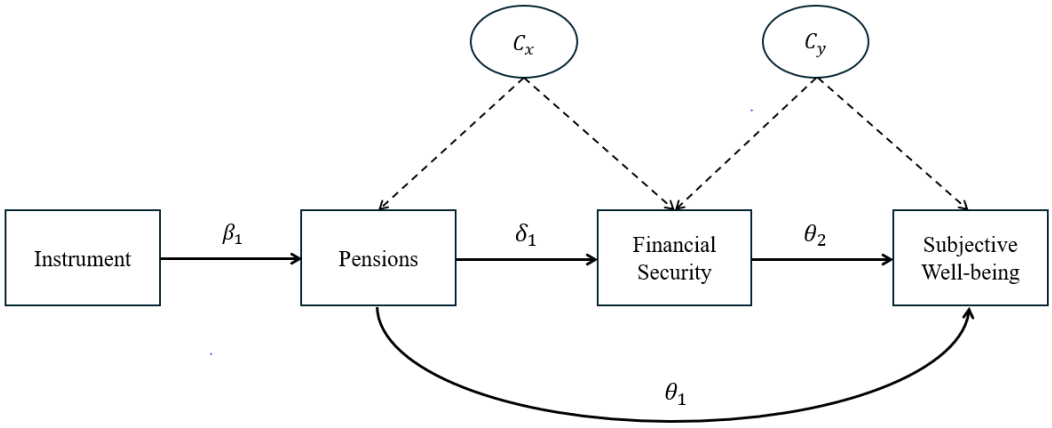


Figure 4: Causal diagram Illustrating the Relationship between Variables.

Notes: The diagram shows the total effect of Pensions on SWB, split into direct (θ_1) and indirect ($\delta_1 \cdot \theta_2$) effects. Unobserved confounders C_X and C_M affect Pensions, Financial Security, and SWB, but not directly between Pensions and SWB. The variable Instrument isolates exogenous variation in Pensions, enabling the decomposition of the total effect.

Stage 1: Predict Pension using Instrument Z

In the first stage, the causal effect of the instrument (Z) on pensions is estimated to establish its relevance and to isolate exogenous variation in the explanatory variable. The first stage model is specified as follows:

$$Pension_{it} = \alpha_0 + \beta_1 \cdot Z + \gamma_2 \cdot Control_{it} + \epsilon_{it} \tag{1}$$

The coefficient β_1 measures the effect of the instrument on pensions.

Stage 2: Predict Financial Security using $\widehat{Pension}$

To clarify the causal mechanism, the second stage examines the effect of pensions on financial security (FS) using its predicted value from the first stage. The second stage model isolates the extent to which differences in pensions affect financial security.

$$FS_{it} = \alpha_0 + \delta_1 \cdot \widehat{Pension}_{it} + \gamma_2 \cdot Control_{it} + \nu_{it} \tag{2}$$

Here, δ_1 represents the causal effect of pensions on financial security, leveraging exogenous variation from the instrument.

Stage 3: Estimate Subjective Well-being using Pension and $\widehat{FS}$

In the third stage, the impact of the mediator—financial security—is estimated while controlling for pensions.

$$SWB_{it} = \alpha_0 + \theta_1 \cdot Pension_{it} + \theta_2 \cdot \widehat{FS} + \gamma_3 \cdot Control_{it} + \varepsilon_{it} \tag{3}$$

In this equation, θ_1 represents the direct effect of pensions on the outcome while θ_2 captures the mediated effect via financial security.

7.3 Decomposition Effect

The analysis decomposes the total effect (TE) of the pension system on subjective well-being into two effects: direct effect and indirect effect. The direct effect (DE) represents the effect of pensions on subjective well-being that is independent of financial security. The indirect effect (IDE) indicates the effect mediated through financial security—a change in subjective well-being. Therefore the effects are expressed as:

$$\begin{aligned} DE &= \theta_1 \\ IDE &= \delta_1 \times \theta_2 \\ TE &= DE + IDE \end{aligned}$$

Regarding the indirect effect, δ_1 represents the pathway from independent variable to mediator (Pensions $\rightarrow$ Financial Security); θ_2 represents the pathway from mediator to outcome variable (Financial Security $\rightarrow$ Subjective Well-being). The total mediated pathway, which is the indirect effect (IDE), is indicated by the product of these two coefficients ($\delta_1 \times \theta_2$). The

direct effect θ_1 is the residual direct pathway from the explanatory variable to the outcome variable (Pensions → Subjective Well-being) without being influenced by the mediator. We have full mediation when the direct effect is statistically insignificant.

7.4 Constructing the Instrumental Variable – Justifying Historical Inflation

Ensuring the validity of the instrumental variable is essential for identifying causal pathways in mediation analysis. A valid instrumental variable must satisfy two core conditions. First, the **relevance condition** requires that the instrument be strongly correlated with the endogenous explanatory variable—in this case, the pension system structure. In the context of causal mediation analysis, this condition must also extend to the mediator, financial security. That is, the instrument should induce variation in financial security through its effect on pensions. This is necessary to identify the indirect pathway from pensions to well-being via financial security, and to ensure that the estimated mediation effect reflects exogenous variation rather than confounding influences. Second, the **exclusion restriction** requires that the instrument affects the outcome variable, subjective well-being, only through its influence on the explanatory variable and the mediator, and not through any alternative pathway.

Historical Inflation as an Instrument In this study, we construct our instrument based on a key historical determinant of pension system configuration: interwar inflation. Table 4 presents Spearman correlation coefficients, illustrating the associations between pension system diversity—captured by replacement rates from PAYG and funded components—and key explanatory factors commonly highlighted in the literature on pension design. Notably, interwar inflation experiences show a significant correlation with the present-day composition of national pension systems, supporting the hypothesis that historical macroeconomic performance have left lasting pension-institutional legacies.

Table 4: Correlation Matrix with Determinants of Pension Diversity

	PAYG RR	Funded RR	Inflation	UA	Trust	ProtF	FinArc
Inflation 1919–1940	0.58	−0.55					
Uncertainty Avoidance	0.68	−0.71	0.69				
Trust in Others	−0.50	0.47	−0.69	−0.75			
Protestant Fraction	−0.45	0.31	−0.46	−0.65	0.84		
Financial Architecture	−0.75	0.46	−0.56	−0.48	0.22	0.28	
Welfare State (excl. pensions)	0.77	−0.70	0.76	0.75	−0.61	−0.44	−0.54

Note: This table presents Spearman correlation coefficients showing the associations between pension diversity—measured by replacement rates from PAYG and funded pensions—and key economic, cultural, and institutional variables. Welfare state spending is measured net of PAYG pension expenditures. Financial architecture refers to the dominant mode of financial intermediation: increasingly negative values indicate a more bank-based system, while increasingly positive values reflect a more market-based orientation. The indicator follows the methodology of Kwok and Tadesse (2006).

Perotti and Schwienbacher (2009) provide strong empirical evidence that the structure of postwar pension finance is closely linked to prewar inflation. This supports the use of historical inflation as an instrumental variable in our analysis, as it satisfies the relevance condition. Perotti and Schwienbacher (2009) argue that countries that suffered from high or volatile

inflation—such as Germany, France, and Italy—developed a post-war preference for pay-as-you-go (PAYG) systems. The rationale was both economic and political: the middle class had experienced severe real wealth losses through inflation, eroding trust in long-term financial contracts and capital-funded pension arrangements. In this context, PAYG systems, which operate through current wage-linked contributions and state-administered redistribution, offered a politically feasible and inflation-insulated solution.

Conversely, countries with low and stable interwar price experiences —such as the Netherlands, Switzerland, and the UK—were more willing to adopt or retain funded components in their pension systems, benefiting from favorable capital market conditions and stronger institutional trust in private sector agents.

A key feature of pay-as-you-go (PAYG) financing is its Pareto efficiency: once established, it can not be replaced by funding without hurting one or more of the involved generations involved in the transition (Breyer, 1989), Feldstein (2005). It is either workers paying a double burden - saving for their own pension as well as paying the benefits of the retirees - or cutting the benefits of the retirees. As a result, countries with substantial PAYG financing face insurmountable challenges in transitioning to funded pension schemes. These countries must address the burden of an ageing population through parametric reforms, such as reducing benefits, modifying indexation mechanisms, or increasing the statutory retirement age. As noted by Ebbinghaus and Gronwald (2011), this phenomenon—known as path dependence—is particularly evident in pension financing structures.

It is plausible that historical inflation satisfies the **exclusion restriction** as well, as it influenced the institutional design of pension systems but is unlikely to have a direct effect on contemporary well-being outcomes, except through its impact on pension structure. Inflation from 1919–1940 precedes the establishment of modern pension systems in the 50s and 60s, as well as contemporary measures of subjective well-being. It primarily reflects macroeconomic instability following World War I, the Great Depression, and early phases of monetary policy formation. These shocks are plausibly unrelated to current levels of subjective well-being, except through the institutional choices regarding pensions they helped to shape.

We formally assess the plausibility of the exclusion restriction in the Appendix. Specifically, we present evidence from a reduced-form equation, examine the correlation between pre-war and post-war inflation, and conduct a full 2SLS analysis. The combined results provide strong support that the exclusion restriction is satisfied in our empirical context.

We use historical inflation as the sole instrument in our mediation analysis, despite the fact that pension system diversity is also correlated with a broader set of factors (compare Table 4). Relying on a single instrument enhances both transparency and interpretability, and avoids potential identification problems that may arise from combining conceptually distinct sources of exogenous variation.

Controls To address the possibility that cultural, institutional, and economic characteristics jointly influence both pension system preferences and subjective well-being, we include a set of theoretically grounded control variables in the model.

- Uncertainty Avoidance, reflecting cultural preferences for order, security, and risk aversion, shapes societal attitudes toward pension design. High uncertainty avoidance societies tend to prefer state-led PAYG systems, while low uncertainty avoidance societies are more receptive to market-based pensions (Hofstede, 2001; Aggarwal and Goodell, 2013; Rivera-Rozo et al., 2018).

- Interpersonal Trust captures general confidence in others and institutions, which affects willingness to entrust savings to private pension providers. High-trust societies are more likely to rely on funded systems with private-sector involvement (Martela et al., 2020). Trust is highly correlated with the protestant fraction in a country. Milevsky and Velazquez (2024) highlight the fraction of Protestants in a country as an important factor influencing pension system design. Protestant cultures emphasize self-reliance, long-term savings, and financial responsibility, which fosters a greater prevalence of funded pensions and higher pension funding levels.

- Welfare State Spending (excluding pensions) serves as a proxy for state involvement in economic security more broadly. Countries with larger welfare states tend to have more redistributive, PAYG-based pension schemes, while leaner welfare states often support more privately managed, funded alternatives.

- Financial Architecture, measuring the degree to which financial intermediation is market-based or bank-based (Kwok and Tadesse, 2006), affects the institutional viability of funded pensions. Countries with strong capital markets are structurally better positioned to support funded pension pillars.

These control variables are theoretically relevant but also empirically correlated with historical inflation, raising concerns about overlapping variation. To address this, we apply an orthogonalization procedure: we regress each potentially collinear control variable—uncertainty avoidance, interpersonal trust, financial architecture and welfare state spending—on the instrumental variable (historical inflation), and retain the residuals from these regressions. We exclude the Protestant population share from the controls due to its high collinearity with interpersonal trust.

These residualized variables—hereafter referred to as the Trust Residual, Welfare Residual, Financial Architecture Residual, and Uncertainty Avoidance Residual—capture only the variation in each control that is independent of historical inflation. This approach helps ensure that the instrument retains its explanatory power, as we avoid adjusting for variables that are themselves partly shaped by the same historical influences. By separating out the variation linked to inflation, we maintain a clear distinction between the instrument and the control variables, thereby strengthening the validity of our identification strategy.

Incorporating the orthogonalized controls into our analysis strengthens the causal interpretation of our mediation estimates. It ensures that:

(1) the instrument captures only exogenous variation in pension system design stemming from historical inflation, and

(2) the control variables explain additional variation in financial security and subjective well-being without undermining identification.

8 Results

8.1 Country level

8.1.1 Main Results

In the following section, we present the results of the causal mediation analysis assessing the impact of pensions on subjective well-being, applying Dippel's approach.

Private pensions

Table 5 presents the results of the causal mediation analysis linking private pension replacement rates to subjective well-being (SWB), with financial security in old age as the mediator. The analysis is conducted at the country level for the period 2009–2023, using average historical inflation (1919–1940) as an instrument. Orthogonalized residuals for trust, welfare state size, financial architecture, and uncertainty avoidance are included as controls, along with co-variates related to pensions and macro-economy.

Column (1) confirms a strong negative association between historical inflation and private replacement rates (-2.138, $p < 0.01$), consistent with Hypothesis 1. This suggests that countries with high interwar inflation are less likely to have developed funded pension systems. As noted earlier, the range in historical inflation (approx. 12 percentage points) implies that the instrument accounts for up to 27 percentage points of the variation in private replacement rates, underlining its substantive relevance.

Column (2) investigates the determinants of financial security in old age—the proposed mediator. Historical inflation is negatively and significantly associated with financial security (-1.194, $p < 0.01$), as expected. The private replacement rate is also significant and positively related (0.157, $p < 0.01$), supporting the hypothesis that greater reliance on funded pensions enhances individuals' perceived financial security. These results suggest that historical inflation indirectly influences perceived security through its effect on pension system design. The model accounts for a large proportion of the variance in financial security (Adjusted $R^2 = 0.842$).

Column (3) presents the final step in the causal chain, linking financial security in old age to subjective well-being (SWB). Financial security is positively and significantly associated with SWB (0.038, $p < 0.01$), supporting its role as a mediator. Notably, the direct effect of private replacement rates becomes statistically insignificant once financial security is included, consistent with a full mediation pathway. Historical inflation is likewise insignificant in this final equation. These findings strengthen the case for the exclusion restriction—that historical inflation influences well-being only indirectly, through its effect on pension structure and perceived financial security. This is also consistent with Hypothesis 2, which posits that individuals do not perceive a direct link between pensions and well-being, but instead evaluate pension systems based on the financial security they provide in old age.

Among the controls, healthy life expectancy and log GDP per capita emerge as strong predictors of well-being. Interpersonal trust (measured via the trust residual) is significantly associated with financial security (0.463, $p < 0.01$), but becomes statistically insignificant in the final SWB equation (-0.001, $p > 0.1$) once financial security is included. Central Bank Independence (CBI) is statistically significant only in the financial security equation (7.601, $p < 0.01$), suggesting that credible macroeconomic institutions may enhance individuals' perceptions of long-term financial stability, even if they do not directly affect subjective well-being.

Overall, these results provide coherent support for the proposed causal pathway: historical inflation influenced the composition of pension systems, which in turn shaped individuals' perceptions of financial security in old age—ultimately affecting their subjective well-being.

Public pensions

The appendix presents in section A.2 the mediation analysis results for the public pension scheme. The same mediation framework as used in Table 5 is applied, but with the Private Replacement Rate replaced by the Public Replacement Rate. The results are broadly comparable across most variables. However, two notable differences emerge: in Model 1, the instrument now shows a significant *positive* relationship with the Public Replacement Rate ($+1.883$, $p < 0.01$), and in Model 2, the coefficient linking the public plan to financial security becomes *negative* (-0.200, $p < 0.01$). These findings further highlight the contrasting effects of PAYG-based versus funded pension systems on financial security and well-being.

Relative Impact of Private and Public Pensions on Well-Being

To illustrate the magnitude of the mediation effect, we express the indirect effects of public and private pensions on subjective well-being (SWB) relative to the observed range in well-being scores—this is 3.07 points across the 18 countries in our sample.

For private pensions, the estimated indirect effect is 0.5966 per 100 percentage points of replacement rate (multiplying the regression coefficients 0.157×0.038, yielding 0.005966 per 1 percentage). For PAYG pensions, the corresponding effect is negative: -0.9400 per 100 percentage points.

As a realistic illustration, consider two otherwise similar countries both having a total replacement rate of 60%: one entirely reliant on PAYG (60% public, 0% private), and the other with a balanced design (30% PAYG, 30% funded). Based on our estimates, the mixed-financing country would score 0.46 points higher on the well-being scale than the full PAYG country[2]. This is equivalent to 15% of the observed SWB range of 3.07 in our country set. A comparable difference arises when we contrast the two country clusters[3].

[2] A mix of 30% PAYG and 30% would lead to a contribution to SWB of –0.1030 ($= 30 \times -0.0094 + 30 \times 0.005966$), whereas a mix of 60% PAYG yields a negative contribution to SWB of -0.564 ($= 60 \times -0.0094$).

[3] The cluster of Beveridge countries exhibits a near-even split between public and private pensions (29% each), compare Table 3. This cluster achieves a net SWB effect of approximately –0.10. In contrast, Bismarck countries—with 62% public and only 2% private pension provision—reach a much lower value of –0.57. This implies a well-being gap of +0.47 points, or 15.31% of the SWB range, between the two system types.

Table 5: Causal Mediation Analysis between Pensions and SWB at the Country Level

	Dependent variable:		
	Private Replacement Rate	Financial Security in Old Age	SWB (WHR)
	(1)	(2)	(3)
Financial Security in Old Age			0.038^{***}
			(0.011)
Private Replacement Rate		0.157^{***}	0.002
		(0.033)	(0.004)
Inflation 1919–1940	-2.138^{***}	-1.194^{***}	0.006
	(0.310)	(0.136)	(0.021)
log GDP per capita	3.215	4.478^{***}	1.050^{***}
	(4.037)	(1.526)	(0.191)
Uncertainty Avoidance Residual	-0.401^{***}	0.028	−0.0004
	(0.060)	(0.026)	(0.003)
Trust Residual	−0.158	0.463^{***}	−0.001
	(0.120)	(0.045)	(0.007)
Financial Architecture Residual	1.122	−0.791	−0.009
	(1.287)	(0.487)	(0.060)
Welfare Residual	-2.568^{***}	−0.190	0.040^{*}
	(0.458)	(0.192)	(0.023)
Healthy Life Expectancy	-2.109^{***}	-0.700^{***}	0.092^{***}
	(0.581)	(0.230)	(0.029)
Dependency Ratio	0.039	0.542^{***}	-0.029^{*}
	(0.351)	(0.132)	(0.017)
Central Bank Independence	0.554	7.601^{***}	0.026
	(7.472)	(2.818)	(0.351)
Retirement Age	-1.839^{***}	-0.504^{**}	−0.019
	(0.642)	(0.249)	(0.031)
Constant	255.352^{***}	39.821	-9.729^{***}
	(62.665)	(25.065)	(3.071)
Observations	144	144	144
Adjusted R^2	0.712	0.842	0.606

Note: This table presents the results of a causal mediation analysis over the period 2009–2023 between private replacement rate and subjective well-being, with financial security in old age as a mediator at the country level. The instrument is the historical inflation rate over the period 1919–1940. Residual variables are orthogonalized to the instrument.

*p<0.1; **p<0.05; ***p<0.01

These findings emphasize the relevance of pension system design for well-being. A more balanced financing structure—combining public and private elements—appears to foster higher perceived financial security and, in turn, greater subjective well-being.

Quantifying the mediation effects

The bootstrapping method in Table 6 further confirms the size and significance of the indirect effect. This method provides robust estimates of both mediated and direct effects, bypassing the parametric assumptions typically related to the data distribution (Alfons et al., 2022). Nonparametric bootstrapping is particularly useful for examining causal relationships through intermediary variables. The analysis involves resampling the dataset by 2,000 times, yielding confidence intervals for the average causal mediation effect (indirect effect), average direct effect, and total effect. The proportion mediated is estimated at 71.9% (0.0060/0.0083 = 0.719), highlighting the substantial indirect effect of private pension provision on subjective well-being operating through financial security.

Table 6: Nonparametric Bootstrap Confidence Intervals on Country-level

Effect	**Estimate**	**95% CI Lower**	**95% CI Upper**	**p-value**
Indirect Effect	0.0060	0.0021	0.01	<2e-16 ***
Direct Effect	0.0023	−0.0061	0.01	0.82
Total Effect	0.0083	0.0013	0.02	0.02 **
Prop. Mediated	0.719	0.2035	3.41	0.02 **

Notes: Confidence intervals are derived from nonparametric bootstrap with the percentile method.
Sample size = 144
Simulations = 2000 *Significance:* *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

8.1.2 Final

The discussed empirical findings with the country-level dataset provide strong empirical support for the hypothesis that private pension funding enhances subjective well-being, but primarily through its effect on financial security in old age. The analysis reveals a substantial mediated relationship, in which financial security is the key channel linking private pension replacement rates to well-being. Public pensions, on the other hand, illustrate the opposite results; they have a negative impact on the subjective well-being of almost equal size, also completely channeled via their impact on financial security.

8.2 Individual level

The analysis in the previous sub-section 8.1, based on country averages, cannot fully capture the heterogeneity of individuals' experiences. To address this gap, we complement the country-level with an individual-level analysis, keeping examining the same causal structural relationship. Importantly, this shift does not represent a departure from the overarching analytical framework

but rather an extension for a more comprehensive understanding of the results. Both datasets are methodologically aligned, employing consistent variables–private replacement rate, financial security, and subjective well-being–at different levels of aggregation.

8.2.1 Dataset Individual-level

To elucidate the causal mechanisms within the context of European countries, the analysis conducts an individual-level study based on data collected from a survey conducted by Ponds and Webers (2025) using the Dynata panel. The survey gathered responses from a total of 2,241 individuals across 9 European countries: Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, and the United Kingdom. These countries were selected to ensure a comprehensive representation of Europe's diverse landscape. Initially, the data collection procedure also included Poland and Estonia but these two countries were excluded from the final analysis due to the unavailability of historical inflation rates required for the instrumental variable. The dataset encompasses both individual- and country-level variables. The dependent variable— subjective well-being—is operationalized as a measure of individuals' self-reported happiness on a scale ranging from 1 ("Very Dissatisfied") to 8 ("Very Satisfied"). This variable captures perceived life satisfaction and serves as the primary outcome of the study. A key mediating variable—financial security—reflects individuals' perceptions of their current and future financial stability in old age. This index is constructed based on the survey questions assessing financial concerns and expectations regarding post-retirement income adequacy. Income, age, education, and gender are available for each individual. To ensure consistency and comparability with the prior analyses, the study includes similar explanatory country-level variables, such as historical inflation, private and public replacement rates, and the residual control variables. Descriptive statistics for the dataset are provided in Table 7.

Table 7: Descriptive Statistics Database Individual Level

Statistic	Mean	St. Dev.	Min	Max	N
Well-being (SWB)	5.15	1.42	1	8	2,241
Financial Security	2.93	1.17	1	5	2,241
Absolute Income	6.20	2.89	0.00	11.14	2,241
Relative Income	−0.53	2.28	−7.91	6.48	2,241
Age	48.94	15.98	18	80	2,241
Male	0.51	0.50	0	3	2,241
Education	5.18	2.04	1	8	2,241
Private Replacement Rate	12.28	15.03	0.00	45.60	9
Public Replacement Rate	49.17	19.99	21.70	80.80	9
Inflation 1919–1940	4.90	4.09	-0.70	11.20	9
Trust Residual	−0.27	8.45	−9.92	13.70	9
Uncertainty Avoidance Residual	−0.80	17.49	−33.70	24.90	9
Welfare Residual	0.34	2.94	−3.34	6.40	9
Financial architecture Residual	−0.10	0.47	−0.66	0.92	9

Note: All variables are derived from the survey, except for historical inflation, pension characteristics and the residual controls, which are obtained from the country-level dataset.

8.2.2 Consistency of Datasets

We first examine the consistency between the two datasets. For the 9 countries present in both, we compare the values of the two key variables—well-being and financial security—from the country-level dataset with their corresponding country averages from the individual-level dataset. Figure 5 presents the results.

Diagram (a) shows a Pearson correlation of 0.70 for financial security, while diagram (b) reports a Pearson correlation of 0.66 for well-being. When the outlier Finland is excluded, these correlations increase to 0.87 and 0.83, respectively. We consider this level of consistency to be strong.

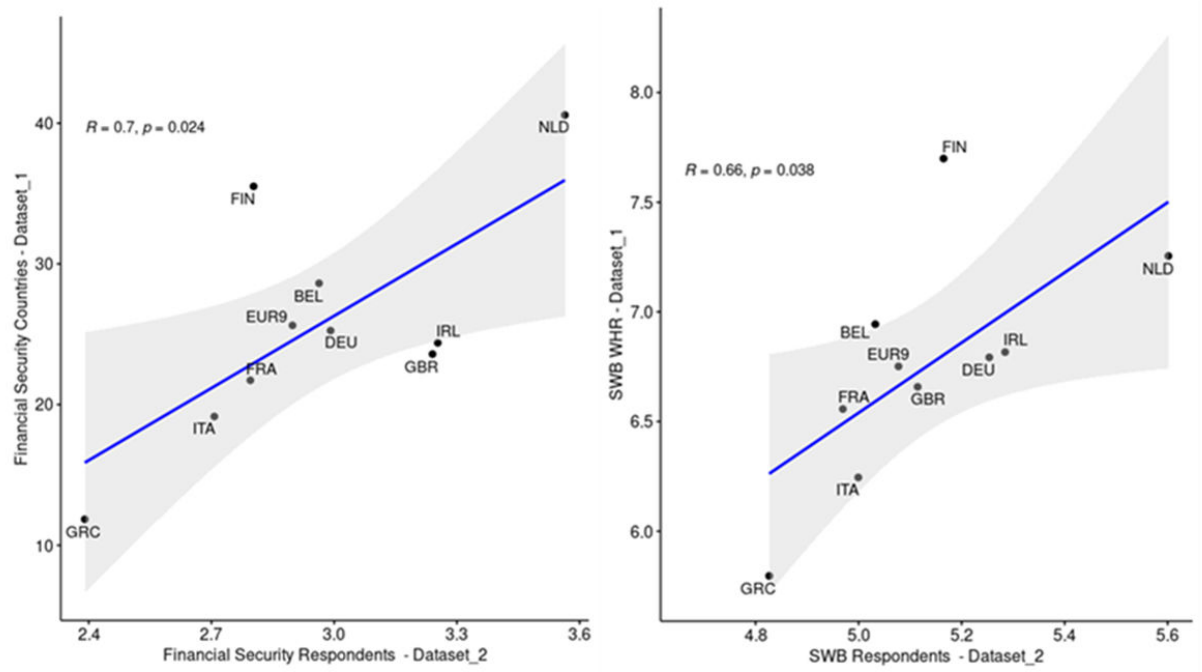


Figure 5: Consistency Check between the Country-level Data (Dataset_1) and Individual-level Data (Dataset_2)

Note: Panel (a) presents the correlation between financial security measures from the two datasets (R = 0.70, p = 0.024). Panel (b) shows the correlation for subjective well-being (R = 0.66, p = 0.038). After excluding Finland, the correlations increase to 0.87 and 0.83, respectively, indicating strong consistency between the datasets.

8.2.3 Main Results

This section presents the results of a mediation analysis investigating the relationship between private replacement rate, financial security, and subjective well-being at the individual-level, employing the same instrument as utilized in the prior analyses, i.e. historical inflation.

Table 8: Causal Mediation Analysis between Pensions and SWB at the Individual Level

	Dependent variable:		
	Private Replacement Rate	Financial Security	SWB
	(1)	(2)	(3)
Financial Security in Old Age			0.449^{***}
			(0.024)
Private Replacement Rate		0.013^{***}	0.003
		(0.004)	(0.004)
Inflation 1919–1940	-2.352^{***}	-0.021^{**}	0.004
	(0.035)	(0.011)	(0.012)
Absolute Income	1.729^{**}	0.443^{***}	0.395^{***}
	(0.685)	(0.119)	(0.135)
Relative Income	-1.063	0.360^{**}	0.896^{***}
	(0.828)	(0.143)	(0.162)
Trust Residual	0.003	-0.0001	0.011^{***}
	(0.019)	(0.003)	(0.004)
Welfare Residual	-3.142^{***}	-0.008	0.019
	(0.064)	(0.016)	(0.018)
Uncertainty Avoidance Residual	0.080^{***}	-0.003	0.0001
	(0.011)	(0.002)	(0.002)
Financial Architecture Residual	8.216^{***}	0.035	0.023
	(0.386)	(0.073)	(0.083)
Male	-0.096	0.271^{***}	-0.140^{***}
	(0.271)	(0.047)	(0.054)
Age	0.012	0.002	0.005^{***}
	(0.009)	(0.001)	(0.002)
Education	0.052	0.020	0.039^{***}
	(0.072)	(0.012)	(0.014)
Constant	23.755^{***}	2.268^{***}	3.232^{***}
	(0.778)	(0.160)	(0.189)
Observations	2,241	2,241	2,241
Adjusted R^2	0.819	0.109	0.219

Note: This table presents the results of a mediation analysis between private replacement rate and subjective well-being, with financial security as a mediator based on survey data by Ponds and Webers (2025). The dataset contains 2,241 individuals from 9 European countries. The instrument is the historical inflation rate over the period 1919–1940. The residual variables result from orthogonalizing the main variables with the instrument to strip the overlap in variance.

*p<0.1; **p<0.05; ***p<0.01

Private Pensions and Financial Security The results shown in Table 8 aligns with the previous findings of country-level data. Column (1) demonstrates a statistically significant negative relationship between historical inflation as instrument and the private replacement rate in 2023, with a coefficient of -1.704 ($p < 0.01$). This result indicates that countries with lower inflation rates during the interwar period tend to have higher private replacement rates in the present day. Column (2) further establishes a significant positive relationship between private replacement rate and financial security, as reflected in the coefficient of private replacement rate (0.016, $p < 0.01$). This suggests that elevated private replacement rates contribute to enhanced financial security for individuals, reinforcing the argument that funded pensions play a pivotal role in mitigating individuals' perceived financial risks.

Financial Security and Subjective Well-being Column (3) integrates financial security as a mediating variable in the relationship between private replacement rate and subjective well-being. The results indicate that financial security exerts a statistically significant positive effect on subjective well-being, with a coefficient of 0.449 ($p < 0.01$). In contrast, once financial security is introduced into the model, the direct effect of private replacement rate on subjective well-being becomes statistically insignificant ($0.003, p > 0.1$). This suggests that the influence of the private replacement rate on subjective well-being operates primarily through financial security, with no remaining direct effect once this mediating pathway is accounted for.

Control Variables Absolute and relative income both show consistent positive associations with financial security and SWB, reaffirming the role of income in enhancing life satisfaction. Education and age are also positively linked to SWB. Gender effects are more complex: being male is associated with higher financial security but lower well-being, potentially reflecting gendered expectations and emotional orientations.

The residual variables are orthogonalized to remove shared variance with the historical inflation instrument, allowing us to examine their unique contribution to the outcomes. Trust shows no significant effect on pension design or financial security but has a small, significant positive effect on subjective well-being ($0.011, p < 0.01$). This suggests trust acts as an independent contributor to well-being, not as a mediator or confounder, but as a meaningful control reflecting interpersonal or cultural context. The residual component of welfare state spending is strongly negatively associated with private replacement rates ($-3.142, p < 0.01$), indicating that more generous welfare systems are linked to less pension funding. However, it does not directly influence individual-level security or well-being. Residuals for uncertainty avoidance and financial architecture explain variation in pension system design but are unrelated to individuals' financial security or well-being once the pension system is accounted for.

Quantifying the mediation effects To quantify the extent of mediation, the indirect effect of the private replacement rate on subjective well-being via financial security can be manually calculated as $0.013 \times 0.449 = 0.0065$ per 1 percentage private replacement rate. Given the observed maximum variation in the private replacement rate (45.6 percentage points) and in subjective well-being scores (7 points), the predicted variation in well-being attributable to the

mediated effect is approximately $\frac{45.6 \times 0.0065}{7} = 0.032$, or roughly 3% of the observed well-being range. The direct effect of private replacement rate in contrast, lacks statistical significance (0.002, $p > 0.1$).

The bootstrapping method in Table 9 further confirms the size and significance of the indirect effect. The proportion of the total effect mediated by financial security—computed as the indirect effect divided by the total effect (0.0060/0.0083)—is 72%. This finding underscores the crucial role of financial security as the primary transmission channel through which pensions enhance subjective well-being. The manual derived results are confirmed in Table 9, which reports the results from the nonparametric bootstrapping method. The indirect effect is statistically significant ($p = 0.002$), and the proportion mediated is 67%, with weak significance ($p = 0.054$), as is the total effect. The direct effect is non-significant.

These results underscore the importance of the causal pathway, revealing that the majority of the impact of pension assets on well-being operates through financial security, thus reinforcing its pivotal role in enhancing individuals' overall life satisfaction. The indirect (mediated) effect dominates whereas the direct effect remains negligible.

Table 9: Nonparametric Bootstrap Confidence Intervals Individual-level

Effect	**Estimate**	**95% CI Lower**	**95% CI Upper**	**p-value**
Indirect Effect	0.0057	0.00	0.01	0.002 ***
Direct Effect	0.0028	−0.00	0.01	0.50
Total Effect	0.0084	0.00	0.01	0.054 *
Prop. Mediated	0.6728	-0.32	4.42	0.052 *

Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Confidence intervals are derived from nonparametric bootstrap with the percentile method.
Sample size = 2241
Simulations = 2000

8.3 Financial security, ageing and trust

The preceding analysis has highlighted the key role of perceived old-age financial security in linking pensions to well-being. This section examines how pension-related factors shape cross-country differences in financial security.

From a lifecycle perspective, rational, forward-looking individuals base their well-being not just on current income, but on expected lifetime consumption and its perceived uncertainty. Pensions are critical to this outlook, especially given the anticipated absence of labor income after retirement. Confidence in pensions depends not only on replacement rates as such, but also on the perceived reliability of these pension promises in light of demographic pressures and institutional trust. In the motivation for Hypothesis 3 of the problem set, we identified two key mechanisms that shape post-retirement financial security. First, the **Ageing Discount Effect** – In ageing societies, rising dependency ratios may lead individuals to discount future pension benefits—especially in PAYG systems reliant on future contributions, but also in funded schemes, where capital abundance may depress future market return. Both routes can erode

perceived financial security. Second, the **Confidence Effect** – High levels of interpersonal trust mitigate concerns about pension sustainability. In high-trust societies, individuals are more likely to believe that pension promises—public or private—will be fulfilled, even under demographic and fiscal strains.

We expect PAYG pensions to be more vulnerable to ageing-related pessimism, especially in low-trust environments. Regarding funded pensions, we expect that trust is the dominant factor compared to ageing discounting effect.

Empirical Results We test these mechanisms with the country-level dataset. We estimate interaction models where financial security (FS) is regressed on either public or private replacement rates, ageing (the projected rise in the dependency ratio over the period 2020–2080), and interpersonal trust, including two-way and three-way interaction terms. Results are summarized in Table 10, comparing models for public (columns 1–2) and private (columns 3–4) pensions. We use the trust_residual variable to represent trust, as both trust and the replacement rates share a common influence from historical inflation.

The regression results provide strong empirical support for both the Ageing Discount Effect and the Confidence Effect as hypothesized.

Ageing Discount Effect In Models (1) and (3), the main effect of Ageing is significantly negative (–0.494 and –0.490), indicating that increasing dependency ratios are associated with lower perceived financial security in old age. This supports the notion that individuals in higher ageing societies are more pessimistic about the sustainability of pension promises, especially when demographic pressure increases. For PAYG systems, this effect is intensified through interaction: the term PAYG_RR $\times$ Ageing in Model (2) is negative and highly significant ($-0.014, p < 0.01$), confirming that the perceived value of PAYG pensions declines more steeply in ageing contexts. Conversely, in funded systems, PrivateRR $\times$ Ageing in Model (4) is positive and significant (0.014), suggesting that higher funded replacement rates may buffer against ageing-induced insecurity—likely due to the visible accumulation of pension assets.

Confidence Effect The main effect of Trust is consistently positive and significant across Models (1), (3), and (4), confirming its strong role in bolstering perceived financial security. However, interaction effects tell a more nuanced story. In Model (2), PAYG_RR $\times$ Trust is insignificant, but the three-way interaction PAYG_RR $\times$ Ageing $\times$ Trust is significantly negative ($-0.001, p < 0.01$). This suggests that trust alone does not offset the ageing discount in PAYG systems; instead, in high-trust environments, the negative impact of ageing may even be more salient due to heightened awareness of intergenerational imbalances. For funded pensions, the three-way interaction PrivateRR $\times$ Ageing $\times$ Trust is significantly positive ($0.001, p < 0.01$), indicating that in high-trust societies, the negative ageing effect on financial security in funded systems is fully neutralized or even reversed.

Table 10: Drivers of Financial Security in Old Age – Ageing and Trust

	Dependent variable: Financial Security Old Age			
	(1)	(2)	(3)	(4)
PAYG_RR	−0.096***	0.283**		
	(0.030)	(0.110)		
PrivateRR			0.149***	−0.358***
			(0.025)	(0.111)
Ageing	−0.494***	0.252	−0.490***	−0.785***
	(0.085)	(0.215)	(0.066)	(0.097)
Trust	0.363***	−0.686	0.369***	0.808**
	(0.046)	(0.686)	(0.042)	(0.317)
PAYG_RR × Ageing		−0.014***		
		(0.004)		
PAYG_RR × Trust		0.020		
		(0.014)		
PrivateRR × Ageing				0.014***
				(0.003)
PrivateRR × Trust				−0.025**
				(0.010)
PAYG_RR × Ageing × Trust		−0.001**		
		(0.0005)		
PrivateRR × Ageing × Trust				0.001***
				(0.0004)
Constant	44.683***	25.593***	37.341***	45.662***
	(1.785)	(5.643)	(2.129)	(2.810)
Observations	144	144	144	144
Adjusted R^2	0.693	0.719	0.735	0.779

Note: Ageing stands for the increase in the dependency ratio over the period 2020–2080. *Trust* refers to *trust_residual*.

*p<0.1; **p<0.05; ***p<0.01

The positive sign for PAYG_RR in Model (2) and the negative sign for PrivateRR in Model (4) represent conditional effects, meaning that these effects depend on the values of the interacting variables, ageing and trust.

Final The findings align well with the theoretical expectations: PAYG pensions are especially vulnerable to high ageing pessimism, and trust offers limited protection in such cases. Funded pensions, in contrast, benefit from trust: they are seen as more resilient in ageing societies, and individuals place greater confidence in their ability to deliver future benefits. These results emphasize that pension security perceptions are shaped by the interaction of demographic trends, pension institutions, and trust.

9 Robustness

We have tested the validity of the hypothesized causal link between pensions and well-being at both the country level and the individual level. The joint use of these two datasets serves already as an internal robustness check, strengthening the overall reliability of our findings.

This section presents two additional robustness checks within the country-level framework. First, we assess the stability of results when using the full set of WHR (World Happiness Report) covariates. Second, we evaluate the explanatory power of pension assets as an alternative pension indicator.

WHR covariates – Do our findings remain robust when incorporating WHR covariates? These covariates have been developed over time and demonstrate high explanatory power in relation to the WHR well-being index (Helliwell et al., 2023). To test this, we re-run the baseline regressions from our causal mediation analysis, now including WHR covariates. The results are presented in Table 11, which replicates the base regressions of the causal mediation analysis through Models (1)–(3). Model (4) presents Model (3) without pension variables, including only WHR covariates.

We observe from Table 11 that the hypothesized causal relationship from pensions to well-being remains intact. The instrument remains highly significant, confirming its strong predictive power. Private pensions continue to positively influence well-being via the mediating role of financial security. The relative impact size of private pensions on well-being is lower when using WHR covariates compared to our original model, around 1/3 of the effect with our controls. Compared to Model (3), Model (4) excludes pension-related variables, resulting in a nearly 1 percentage point drop in explained adjusted R^2. This decline suggests that pension system characteristics contribute significantly to explaining cross-country differences in well-being.

While causal mediation analysis uncovers the pathway from pensions to well-being via financial security, it does not address the relative explanatory power of pension system characteristics compared to other well-being determinants. To assess this, we apply a Shapley value decomposition of the model's R^2, which attributes explained variance to individual regressors and covariate groups. This allows us to evaluate the marginal contribution of pension variables—relative to established WHR covariates such as income, social support, health, and trust. The results, presented in Appendix A.3, show that pension-related variables account for approximately 17%

of the explained variance in subjective well-being, even after controlling for the full WHR set. This underscores that pension financing structures are not only causally meaningful, but also substantively important in explaining cross-country variation in well-being.

Table 11: Causal Mediation Analysis with WHR Covariates

	Dependent variable:			
	Private RR	Financial Security Old Age	SWB_WHR	SWB_WHR
	(1)	(2)	(3)	(4)
Financial Security Old Age			0.011**	
			(0.005)	
Private Replacement Rate		0.178***	0.0001	
		(0.036)	(0.002)	
INF 1919–1940	−0.943***	−0.664***	−0.004	
	(0.326)	(0.141)	(0.009)	
log GDP capita	3.423	0.275	0.525***	0.546***
	(5.978)	(2.518)	(0.152)	(0.155)
Social Support	−27.053	−0.094	3.176***	3.395***
	(37.834)	(15.947)	(0.965)	(0.967)
Healthy Life Expectancy	−3.385***	−0.906**	0.025	0.001
	(0.775)	(0.348)	(0.022)	(0.020)
Freedom Life Choices	8.122	14.938**	1.302***	1.436***
	(16.258)	(6.846)	(0.422)	(0.421)
Generosity	43.609***	−12.192***	0.463*	0.559**
	(9.290)	(4.213)	(0.263)	(0.225)
Corruption	8.567	−16.470***	−0.643***	−0.843***
	(7.161)	(3.029)	(0.202)	(0.185)
Constant	231.338***	83.481**	−4.538**	−2.960
	(76.025)	(33.055)	(2.048)	(1.973)
Observations	144	144	144	144
R^2	0.464	0.638	0.777	0.763
Adjusted R^2	0.437	0.617	0.762	0.752

*p<0.1; **p<0.05; ***p<0.01

Pension assets relative to GDP – In Table 12, we replace our primary explanatory variable, private replacement rate, with pension assets held by countries. The results remain consistent with previous mediation findings, confirming that funded pensions influence well-being primarily through financial security as the key transmission mechanism. However, the overall effect of pension assets on well-being appears weaker than that of private replacement rates.

This is understandable as pension assets are a less precise indicator of the role of funded pensions in individuals' well-being for two reasons. First because of plan maturity. Pension assets reflect both the size of private replacement rates and the maturity of the pension system. Newly established pension plans will naturally have lower asset levels compared to long-

standing, mature plans, making cross-country comparisons more complex. Second because of market volatility. Pension assets are subject to fluctuations in financial markets, leading to year-to-year short-term variations that may not accurately reflect the stability or adequacy of pension benefits for individuals. Thus, while pension assets relative to GDP provide useful macroeconomic insights, the private replacement rate remains a more reliable measure of how funded pensions contribute to individuals' financial security and well-being.

Table 12: Causal Mediation Analysis with Pension Assets Relative to GDP as explanatory variable

	Dependent variable:		
	Pension Assets GDP	Financial Security in Old Age	SWB (WHR)
	(1)	(2)	(3)
Financial Security in Old Age			0.036^{***}
			(0.010)
Pension Assets GDP		0.041^{***}	-0.002
		(0.008)	(0.001)
Inflation 1919–1949	-12.919^{***}	-0.843^{***}	-0.021
	(1.197)	(0.150)	(0.019)
Controls	Y	Y	Y
Observations	144	144	144
Adjusted R^2	0.605	0.820	0.590

Note: This table presents the results of a causal mediation analysis where pension assets relative to GDP replace the private replacement rate as the key explanatory variable.

*p<0.1; **p<0.05; ***p<0.01

Fixed effects robustness check — To ensure that our results are not driven by within-country changes over time, we estimate a fixed effects panel model covering the 18 countries over the period 2009–2023. This model controls for all time-invariant country characteristics and focuses solely on within-country variation. The results, reported in Appendix A.4, show that changes in public pension generosity are significantly associated with changes in subjective well-being. In particular, increases in public replacement rates are consistently linked to higher well-being, while cuts tend to reduce well-being.

Taken together, the causal mediation analysis (CMA) and fixed effects (FE) models present a coherent narrative: private and public pensions influence well-being structurally through their perceived security, while public pensions affect well-being dynamically through policy changes in generosity over time.

10 Discussion

Policy implications — Leading scholars in the well-being field, including Layard (2006) and Clark (2018), emphasize the importance of integrating well-being research into the design of public policies and institutional frameworks. Our findings indicate that increasing the role of funded

pension systems—while reducing reliance on pay-as-you-go (PAYG) arrangements—could enhance overall well-being. However, implementing such a transition is far from simple. Moving from PAYG to a funded system involves the so-called double burden dilemma: the working population must simultaneously finance the pensions of current retirees while saving for their own future benefits. Consequently, replacing PAYG with funding cannot be done without imposing significant costs on one or more generations (Feldstein, 2005; Sinn, 2000).

As a result, countries with predominantly PAYG systems must accept pensions-induced lower levels of subjective well-being as they have limited reform options. The most viable approach is to introduce parametric adjustments that equitably distribute the ageing burden across generations—such as raising the retirement age, reducing benefit levels, or building an ageing reserve through partial pre-funding.

Variation in the impact of pensions on well-being - Empirical findings from both country-level and individual-level analyses confirm that financial security is the primary channel through which pensions affect subjective well-being. The country-level results remain robust when including the control variables used in the World Happiness Report (WHR).

Notably, we observe differences in the magnitude of the estimated mediation effects across levels of analysis. At the individual level, the mediation effect accounts for approximately 4% of the variation in subjective well-being, while country-level data indicate a substantially larger effect size—ranging from 13 to 14%. These discrepancies are expected due to differences in data aggregation and the nature of the effects being captured. Country-level analyses reflect macroeconomic structures and institutional design, whereas individual-level analyses also capture personal experiences and subjective perceptions. National averages in country-level data also remove the noise of individual differences, leading to clearer patterns—and possibly resulting in stronger average effects.

Despite these differences in magnitude, both approaches consistently support the same conclusion: financial security is the key mediator linking pension systems to well-being. The variation in effect sizes is methodological, not conceptual, and reflects differences in data structure and analytical perspective.

11 Conclusion

This study is the first to analyze whether there is a causal link between the financial structure of national pension systems and subjective well-being, addressing a largely overlooked dimension in well-being research. Using a causal mediation framework, we provide empirical evidence that pension systems influence well-being primarily through their effect on perceived financial security in retirement.

Our findings indicate that greater reliance on private, funded pension arrangements enhances individuals' financial security, which in turn contributes positively to well-being. In contrast, pension systems that depend heavily on PAYG financing are associated with lower perceived financial security and, consequently, reduced well-being. Cross-country differences in financial security can be explained by two key mechanisms: the ageing-discount effect, which undermines the long-term perceived value of both PAYG and funded pensions; and the trust-based confi-

dence effect, which helps mitigate ageing-related concerns. In funded plans, the confidence effect is stronger than the ageing-discount effect, indicating that trust can offset demographic concerns and bolster perceived pension security. In contrast, PAYG pensions appear more vulnerable to ageing pressures and less responsive to trust, likely due to their political character.

These findings reinforce the interpretation of financial security as a subjective filter through which individuals assess the sufficiency and reliability of their pensions. While replacement rates offer objective measures of adequacy, their influence on well-being is mediated by how trustworthy pension promises appear in light of demographic trends and institutional trust. The consistency of these results across both country-level and individual-level analyses reinforces their relevance for policy.

Additionally, we found that within-country variation in public pension generosity over time—due, for example, to pension reforms—may lead to changes in national well-being.

More broadly, our findings highlight the crucial role of pension institutions in shaping financial security and life satisfaction. Given their material importance over the life course, pension systems warrant a more prominent place in the academic literature on subjective well-being.

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A Appendix

A.1 Testing the exclusion restriction

This section formally assesses whether our instrument—historical inflation—satisfies the exclusion restriction. We apply three tests.

Reduced-form Column [1] of Table 13 reports a reduced-form regression of subjective well-being on the instrument and covariates, including perceived financial security. The coefficient on historical inflation is small and statistically insignificant, suggesting no direct effect on well-being once the mediator is accounted for. This supports—but does not prove—the exclusion restriction.

Table 13: Reduced-form Regression: Subjective Well-Being (SWB) and Historical Inflation

	SWB_WHR
Inflation 1919–1940	−0.015 (0.011)
Financial Security (Old Age)	0.026^{***} (0.005)
log GDP per capita	1.357^{***} (0.160)
Constant	-8.328^{***} (1.708)
Observations	144
Adjusted R^2	0.580

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Inflation persistency A potential challenge to the exclusion restriction is that historical inflation could affect present-day well-being through channels such as persistent inflation expectations, beyond its effect on pension system design. To evaluate this, we test for long-term inflation bias by examining OLS regressions between pre- and post-WWII inflation rates. While coefficients are statistically significant, the adjusted R^2 values remain below 8%, indicating weak economic relevance. This suggests that historical inflation is better viewed as a historically specific shock rather than a proxy for persistent inflationary regimes, reinforcing its plausibility as an exogenous instrument.

Table 14: Effect of Interwar Inflation on Postwar Inflation

	Dependent variable:		
	Inflation 1950-2020	Inflation 1990-2020	Inflation 1950-2020
	(1)	(2)	(3)
Inflation 1919-1940	0.077^{***}	0.032^{***}	0.114^{***}
	(0.026)	(0.009)	(0.041)
Constant	4.072^{***}	2.006^{***}	5.647^{***}
	(0.131)	(0.047)	(0.207)
Observations	144	144	144
Adjusted R^2	0.053	0.073	0.046

Note: *p<0.1; **p<0.05; ***p<0.01.

Instrumental Variable Analysis To formally assess instrument validity, we estimate a two-stage least squares (2SLS) model using historical inflation (1919–1940) as an instrument for perceived financial security in old age, compare Table 15. The first-stage regression confirms the relevance condition: historical inflation is a strong negative predictor of financial security (-1.526, $p < 0.01$), with a first-stage F-statistic of 64.8, well above the conventional threshold of 10. In the second stage, predicted financial security is positively associated with well-being (0.037, $p < 0.01$), supporting the hypothesis that pension system characteristics affect well-being primarily through their impact on perceived security.

Instrument diagnostics further strengthen the case: the weak instrument test confirms relevance, the Wu-Hausman test does not reject exogeneity (p = 0.571), and the Sargan test suggests no violation of overidentifying restrictions (p = 0.844). Taken together, these results provide robust support for the mediation pathway from pension design to well-being via financial security.

Table 15: IV Estimation: The Effect of Financial Security on Subjective Well-Being

	First Stage: FinSec	**Second Stage: SWB**
Historical Inflation (1919–1940)	-1.526^{***}	–
	(0.135)	
Financial Security	–	0.037^{***}
		(0.010)
log GDP per capita	2.034	1.308^{***}
Control Variables	Yes	Yes
First-stage F-statistic	64.8	
Weak instruments (p-value)	0.000	
Wu-Hausman (p-value)	0.571	
Sargan (p-value)	0.844	

Note: $^{***}p < 0.01$; robust SEs in parentheses. Controls included but not reported.

A.2 Additional Regression: Public Replacement Rate

To complement the analysis of private pensions in Section 8, we replicate the mediation framework using the public replacement rate as the main explanatory variable. The structure of Tables 16 and 17 mirrors that of the earlier analysis, but with the public pension component replacing the private one. Results are presented both at the country level and the individual level, Tables 16 and 17 respectively.

At both levels of analysis, a greater reliance on public (PAYG) pensions is associated with lower financial security, in contrast to the positive relationship observed for private pensions. The indirect pathway from public pensions to subjective well-being is therefore negative. The direct relationship between public pensions and well-being is small and statistically insignificant.

These results support the hypothesis that heavily PAYG-based systems—despite offering formal replacement income—are perceived as less financially secure, possibly due to concerns over political risk, demographic pressures, or limited individual ownership. The control variables

used in the main specification (e.g., GDP per capita, education, trust, income) are included in all models but are not shown here to enhance readability (Controls: Y Y Y).

Table 16: Causal Mediation Analysis with Public Replacement Rate at the *country* level

	Dependent variable:		
	Public Replacement Rate	Financial Security in Old Age	SWB (WHR)
	(1)	(2)	(3)
Financial Security in Old Age			0.047***
			(0.011)
Public Replacement Rate		−0.200***	0.005
		(0.029)	(0.004)
Inflation 1919-1940	1.883***	−1.153***	0.006
	(0.326)	(0.121)	(0.021)
Controls	Y	Y	Y
Observations	144	144	144
Adjusted R^2	0.744	0.864	0.609

*p<0.1; **p<0.05; ***p<0.01

Table 17: Causal Mediation Analysis with Public Replacement Rate at the *individual* level

	Dependent variable:		
	Public Replacement Rate	Financial Security in Old Age	SWB
	(1)	(2)	(3)
Financial Security in Old Age			0.452***
			(0.024)
Public Replacement Rate		−0.011***	0.004
		(0.004)	(0.004)
Inflation 1919-1940	2.459***	−0.023**	−0.012
	(0.036)	(0.011)	(0.012)
Controls	Y	Y	Y
Observations	2,241	2,241	2,241
Adjusted R^2	0.889	0.108	0.219

*p<0.1; **p<0.05; ***p<0.01

A.3 WHR covariates with and without pension variables: Shapeley's decomposition of R2

Shapley Decomposition Analysis – To further evaluate the explanatory contribution of pension system characteristics relative to the strong set of standard WHR covariates, we conducted a Shapley value decomposition of the R^2 in the model with WHR covariates and pension variables, i.e. private and public replacement rates and and financial security in old age. The

results confirm the added value of pensions in explaining international differences in subjective well-being, even when controlling for the full set of WHR covariates.

In the model with pension replacment rate variables and financial security old age, pension variables account for a meaningful share of explained variance: 10.8% for financial security, 3.2% for private replacement rates, and 3.7% for public replacement rates. Together, pension-related variables contribute almost 17% to total model explanatory power. In contrast, when pension variables are excluded and only WHR variables are retained, the model's adjusted R^2 declines by more than two percentage points, and the total variance explained drops from 80.3% to 76.3%.

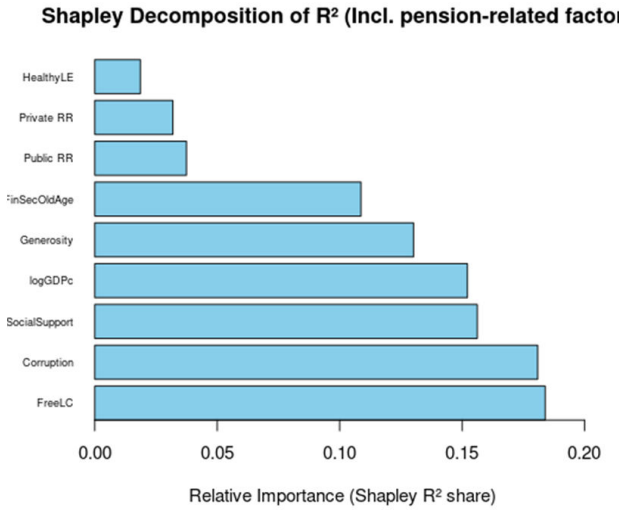

Figure 6: Shapley's decomposition of R^2, with pension-related variables

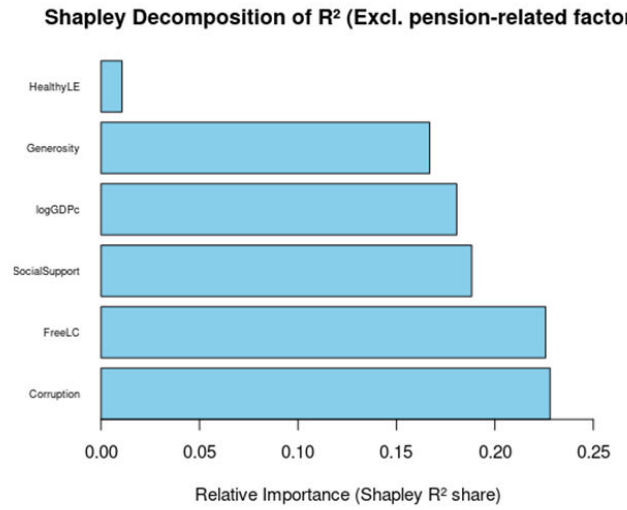

Figure 7: Shapley's decomposition of R^2, without pension-related variables

A.4 Fixed Effects Panel Model: Capturing Within-Country Dynamics

To assess the robustness of our findings and mitigate potential bias from unobserved, time-invariant country characteristics, we estimate a fixed effects (FE) panel model including public and private replacement rates, welfare effort, retirement age, and the old-age dependency ratio. The FE approach isolates within-country changes over time, controlling for stable national factors that could otherwise confound cross-country comparisons.

Table 18 shows that the public replacement rate is a robust and significant predictor of within-country changes in well-being ($\beta = 0.020$, $p < 0.01$), even after adjusting for structural controls. In contrast, private replacement rates are not statistically significant in this specification. Control variables such as perceived financial security, trust, financial architecture, and central bank independence were excluded due to limited within-country variation.

Figure 8 illustrates the relationship between changes in public pension generosity and changes in subjective well-being from 2009 to 2023. Countries that expanded generosity—most notably Portugal, Finland, and France—also recorded notable improvements in well-being. Conversely, countries such as Canada, Switzerland, and the United States reduced generosity and experienced corresponding declines. The strong positive correlation ($R = 0.68$, $p = 0.0017$) suggests that public pension generosity and well-being tend to move in tandem over time. Private pension generosity remained largely stable, consistent with its non-significance in the FE model.

At first glance, these findings may seem at odds with the causal mediation analysis (CMA), which showed that private pensions enhance well-being by increasing perceived financial security, while public pensions lower it. However, the CMA captures structural, cross-country differences, whereas the FE model isolates dynamic, within-country effects of policy change over time.

Thus, while public pensions are perceived as less secure (CMA), actual increases or decreases in generosity tend to be mirrored by changes in well-being (FE model).

Taken together, the CMA and FE results present a coherent narrative: private and public pensions shape well-being structurally via perceptions of security, while public pensions also exert dynamic influence via policy reforms.

Table 18: Fixed Effects Panel Model, 2009–2023 (Within Estimator)

Variable	**Coefficient**	**Std. Error**	**Significance**
Private Replacement Rate	0.006	0.007	n.s.
Public Replacement Rate	0.020	0.006	***
log GDP per capita	1.350	0.220	***
Welfare State (residual)	0.064	0.039	n.s.
Retirement Age	–0.026	0.043	n.s.
Dependency Ratio	0.006	0.020	n.s.
Observations	144		
R^2	0.317		
Adj. R^2	0.179		
F Statistic	7.888 *** (df = 7; 119)		

Note: *** p < 0.01; n.s. = not significant

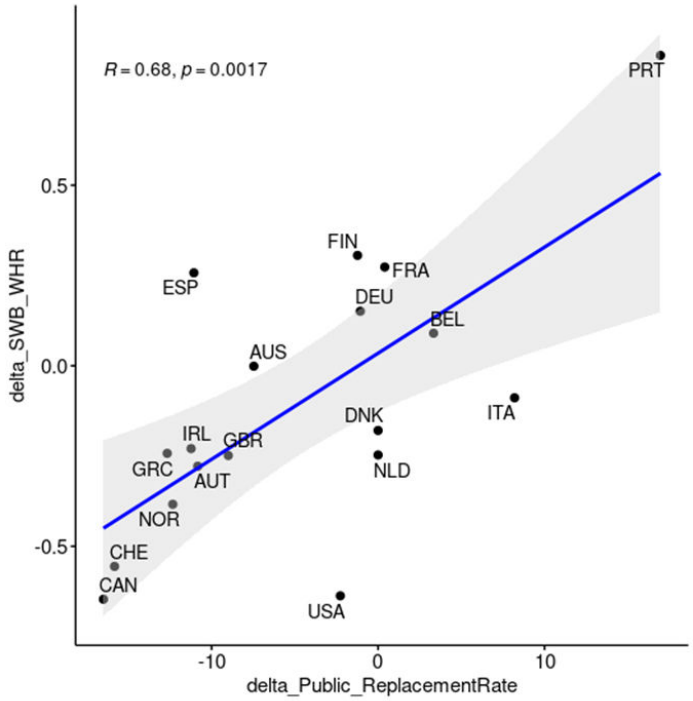

Figure 8: Change in Public Replacement Rate and Change in Subjective Well-being, 2009–2023. Countries with increasing public pension generosity tend to experience improvements in subjective well-being, and vice versa.