Structural and Demographic Predictors of Voluntary Pension Participation: Evidence from the Baltic States

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Abstract.

Voluntary private pensions play a growing role in supplementing public retirement systems, yet participation remains markedly unequal. While most research emphasizes behavioral and informational drivers, this study examines how structural and demographic characteristics shape voluntary pension engagement in Estonia, Latvia, and Lithuania. Drawing on social stratification theory, we focus on individuals already aware of retirement planning needs, thereby isolating structural exclusion from informational deficits. Using 2023 OECD/INFE survey data and logistic regression models, we find that higher income, education, urban residence, and self-employment significantly increase the likelihood of pension ownership, while unemployment, economic inactivity, and residence in Latvia or Lithuania reduce it. These findings contribute to the statistical measurement of long-term financial inclusion and highlight how socio-economic position and institutional context jointly structure access to retirement instruments. The results carry implications for evidence-based pension reforms, regional policy design, and sustainable economic planning in post-socialist EU member states.

Keywords: Voluntary pensions, social stratification, financial inclusion, post-socialist welfare, Baltic countries

1 Introduction

Ensuring adequate retirement income has become increasingly complex amid demographic ageing, labour market flexibilization, and fiscal pressures on state-based pension systems. In response, voluntary private pension schemes have gained policy prominence as supplementary tools to enhance retirement adequacy and reduce long-term financial vulnerability. Yet uptake remains uneven and often regressive—especially in post-socialist societies, where institutional trust, financial infrastructure, and social security reforms are still evolving. Understanding who participates in voluntary pensions, and under what conditions, is essential for addressing retirement inequality and ensuring inclusive financial sustainability.

Existing research on pension participation has largely centred on behavioural explanations. Life-cycle hypotheses [1], financial capability frameworks [2], and behavioral economics interventions [3] highlight the roles of intention, information, and psychology in shaping savings behaviour. While these perspectives have advanced microeconomic understanding, they often understate the structural and institutional barriers that mediate individuals' access to pension instruments. In particular, socio-economic conditions such as income security,

employment formality, and educational attainment—alongside national policy designs—remain underexplored as determinants of engagement in private pension schemes.

This study addresses that gap by reframing voluntary pension participation as a structurally conditioned outcome. Drawing on social stratification theory [4,5], we examine how demographic and socio-economic characteristics—including income, education, employment status, household composition, and urban–rural residence—affect participation in voluntary pensions. Using harmonized data from the 2023 OECD/INFE Financial Literacy Survey, we estimate logistic regression models on a cross-national sample from Estonia, Latvia, and Lithuania. Our focus is on individuals who already report awareness of retirement planning, enabling us to isolate structural exclusion from purely informational deficits. We situate this inquiry within the Baltic states—Estonia, Latvia, and Lithuania—where market-oriented pension reforms have advanced formal access, yet real engagement remains fragmented and socially stratified.

This context offers a valuable setting for studying institutionalised inequality. Despite shared post-socialist legacies and EU membership, the three countries exhibit diverging pension designs, welfare mixes, and financial policy interventions. These differences allow for a comparative analysis of how national policy structures mediate the impact of individual-level resources on financial inclusion. Moreover, the Baltic region is facing acute ageing pressures, making it a timely case for evaluating long-term planning capacity and economic sustainability through statistical indicators.

We use harmonised microdata from the 2023 OECD/INFE Financial Literacy Survey and estimate logistic regression models to assess structural predictors of voluntary pension ownership. This approach provides a comparative, evidence-based lens for understanding socio-economic disparities in retirement planning across diverse institutional contexts. By incorporating spatial and demographic variables, the analysis captures how regional and systemic differences mediate financial inclusion in ageing societies. The results offer actionable insight for designing targeted policy interventions to enhance equitable access to long-term financial instruments.

This study contributes to the literature in three key ways. First, it reconceptualises voluntary pension participation as a stratified outcome shaped by embedded socio-economic positions, rather than merely behavioural choice. Second, it extends stratification theory by showing how national policy contexts condition the effects of individual-level characteristics—highlighting the institutional shaping of financial outcomes. Third, it introduces comparative statistical evidence from the Baltic states, illustrating how different reform paths and spatial inequalities structure pension uptake within a shared regional framework.

The paper is organised as follows. Section 2 reviews the literature on voluntary pensions and socio-economic stratification. Section 3 outlines the data and methods, including model specifications. Section 4 presents the empirical results. Section 5 discusses the findings in light of theoretical and policy implications. Section 6 concludes with recommendations and directions for future research.

2. Literature review

2.1 Stratification Theory and Pension Engagement

Voluntary pension engagement—the act of contributing to non-mandatory retirement savings schemes—has often been framed through microeconomic models of behaviour, rational planning, and individual agency. The Life-Cycle Hypothesis [1] remains the dominant paradigm, positing that individuals optimize consumption and savings across life stages. Building on this foundation, research has explored how factors such as age, income, and employment stability influence savings behaviour over the life course [6,7]. A complementary strand highlights the role of financial literacy and cognitive capacity, with Lusardi and Mitchell [2], demonstrating how knowledge gaps constrain long-term financial planning.

While insightful, these behavioural approaches tend to decontextualize financial decision-making, underplaying the structural conditions that constrain access to financial tools. In voluntary pension systems, which require discretionary income, awareness, and trust in institutions, engagement is not solely a function of individual preference or information, but is also shaped by one's position within socio-economic hierarchies [8]. This recognition motivates a shift from behavioural models toward a stratification-based framework that accounts for the distribution of economic and institutional resources.

Stratification theory conceptualises societies as structured by persistent inequalities in education, income, occupation, and geography—dimensions that influence both opportunity and exposure to financial instruments [4,5]. These factors are deeply embedded in labour markets and institutional settings, mediating who has access to risk-mitigation mechanisms such as private pensions [9]. High-income, securely employed individuals are more likely to receive employer contributions, benefit from tax incentives, and possess the financial surplus necessary for pension saving [10]. In contrast, those in precarious or informal employment—often younger, lower-income, or rural populations—face structural exclusion from voluntary pension systems [11].

Although recent work has explored structural inequality in broader domains of financial inclusion [12,13], its application to voluntary pension engagement remains limited [14]. This gap is particularly salient in post-socialist contexts, where welfare state restructuring, institutional volatility, and spatial disparities complicate the landscape of retirement planning [15]. Empirical studies continue to be disproportionately concentrated in high-income Western and Nordic countries [16,17], where pension systems are more mature and structurally inclusive.

In Central and Eastern Europe—and the Baltic states in particular—voluntary pension systems have evolved amid rapid financial reform, fragmented policy implementation, and uneven labour market outcomes [18]. These conditions generate stratified access to long-term financial planning tools and make the region a critical but under-studied context for examining how structural inequality shapes engagement in voluntary pension saving. This study addresses that gap by applying stratification theory to a regional comparative framework, using individual-level survey data and statistical modelling to measure socio-economic exclusion from private pension participation.

2.2 Pension System Context in the Baltic States

Since the early 1990s, pension systems across Europe have undergone extensive reform in response to ageing populations, labour market flexibilization, and fiscal pressures. In Western

and Nordic countries, these changes typically involved gradual adjustments—layering voluntary and occupational pillars onto robust public systems [19]. In contrast, reform trajectories in Central and Eastern Europe (CEE) were more abrupt and externally influenced, often guided by the World Bank's three-pillar model promoting diversification across public, mandatory funded, and voluntary private schemes [20].

Within this regional landscape, the Baltic states—especially Estonia and Latvia—emerged as early and comprehensive adopters of systemic pension reform. In the late 1990s and early 2000s, they introduced mandatory funded second pillars and established legal frameworks for voluntary private savings, reflecting a more liberalized and market-oriented approach than seen in many neighbouring countries [21]. For example, Hungary, the Czech Republic, and Slovenia adopted more cautious or politically contested reforms, often retaining stronger state oversight and delaying the expansion of voluntary pillars [22].

While Baltic countries share a common post-socialist legacy and similar demographic pressures, their reform trajectories and institutional architectures have diverged meaningfully—particularly in the structure and accessibility of voluntary pension schemes [23]. In all three states, the first pillar remains a mandatory PAYG scheme, providing a basic public pension financed through social security contributions. In line with broader European trends, statutory retirement ages have been gradually raised and indexed to life expectancy [24]. However, significant divergence emerges in the design of the second and third pillars.

Estonia and Latvia introduced mandatory funded second-pillar schemes early, channeling a portion of payroll taxes into privately managed individual accounts. These systems include elements of choice, allowing participants to select among fund managers and investment strategies [21]. Lithuania adopted its second-pillar system later and with more caution, incorporating features of both mandatory and voluntary participation under more centralized oversight [25].

Voluntary third-pillar pensions—comprising tax-incentivized private savings—are formally available in all three countries but differ in generosity and uptake. Latvia offers comparatively robust tax deductions for contributions, while Estonia and Lithuania have provided weaker or more inconsistent incentives. Consequently, voluntary pension engagement remains limited and socio-economically skewed across the region. Estonia leads in per-participant asset accumulation, followed by Latvia and Lithuania, though all three exhibit low coverage and substantial inequality in participation rates [26].

These variations are theoretically significant. While behavioural models might predict uniform savings patterns across countries with similar economic profiles, the institutional heterogeneity of the Baltic states offers a natural laboratory for testing how policy structures condition the returns to individual socio-economic capital. In this sense, the region serves not just as an empirical setting but as a critical testbed for stratification theory in the domain of financial inclusion. Institutional differences—whether in tax policy, fund governance, or market liberalization—may amplify or dampen the effects of income, employment, or education on pension engagement.

The diversity in institutional design across the Baltic states underscores the importance of contextualizing individual behavior within national policy environments. While all three countries share a post-socialist legacy, their divergent approaches to pension reform and the degree of market liberalization may shape both awareness and opportunity structures for voluntary pension engagement. These institutional differences support the expectation, that

country of residence will significantly influence the likelihood of pension participation, even when controlling for individual-level structural factors.

These contextual and institutional differences—combined with enduring socio-economic inequalities—form the basis for the following hypotheses, which link individual-level structural characteristics and national policy environments to the likelihood of voluntary pension participation.

2.3 Hypotheses

Grounded in social stratification theory, this study examines how demographic and structural inequalities shape individual engagement with voluntary private pension products in the Baltic countries. Stratification theory posits that access to institutional resources—such as financial products, education, and employment—is unequally distributed based on one's social position [27,28]. These structural positions confer differential capacity to participate in long-term financial planning, such as voluntary pension schemes. From this perspective, we derive the following hypotheses concerning the socio-economic, spatial, and household-level factors that condition voluntary pension participation.

H1: Socioeconomic Stratification and Pension Engagement

Socioeconomic advantages are theorized to enhance pension engagement by improving both material capacity and exposure to formal financial institutions. Higher income enables discretionary long-term saving [29], while higher educational attainment increases awareness, trust, and competence in navigating pension products [30,31]. These advantages reinforce cumulative financial capability, particularly in liberalized pension systems where voluntary participation is not automatic [32,33]. Employment status further differentiates access to financial planning mechanisms: it reflects institutional embeddedness, income stability, and whether retirement benefits are accrued through employer channels [34,35]. While prior studies often use a simple employed–unemployed dichotomy, this study adopts a more granular categorization of employment status—including full-time, part-time, self-employed, unemployed, retired, and inactive groups—to better capture how labor market segmentation maps onto pension engagement.

- **H1a**: Individuals with higher income levels are more likely to engage in voluntary pension products.
- **H1b**: Individuals with higher levels of education are more likely to engage in voluntary pension products.
- **H1c**: Employment status is associated with the likelihood of voluntary pension participation.

H2: Demographic Stratification and Pension Engagement

Demographic characteristics also reflect stratification processes that shape access to long-term financial planning. Age, a key variable in life-cycle theories, is linked to savings behavior, though from a stratification perspective, older individuals may face reduced access due to early exclusion or declining institutional pathways [36,37]. Household composition—such as cohabitation with a partner or the presence of dependent children—can influence planning priorities and disposable income, creating shared or competing financial obligations that

shape engagement with pension systems [38]. Gender is a foundational axis of stratification, shaping lifetime income, employment continuity, and caregiving responsibilities—all of which affect pension participation. Women are more likely to experience career interruptions, part-time work, and lower wages, leading to reduced capacity for long-term financial planning. In liberalized pension systems where participation is voluntary, these structural disadvantages are expected to translate into lower engagement rates among women [39,40].

- **H2a**: Age is significantly associated with pension engagement.
- **H2b**: Living with a partner or dependent children is associated with a higher likelihood of pension engagement.
- **H2c**: Women are less likely than men to participate in voluntary pension schemes.

H3: Spatial and Institutional Stratification

In addition to individual-level factors, institutional and spatial environments shape opportunities for pension engagement. As outlined in Section 2.2, the Baltic states—while sharing a post-socialist legacy—have pursued divergent pension reform trajectories, particularly regarding the generosity and accessibility of voluntary third-pillar schemes. Estonia has offered earlier and more stable market-based structures; Latvia has emphasized tax incentives; Lithuania has adopted a more centralized and cautious approach [41]. These institutional variations structure the incentives, barriers, and normative expectations surrounding pension participation.

From a stratification perspective, such national policy differences interact with individuals' socio-economic positions to create varying opportunity structures. Country of residence thus serves as a proxy for institutional context. In addition, geographic location within countries may shape access to financial services and informational networks. Urban residents tend to have greater exposure to financial institutions, advisory services, and employer-linked pension schemes than their rural counterparts [42].

- **H3a:** Urban residents are more likely to participate in voluntary pension schemes than rural residents.
- **H3b:** Pension engagement significantly varies across Estonia, Latvia, and Lithuania.

The following section outlines the data, variables, and estimation strategy used to evaluate these relationships.

3. Methods

3. 1 Data and Sample

This study draws on microdata from the OECD/INFE 2023 International Survey of Adult Financial Literacy [43], a harmonized cross-national dataset coordinated by the OECD International Network on Financial Education. The data were obtained from the OECD/INFE through a formal research application process. Access to individual-level microdata was granted under strict confidentiality conditions. The dataset contains no personally identifiable information and is used solely for academic research. The survey measures financial

behaviors, knowledge, and attitudes, and includes standardized items on voluntary pension ownership.

The analysis focuses on Estonia, Latvia, and Lithuania—three post-socialist Baltic states that, while sharing institutional legacies, exhibit distinct pension reform trajectories. The survey employed probabilistic sampling stratified by age, gender, and geographic region to ensure national representativeness. Data collection was conducted via face-to-face interviews using computer-assisted personal interviewing (CAPI) protocols.

The initial sample included 3,071 adults aged 18 and over: 1,025 from Estonia, 1,027 from Latvia, and 1,019 from Lithuania. Exclusion criteria included item nonresponse or refusal on key independent variables such as employment status, income group, and education. This listwise deletion approach is widely recognized for enhancing internal validity and maintaining interpretability in multivariate estimation [44]. After exclusions, the final analytic sample consisted of 2,154 respondents, with balanced distributions across countries and demographic groups. Sampling weights provided in the dataset were applied in all analyses.

The dependent variable is a binary indicator of voluntary pension product ownership (Pension_Owner), coded 1 for respondents who report currently owning or having actively chosen a non-compulsory pension product, and 0 otherwise. Structural predictors include harmonized measures of age, gender, education, labor market status, income group, household composition, urbanicity, and country of residence.

A post hoc power calculation, using a baseline pension participation rate of 39% and an odds ratio of 1.2, indicated that the available sample size (N = 2,154) yields an estimated statistical power of 98.5% ($\alpha = 0.05$, two-tailed). This confirms the adequacy of the sample for detecting small-to-moderate structural effects in logistic regression models.

3.2 Variable Definitions

The dependent variable is defined as voluntary pension product ownership, based on OECD/INFE 2023 coding instructions. Only respondents who were aware of pension products (QP1_1 = “Yes”) and who indicated active holding of a non-compulsory pension or retirement product (QP2_1 = “Yes”) were coded as participants (1); others were coded as non-participants (0). Respondents unaware of pension products or with missing responses were excluded through listwise deletion.

Independent variables were selected based on social stratification theory, which emphasizes how structural positions—such as education, employment, and income—shape access to financial instruments. All variables were directly derived from the OECD/INFE dataset and harmonized to ensure comparability across the three Baltic states.

All variables were derived from the OECD/INFE dataset and harmonized according to official documentation and standard cross-national procedures [45], ensuring full comparability across Estonia, Latvia, and Lithuania. Age was grouped into eight ordinal bands ranging from 18–19 (coded 1) to 80+ (coded 8). Education was coded as an ordinal variable on a six-point scale from no formal education (1) to postgraduate level (6). Employment status was categorized into six groups: employed, self-employed, student, retired, unemployed, and other inactive. Subjective income adequacy was used to create within-country income tertiles (low, medium, high). Urbanicity was defined as a three-level categorical variable: rural (1), town (2), and urban center (3). Gender, presence of children under 18 (HH_Children), and cohabitation with a partner (HH_Partner) were coded as binary variables. Responses such as ‘don’t know,’

'refused,' or missing values were coded as system-missing and excluded from the analysis via listwise deletion.

Country was modeled using dummy variables for Latvia and Lithuania, with Estonia serving as the reference group. The other reference categories used in the regression models were: 'Employed' for employment status, 'Low' for income group, and 'Rural' for urbanicity. Table 1 below provides an overview of all variables used in the model, including coding schemes and source items from the OECD survey instrument.

Table 1: Structural Variables Used in the Model

Variable Name	Description	Type	Coding / Values	Source Item (OECD)
Pension_Owner	Voluntary pension product ownership	Binary	0 = No, 1 = Yes	QP2_1 + QP1_1
Age_Band	Age in harmonized bands	Ordinal	1 = 18–19 to 8 = 80+	QD7_a
Gender	Binary gender identity	Binary	0 = Female, 1 = Male	QD1
Educ_Level	Highest completed education	Ordinal	1 = None to 6 = Postgraduate	QD9
Employment_Status	Current main activity	Categorical	1 = Employed, 2 = Other inactive, ..., 6 = Unemployed	QD3
Income_Grp	Subjective income level	Categorical	1 = Low, 2 = Medium, 3 = High	QD11
HH_Children	Lives with children under 18	Binary	0 = No, 1 = Yes	QD4 (has children)
HH_Partner	Lives with a spouse or partner	Binary	0 = No, 1 = Yes	QD4 (has spouse/partner)
Urbanicity	Type of area of residence	Categorical	1 = Rural, 2 = Town, 3 = Urban	QD2
Country	Respondent's country	Categorical	1 = Estonia, 2 = Latvia, 3 = Lithuania	Country metadata

3.3 Empirical Strategy

Given the binary nature of the dependent variable—voluntary pension product ownership—a logistic regression framework was adopted to estimate the likelihood of participation as a function of structural and demographic characteristics. Logistic regression is particularly appropriate in this context, as it accommodates binary outcomes, handles non-linear probability structures, and permits a mix of binary, ordinal, and categorical predictors. It also avoids the major limitations of linear probability models, such as unbounded predicted values and heteroskedastic error structures, and facilitates interpretable results through odds ratios [46].

To account for potential intra-country correlation—stemming from shared institutional, economic, and policy environments—robust standard errors were clustered at the country level. This approach improves statistical inference by correcting for heteroskedasticity and within-cluster dependence, without requiring strong assumptions about the independence of residuals across observations [47].

Alternative modeling strategies were considered but ultimately deemed less suitable. Linear probability models violate key assumptions for binary outcomes and tend to produce inefficient and biased standard errors [48]. Fixed-effects models were not applied due to the limited number of clusters (only three countries), which would yield unstable estimates and

absorb key between-country institutional variance [49]. Multilevel (hierarchical) models were also ruled out for the same reason: insufficient Level-2 units (countries) constrain the estimation of reliable random effects and variance components [50].

Instead, the inclusion of country dummies for Latvia and Lithuania (with Estonia as the reference) allows baseline institutional heterogeneity to be captured directly, while maintaining model parsimony and avoiding overfitting [51].

All regressions were weighted using post-stratification weights provided by the OECD to enhance national representativeness and adjust for differential selection probabilities.

All analyses were conducted using R (version 4.3.2). The data used in this study were accessed through formal research application procedures established by the OECD/INFE. Although the dataset does not contain personally identifiable information, individual-level responses are protected, and researchers are granted access under conditions of confidentiality. As such, the use of this anonymized secondary data did not require formal ethics approval.

3.4 Validity and Robustness

To ensure the reliability of our findings and rule out model dependence or specification bias, we conducted a series of robustness checks grounded in theory and best practice for cross-national stratification research.

First, we estimated the core model without country-level controls to assess whether structural predictors such as income, education, and employment exert consistent effects independent of national institutional variation. This test evaluates the potential for omitted variable bias stemming from unobserved country-specific factors.

Second, country-specific models were estimated to explore the contextual stability of structural effects across Estonia, Latvia, and Lithuania. This disaggregation allows us to test the generalizability of stratification mechanisms and to identify whether institutional environments mediate observed relationships, in line with multilevel stratification theory.

Third, we tested for interaction effects between education and key structural factors—including income, employment status, and urbanicity—to probe compound disadvantage or conditional advantage, as theorized in cumulative inequality frameworks. These tests evaluate whether the predictive power of education varies across different social positions or institutional settings.

Fourth, we tested a refined classification of employment status, using granular OECD response codes to distinguish more precisely among labor force non-participants. This sensitivity check addresses potential misclassification bias and tests whether pension exclusion is systematically patterned along finer distinctions in labor market attachment.

Finally, we re-estimated the main model using a probit specification with clustered standard errors to evaluate robustness to link function assumptions.

4. Results

4.1 Descriptive Statistics

Table 2 presents the descriptive statistics for the variables used in model, based on the OECD sample (N = 2,154). The top panel summarizes continuous and ordinal variables, reporting

central tendency and distribution metrics. The lower panel shows categorical distributions across key structural indicators. Voluntary pension product ownership was reported by 39.3% of respondents. The majority were employed (61.7%), with a relatively high proportion in the high-income group (47.7%). The sample is gender-balanced, and residential distribution is evenly split across rural, suburban, and urban areas.

Table 2A: Descriptive Statistics for Continuous and Ordinal Variables

Variable	Mean	SD	Median	Min	Max	Skew	Kurtosis
Age Band	4.35	1.68	4.0	1	8	0.05	-0.94
Educ_Level	4.46	0.81	4.0	1	6	0.1	0.44

Table 2B: Frequency Distributions for Categorical Variables

Variable	Category	Counts	Percent (%)
Pension_Owner	0 (No) / 1 (Yes)	1275 / 825	60.7 / 39.3
Gender	Female (0) / Male (1)	1174 / 926	55.9 / 44.1
Employment_Status	Employed / Other inactive / Retired / Self-employed / Student / Unemployed	1295 / 127 / 350 / 205 / 78 / 45	61.7 / 6.0 / 16.7 / 9.8 / 3.7 / 2.1
Income_Grp	Low / Medium / High	444 / 655 / 1001	21.1 / 31.2 / 47.7
HH_Partner	No (0) / Yes (1)	1608 / 492	76.6 / 23.4
HH_Children	No (0) / Yes (1)	1405 / 695	66.9 / 33.1
Urbanicity	Rural / Suburban / Urban	698 / 773 / 672	33.2 / 34.8 / 32.0
Country	EE / LT / LV	794 / 776 / 530	37.8 / 36.9 / 25.2

4.2 Regression results

The logistic regression model was estimated using clustered standard errors at the country level to account for intra-group correlation within the OECD Baltic sample (N = 2,154; see Table 3). Age is negatively associated with voluntary pension ownership, while education and income show positive effects. Among employment groups, the self-employed are significantly more likely to report ownership, whereas retirees, students, the unemployed, and other inactive individuals face lower odds relative to employed respondents.

Table 3: Logistic Regression Results (Sample, n = 2,154)

Predictor	β (Log-Odds)	SE (Clustered)	z	p-value	OR	95% CI (OR)
Intercept	-0.975	0.539	-1.81	0.0705	0.377	(0.13, 1.08)
Age Band	-0.171	0.0438	-3.91	9.29E-05	0.843	(0.77, 0.92)
Gender (Female = 1)	0.008	0.123	0.0652	0.948	1.01	(0.79, 1.28)
Education (ordinal)	0.237	0.0756	3.14	0.00172	1.27	(1.09, 1.47)
Employment: Other inactive	-0.697	0.289	-2.41	0.0158	0.498	(0.28, 0.88)
Employment: Retired	-0.973	0.243	-4.01	6.12E-05	0.378	(0.24, 0.61)
Employment: Self-employed	0.294	0.079	3.72	0.000199	1.34	(1.15, 1.57)
Employment: Student	-1.06	0.0795	-13.3	1.50E-40	0.347	(0.3, 0.4)
Employment: Unemployed	-0.45	0.0621	-7.24	4.49E-13	0.638	(0.56, 0.72)
Income:	0.474	0.0269	17.6	1.23E-69	1.61	(1.52, 1.69)

Medium						
Income: High	0.835	0.188	4.43	9.22E-06	2.3	(1.59, 3.33)
Has Partner	0.0875	0.0786	1.11	0.265	1.09	(0.94, 1.27)
Has Children	0.126	0.322	0.39	0.696	1.13	(0.6, 2.13)
Urbanicity: Town	0.0751	0.194	0.388	0.698	1.08	(0.74, 1.58)
Urbanicity: Urban	0.489	0.154	3.18	0.00148	1.63	(1.21, 2.21)
Country: Lithuania (LT)	-0.485	0.0374	-13	1.80E-38	0.616	(0.57, 0.66)
Country: Latvia (LV)	-1.23	0.0163	-75.6	0	0.292	(0.28, 0.3)

Income shows a clear positive gradient: both medium- and high-income respondents are significantly more likely to participate compared to the low-income reference group. Urban residency is positively associated with pension engagement, with a significant effect observed for those living in urban centers. No significant effects are found for gender, having a partner, or having children. Compared to Estonia, both Lithuania and Latvia exhibit significantly lower probabilities of voluntary pension ownership.

Model diagnostics support the adequacy of the specification (Table 4). The model achieves a McFadden's R^2 of 0.135, indicating moderate explanatory power for cross-sectional behavioral data *[52]*. Discriminative performance is acceptable, with an AUC of 0.742. The Hosmer–Lemeshow test indicates good calibration (χ^2 = 3.28, p = 0.915), and multicollinearity is not a concern (VIFs range from 1.00 to 1.24). The model also shows improved fit over the null model, with a residual deviance of 2486.6 and an AIC of 2520.6.

Table4: Model Diagnostics

Metric	Value
McFadden's R^2	0.135
AUC (ROC Curve)	0.742
Hosmer–Lemeshow Test	3.28, p = .915
VIF (all predictors)	1.00–1.24
AIC	2520.6
Residual Deviance	Null deviance: 2876.39 (df = 2153); Residual deviance: 2486.644 (df = 2137)

Figure 1 presents a forest plot of odds ratios (OR) and 95% confidence intervals for key predictors of voluntary pension ownership, plotted on a logarithmic scale (OR = 1 indicates no effect). High income (OR = 2.30), urban residence (OR = 1.63), and self-employment (OR = 1.34) emerge as the strongest positive predictors. Education (OR = 1.27) and medium income (OR = 1.61) also show significant positive associations. Age is inversely related to engagement (OR = 0.84).

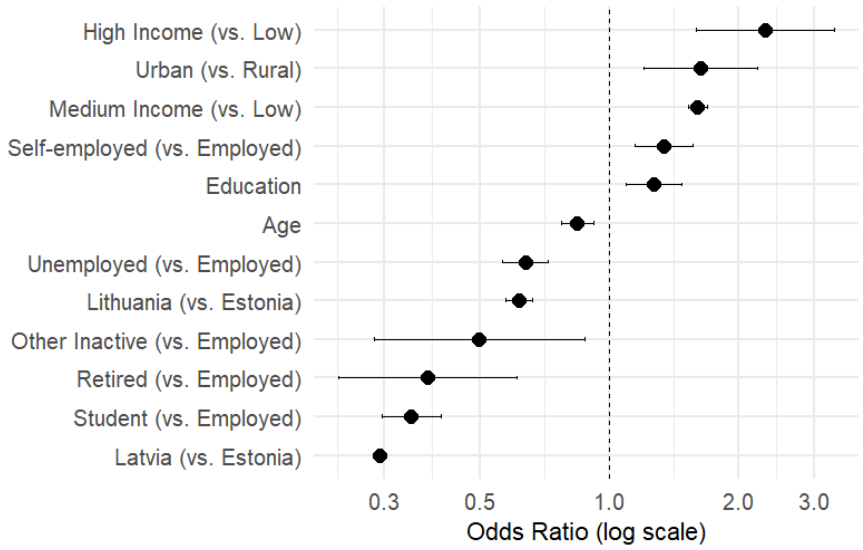

Figure 1: Forest Plot of Significant Predictors of Voluntary Pension Ownership (Odds Ratios with 95% Confidence Intervals)

In contrast, students (OR = 0.35), retirees (OR = 0.38), the unemployed (OR = 0.64), and other inactive individuals (OR = 0.50) are significantly less likely to own a voluntary pension product compared to the employed. Country-level differences are substantial: respondents in Latvia (OR = 0.29) and Lithuania (OR = 0.62) exhibit markedly lower engagement relative to Estonia, controlling for other covariates.

4.3 Robustness check

4.3.1 Excluded Country Effects

To test the robustness of structural predictors, we re-estimated the model without country-level controls, retaining clustered standard errors by country. Results closely aligned with the full model: age, education, income, and key employment categories remained significant. Notably, self-employment ($p = 0.036$), urban residence ($p = 0.016$), and single-adult household status ($p = 0.042$) retained significance. These findings confirm that the model's core predictors are not artifacts of national-level heterogeneity.

4.3.2 Country-Specific Models

To assess contextual variation, separate models were estimated for Estonia, Latvia, and Lithuania. While structural predictors remained relevant, their strength and significance varied. In Lithuania, age, urban residence, and having children predicted engagement; in Estonia, education and age were key; in Latvia, only education, high income, and urbanicity were significant. These differences indicate that although structural factors matter across contexts, their effects are mediated by country-specific institutional arrangements.

4.3.3 Interaction Effects

We examined whether education's effect is conditioned by other structural dimensions. First, a significant interaction between education and high income ($p < 0.001$) indicates

compounded advantages for financially privileged individuals. A marginal effect with medium income ($p = 0.096$) supports a broader pattern of cumulative stratification. Second, interactions with employment status showed that education mitigates exclusion among students ($p = 0.023$) and the unemployed ($p < 0.001$), but not among other inactive groups.
Third, no interaction emerged for urbanicity, but education's effect varied significantly across countries—stronger in Latvia, weaker in Lithuania—underscoring the mediating role of national institutions.

4.3.4 Refined Employment Categories

Using a more granular QD10 classification, all non-employed groups showed significantly lower engagement odds relative to the self-employed. The "other inactive" group exhibited the largest penalty ($\beta = -14.30$, $p < 0.001$), followed by students, retirees, and the unemployed. Model performance remained acceptable (McFadden's $R^2 = 0.140$, AUC = 0.745), confirming that labor market segmentation shapes pension participation and that disaggregation enhances explanatory clarity without degrading fit.

4.3.5 Probit Specification and Diagnostics

To confirm that our findings are not sensitive to the choice of link function, we re-estimated the main model using a probit specification with clustered standard errors by country. The direction, magnitude, and statistical significance of the core structural predictors—including age, education, income level, employment status, and country—remained consistent with those observed in the logistic regression model. This confirms that the main associations are robust to functional form assumptions.

Model diagnostics further support the adequacy of the probit specification. The model achieved a McFadden's pseudo R^2 of 0.135 and an area under the ROC curve (AUC) of 0.7421, closely mirroring the logistic model (McFadden's $R^2 = 0.135$, AUC = 0.742). Multicollinearity was not a concern: all generalized variance inflation factors (GVIFs) were well below accepted thresholds, with GVIF^(1/2df) values ranging from 1.006 to 1.285. Marginal effects from the probit model also aligned with odds ratios from the logistic model, supporting substantively equivalent interpretations of structural inequalities. These results confirm that the core findings are not model-specific artifacts, but reflect stable associations consistent with social stratification theory.

5. Discussion

5.1 Structural Stratification and the Role of Education and Income

This study investigated how structural and institutional factors influence voluntary pension engagement in the Baltic states, guided by stratification theory. The findings broadly support Hypothesis 1 and align with prior evidence from Central and Eastern Europe [53], while offering key empirical and theoretical extensions to the literature on welfare stratification and financial inclusion.

First, both education and income emerged as statistically significant and directionally consistent predictors of pension participation. Education retained its effect after adjusting for income, employment status, and demographic covariates, confirming it as an independent predictor rather than a proxy for earnings or labor market attachment. This finding aligns with

prior work showing that education is closely linked to contribution behavior and financial decision-making [54], including in diverse institutional contexts such as Chile [8].

Income showed a strong, graded association with pension participation. These results are consistent with findings from Tanzania, where income volatility and irregularity were key deterrents to pension engagement, even among high earners [55]. Our study confirms that stable financial capacity is a prerequisite for participation, even in systems framed as voluntary.

Employment status also significantly differentiated participation. Relative o the employed, the self-employed had higher odds of participation, while retirees, students, the unemployed, and those in the "other inactive" category had significantly lower odds. Castro-González et al. [56] emphasized that individuals outside stable employment settings—especially those without consistent financial behavior—are significantly less likely to participate in voluntary pension schemes, particularly in the absence of self-control and planning capacit. Our use of detailed employment categories adds precision to these findings. Disaggregation reveals especially low participation among students and the economically inactive—groups often overlooked in comparative analyses. These results clarify how labor market segmentation structures access to voluntary pension systems and expose specific subgroups at risk of exclusion.

5.2 Demographic Stratification and the Limits of Life-Cycle and Household Effects

Hypothesis 2 proposed that demographic factors—age, household composition, and gender—would significantly predict voluntary pension participation, in line with life-cycle and stratification models. However, the findings offer limited support for these expectations.

First, age was negatively associated with pension ownership, contrary to H2a. This finding departs from life-cycle models, which posit that financial planning increases with age, and instead supports stratification-based accounts that emphasize generational discontinuities and institutional familiarity [57,58]. In the post-socialist Baltic context, older individuals may have had limited exposure to or trust in third-pillar instruments, which require voluntary enrollment and sustained financial initiative. The observed age gradient appears to reflect reduced institutional access among older cohorts, rather than a decline in planning motivation over the life course.

Second, cohabitation with a partner and the presence of dependent children were not significantly associated with pension engagement, offering no support for H2b. This result challenges the assumption that household roles and shared financial responsibilities consistently promote long-term saving behavior. When structural predictors such as income and employment status are included, household composition adds little explanatory power—indicating that its effects are likely mediated through material conditions. Although few studies examine household structure in voluntary pension contexts, evidence from Peru suggests that informal family-based support may substitute for formal savings mechanisms, underscoring the need for more focused analyses at the household level [59].

Third, gender was unrelated to pension participation in multivariate models, counter to H2c. This finding contrasts with studies in liberalized or contributory pension systems where women's lower earnings and interrupted careers typically result in lower participation rates. However, recent evidence from Estonia's tax-incentivized voluntary pension scheme shows only marginal gender gaps in contribution rates and amounts, which could reflect differences in preferences or risk attitudes rather than structural exclusion [60]. Similarly, findings across

20 European countries suggest that while men are slightly more likely to own voluntary pension assets, these differences are not statistically significant in most countries when labor market factors are controlled [61].

Collectively, these results refine our understanding of demographic stratification in financial behavior. They show that once structural variables are accounted for, demographic factors—age, gender, and household composition—have limited direct effects, at least in the Baltic context. This suggests that the primary drivers of pension participation are cumulative structural advantages, rather than life stage, caregiving roles, or gender-based labor segmentation alone.

5.3 Spatial and Institutional Stratification

Hypothesis 3 proposed that pension engagement would vary systematically by geographic location and national institutional context. The findings provide strong support for both dimensions.

First, consistent with H3a, urban residents were significantly more likely to participate in voluntary pension schemes than rural counterparts. This association remained robust after adjusting for income, education, and employment, indicating that spatial disparities reflect more than individual-level differences. Geographic context appears to shape financial inclusion through access to infrastructure, information, and institutional outreach. Similar dynamics have been observed in China's rural pension scheme, where participation lags among rural residents due to limited financial literacy and weaker delivery systems—despite formal inclusion—highlighting how institutional proximity influences voluntary engagement [62,63].

Second, and in line with H3b, substantial cross-national differences were observed. Estonian respondents were markedly more likely to report ownership of a voluntary pension than their Latvian or Lithuanian peers. These differences remained significant after adjusting for structural and demographic predictors, indicating that institutional context exerts an independent effect on participation. This supports stratification models that treat national policy environments as key determinants of financial behavior [57].

The Estonian case is especially illustrative: its third-pillar system has been characterized by early introduction, policy continuity, fiscal incentives, and administrative simplicity [41,64]. In contrast, Latvia has employed a more tax-driven approach, and Lithuania has historically favored a cautious, state-centric design with limited promotional mechanisms. These institutional configurations not only shape financial incentives but also condition normative expectations and trust in long-term saving instruments.

6. Conclusion

This study examined voluntary pension participation in the Baltic states, highlighting how structural and institutional factors jointly shape engagement in long-term financial planning. Drawing on stratification theory and cross-national data, we find that socio-economic position—particularly education, income, and employment status—remains a powerful determinant of pension ownership, even in liberalized, voluntary systems.

Significant geographic and country-level disparities further underscore the role of institutional context. Estonia's consistently higher participation rates illustrate how policy architecture—

especially fiscal incentives, administrative design, and communication—can enable or constrain individual engagement, irrespective of personal characteristics.

Theoretical Implications

The findings extend stratification theory by demonstrating that structural inequalities persist in financial domains typically assumed to reflect individual choice. The observed interaction between education and income supports the logic of cumulative advantage, while null effects for gender and household composition suggest that socio-economic resources override demographic predictors in shaping pension behavior. Importantly, the study links individual-level determinants to national systems, reinforcing the view that financial inclusion must be analyzed as a socio-institutional process rather than a purely behavioral outcome.

Practical Implications

From a policy perspective, the study highlights several levers for promoting more inclusive pension participation. Enhancing educational outreach and tailoring financial tools to lower-income or precariously employed groups could reduce exclusion. Country-specific differences suggest that institutional reforms—such as simplifying enrollment procedures, offering stronger fiscal incentives, or increasing transparency—may substantially raise engagement. In an era of growing individual responsibility for retirement, policymakers must address the stratifying effects of both personal resources and systemic design.

Limitations and Future Research

This study has several limitations. First, its cross-sectional design restricts causal inference, limiting our ability to assess temporal ordering or individual behavioral change. Second, while we intentionally focused on structural and demographic determinants, this approach did not incorporate psychological or behavioral constructs such as financial literacy, future orientation, or trust in institutions. This was a deliberate theoretical decision to isolate the role of socio-economic stratification; however, future work could enrich explanatory power by integrating these complementary dimensions.

Moreover, although country-level differences were observed, we did not directly model policy instruments—such as contribution incentives, default options, or administrative complexity—which likely shape national variation. Future research should consider multi-level models incorporating institutional variables, or longitudinal data that tracks changes in participation over time. Expanding the scope beyond the Baltic context, especially into contrasting welfare regimes, would also help to test the broader applicability of stratification dynamics in voluntary pension participation.

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accessing the microdata may contact the OECD Secretariat directly at SecretariatINFE@oecd.org. Aggregated data and related documentation are publicly available on the OECD website.

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References

[1] Modigliani F, Brumberg R. Utility analysis and the consumption function: An interpretation of cross-section data. Post-Keynesian Economics 1954:388–436.

[2] Lusardi A, Mitchell O. Financial Literacy and Planning: Implications for Retirement Wellbeing. Cambridge, MA: National Bureau of Economic Research; 2011. https://doi.org/10.3386/w17078.

[3] Thaler RH, Benartzi S. Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving. Journal of Political Economy 2004;112:S164–87. https://doi.org/10.1086/380085.

[4] Bourdieu P. Distinction: A Social Critique of the Judgement of Taste. Harvard University Press; 1984.

[5] Goldthorpe JH. Class Analysis and the Reorientation of Class Theory: The Case of Persisting Differentials in Educational Attainment. On Sociology, Oxford University PressOxford; 2000, p. 161–81. https://doi.org/10.1093/oso/9780198295716.003.0008.

[6] Angerer M, Hanke M, Shakina E, Szymczak W. The Effect of Different Saving Mechanisms in Pension Saving Behavior: Evidence from a Life-Cycle Experiment. Journal of Risk and Financial Management 2025. https://doi.org/10.3390/jrfm18050240.

[7] Shah AM, Osborne M, Kalter JL, Fertig A, Fishbane A, Soman D. Identifying heterogeneity using recursive partitioning: evidence from SMS nudges encouraging voluntary retirement savings in Mexico. PNAS Nexus 2023;2. https://doi.org/10.1093/pnasnexus/pgad058.

[8] Ciriotto V, Cuevas C, Aravena F. What Are the Main Socio-Economic and Behavioral Characteristics That Determine Voluntary Pension Contributions for Self-Employed Workers in Chile? Urban Economics & Regional Studies eJournal 2020. https://doi.org/10.2139/ssrn.3751749.

[9] Mangan M, Mastrogiacomo M, Hochguertel S, Goedkoop F. Broken promises? Trust and pension savings in turbulent times. Work, Aging and Retirement 2024. https://doi.org/10.1093/workar/waae007.

[10] Bednarczyk TH, Skibińska-Fabrowska I, Szymańska A. An Empirical Study on the Financial Preparation for Retirement of the Independent Workers for Profit in Poland. Risks 2021. https://doi.org/10.3390/risks9090160.

[11] King A. Structural Exclusion and Just Development. Int J Technoethics 2015;6:14–30. https://doi.org/10.4018/IJT.2015070102.

[12] Sengar VS. Financial Inclusion and Retirement Planning: A Scenario Analysis of the Feasibility of Atal Pension. INTERANTIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT 2024. https://doi.org/10.55041/ijsrem35092.

[13] Stiemke P, Hess M. Determinants of (in-)voluntary retirement: A systematic literature review. Journal of European Social Policy 2022;32:348–58. https://doi.org/10.1177/09589287221089465.

[14] Barajas A, Beck T, Belhaj M, Naceur SB. Financial Inclusion. IMF Working Papers 2020. https://doi.org/10.5089/9781513553009.001.

[15] Rupeika-Apoga R, Priede J. Retirement Readiness in the Baltics: The Roles of Financial Literacy, Product Ownership, and Advisory Confidence. Risks 2025;13:30. https://doi.org/10.3390/risks13020030.

[16] Anderson KM, Weaver RK. Pensions, policy drift and old-age poverty in Western Europe and North America. Journal of European Social Policy 2025. https://doi.org/10.1177/09589287241312109.

[17] Molina O, Yarin V, Lvova M, Yuzvovich L. Modern pension paradigm in Europe. Management Issues 2024. https://doi.org/10.22394/2304-3369-2024-4-68-79.

[18] Fenger M. Welfare regimes in Central and Eastern Europe: Incorporating post-communist countries in a welfare regime typology. Contemporary Issues and Ideas in Social Sciences 2007:1–30.

[19] Ebbinghaus B. The Privatization and Marketization of Pensions in Europe: A Double Transformation Facing the Crisis 2015;1:56–73. https://doi.org/10.18278/EPA.1.1.5.

[20] Farkas B. The Central and Eastern European model of capitalism. Post-Communist Economies 2011;23:15–34. https://doi.org/10.1080/14631377.2011.546972.

[21] Rajevska O. Sustainability of Pension Systems in the Baltic States. Entrepreneurial Business and Economics Review 2015;3:139–53. https://doi.org/10.15678/EBER.2015.030409.

[22] Guardiancich I. Pension Reforms in Central, Eastern and Southeastern Europe: Legislation, implementation and sustainability 2009. https://doi.org/10.2870/1700.

[23] Dundure E, Sloka B. Tax Incentives as a Part of Governments' Applied Mechanisms for the Third Pension Pillar in Estonia, Latvia, and Lithuania. European Integration Studies 2020;1:146–55. https://doi.org/10.5755/j01.eis.1.14.26379.

[24] Mazure G. State funded pension schemes in the Baltic states: assets and return analysis. Research for Rural Development 2023 : Annual 29th International Scientific Conference Proceedings 2023. https://doi.org/10.22616/rrd.29.2023.017.

[25] Juska A. A shift to libertarian paternalism in old-age income security: Discourses on pension privatization reforms in Lithuania 2016–2018. International Social Security Review 2021;74:3–27. https://doi.org/10.1111/ISSR.12263.

[26] Frătică-Dragomir (Guşe) AM. DIGITAL TRANSFORMATION OF PUBLIC PENSIONS: A CASE STUDY OF FOUR EUROPEAN COUNTRIES. PROCEEDINGS OF THE INTERNATIONAL MANAGEMENT CONFERENCE 2024. https://doi.org/10.24818/imc/2023/02.12.

[27] Léo Y, Fleury E, Alvarez-Hamelin JI, Sarraute C, Karsai M. Socioeconomic correlations and stratification in social-communication networks. Journal of The Royal Society Interface 2016;13. https://doi.org/10.1098/rsif.2016.0598.

[28] Pichler F, Wallace C. Social Capital and Social Class in Europe: The Role of Social Networks in Social Stratification. European Sociological Review 2009;25:319–32. https://doi.org/10.1093/ESR/JCN050.

[29] Lee K. Varying effects of public pensions: Pension spending and old-age employment under different pension regimes. Journal of European Social Policy 2024;34:3–19. https://doi.org/10.1177/09589287231223391.

[30] Eberhardt W, Post T, Hoet C, Brüggen E. Exploring the first steps of retirement engagement: a conceptual model and field evidence. Journal of Service Management 2022. https://doi.org/10.1108/josm-11-2020-0402.

[31] Liu T, Li M, Yang Z, Xue D. Internet Usage, Government Trust, and Participation of Informal Workers in Employee Public Pension Scheme. SAGE Open 2024;14. https://doi.org/10.1177/21582440241258294.

[32] Hinrichs K. Recent pension reforms in Europe: More challenges, new directions. An overview. Social Policy & Administration 2021. https://doi.org/10.1111/SPOL.12712.

[33] Figari F, Fornero E, Oggero N, Rossi M. Support for pension reforms: What is the role of financial literacy and pension knowledge? Journal of Accounting and Public Policy 2023. https://doi.org/10.1016/j.jaccpubpol.2023.107096.

[34] Ma X, Wang Z, Zhang J, Wu J. Precarious Employment, Pension Participation, and Retirement Deferment in China. China Perspectives 2024. https://doi.org/10.4000/11y7k.

[35] Becerra O. The Effect of Future Pension Benefits on Labor Supply in a Developing Economy. Economic Development and Cultural Change 2023;72:1527–66. https://doi.org/10.1086/725338.

[36] Mitchell O, Lusardi A. Financial Literacy and Financial Behavior at Older Ages. SSRN Electronic Journal 2022. https://doi.org/10.2139/ssrn.4006687.

[37] Kang C, Hu R. Age structure of the population and the choice of household financial assets. Economic Research-Ekonomska Istraživanja 2021;35:2889–905. https://doi.org/10.1080/1331677X.2021.1984269.

[38] Herold I. Differences in Public Pension Entitlements within Couples – Analyses Based on SHARE-RV. Jahrbücher Für Nationalökonomie Und Statistik 2025;0. https://doi.org/10.1515/jbnst-2024-0038.

[39] Li D, Niu J. The Gender Gap in Pension Income for Urban Employees in China. SAGE Open 2024;14. https://doi.org/10.1177/21582440241266996.

[40] Canales A, Salinas V, Biehl A. Gender Differences in Retirement Behavior: How Family, Work, and Pension Regime Explain Retirement in Chile. Work, Aging and Retirement 2021;7:107–28. https://doi.org/10.1093/WORKAR/WAAA024.

[41] Rajevska O. Pension systems as risk management: a case of the Baltic states. Challenges to the Welfare State 2021. https://doi.org/10.4337/9781839106118.00019.

[42] Tarigan E. Digital Financial Access as a Solution to Overcome Geographical Constraints. Strategic Financial Review 2024. https://doi.org/10.59762/sfr1220240710133303.

[43] OECD. OECD/INFE 2023 International Survey of Adult Financial Literacy. vol. 39. 2023. https://doi.org/10.1787/56003a32-en.

[44] Reinhardt K. BUSINESS RESEARCH METHODS. SSRN Electronic Journal 2023. https://doi.org/10.2139/ssrn.4488860.

[45] Hoffmeyer-Zlotnik JHP, Wolf C. Advances in cross-national comparison : a European working book for demographic and socio-economic variables 2003.

[46] Harris JK. Primer on binary logistic regression. Family Medicine and Community Health 2021;9. https://doi.org/10.1136/fmch-2021-001290.

[47] Cameron C, Miller DL. A Practitioner's Guide to Cluster-Robust Inference. The Journal of Human Resources 2015;50:317–72. https://doi.org/10.3368/jhr.50.2.317.

[48] Lee M, Lee G, Choi J. Linear Probability Model Revisited: Why It Works and How It Should Be Specified. Sociological Methods & Research 2025;54:173–86. https://doi.org/10.1177/00491241231176850.

[49] McNeish DM, Stapleton LM. Modeling Clustered Data with Very Few Clusters. Multivariate Behavioral Research 2016;51:495–518. https://doi.org/10.1080/00273171.2016.1167008.

[50] Maas C, Hox J. Robustness issues in multilevel regression analysis. Statistica Neerlandica 2004;58. https://doi.org/10.1046/j.0039-0402.2003.00252.x.

[51] Štreimikienė D, Bathaei A. Evaluating and ranking quality education for sustainable development in the Baltic States: A multi-criteria decision-making approach using Eurostat data. Transformations and Sustainability 2025. https://doi.org/10.63775/vq29r460.

[52] Liu D, Zhu X, Greenwell BM, Lin Z. A new goodness-of-fit measure for probit models: Surrogate R 2. The British Journal of Mathematical and Statistical Psychology 2022;76:192–210. https://doi.org/10.1111/bmsp.12289.

[53] Cupák A, Kolev GI, Brokešová Z. Financial literacy and voluntary savings for retirement: novel causal evidence. The European Journal of Finance 2019;25:1606–25. https://doi.org/10.1080/1351847X.2019.1641123.

[54] Marcinkiewicz E. Factors Affecting the Development of Voluntary Pension Schemes in CEE Countries: A Panel Data Analysis. Central European Economic Journal 2018;3:26–40. https://doi.org/10.1515/ceej-2017-0015.

[55] Wango N. Voluntary Contributions to Pension Schemes: A Study Among Actors in the Informal Economy in Tanzania. Journal of Social Science Studies 2024. https://doi.org/10.5296/jsss.v11i1.21953.

[56] Castro-González S, Rey-Ares L, Fernández-López S, Daoudi D. The effect of self-control upon participation in voluntary pension schemes. Economics & Sociology 2020;13:11–23. https://doi.org/10.14254/2071-789x.2020/13-1/1.

[57] Blanc JL. The Third Pillar in Europe: Institutional Factors and Individual Decisions. Pension Risk Management eJournal 2011. https://doi.org/10.2139/ssrn.2785399.

[58] Gonzales S, Fernández JJ. Socio-Economic Gaps in Workers' Participation in Private Pension Programmes in Ten European Countries. Journal of Social Policy 2022;53:1187–219. https://doi.org/10.1017/S0047279422000897.

[59] Li CA, Olivera J. Voluntary Enrolment In The Peruvian Private Pension System 2008.

[60] Piirits M, Soosaar O, Staehr K. Gender gaps in contributions to tax-incentivised pension investment. Early experiences from post-transition Estonia. Post-Communist Economies 2025;37:203–22. https://doi.org/10.1080/14631377.2025.2459531.

[61] Rõõm T. THE GENDER GAP IN PENSION WEALTH IN EUROPE: EVIDENCE FROM TWENTY COUNTRIES 2020.

[62] Li N, Zhang J. The dilemma of the social insurance system for rural workers: a path-dependent analysis 2021;7:1–18. https://doi.org/10.12988/REF.2021.91110.

[63] Wan C, Xu L. Indexes of Individual Characteristics Affecting China's Pension System Participation and Urban-Rural Comparative Empirical Analysis. Proceedings of the 5th International Conference on Computer Information and Big Data Applications 2024. https://doi.org/10.1145/3671151.3671309.

[64] Lindeman DC. Review of Recent Pension Reforms in the Baltic Region 2004:7–24. https://doi.org/10.1787/9789264021068-2-EN.