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MACRO-FINANCIAL INTERACTIONS AND PENSION FUND DEVELOPMENT OF AGING VS. YOUNGER NATIONS

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Abstract
The study examines how dependence ratio, replacement rate, average salary, working wage, and other macro factors affect pension fund growth. The paper shows how these factors vary in aging and younger OECD countries and helps explain the macro dynamics that underpin OECD economies' massive asset-holding finance sectors. Dynamic panel data model was applied to examine the individual relevance of included variables in the model progressively, and R^2-change was seen to identify the fundamental macro factors driving pension fund growth. The study finds that Average Age, Working Wage, Personal Income Tax, and Inflation positively affect pension funds in AGING economies and negatively in YOUNGER economies depending on growth viewpoint. The paper's approach may help OECD pension fund policymakers and data analysts make decisions about pension fund management and its core determinants. A literature review of research in several economies determined the macroeconomic elements used in the study. Thus, the study might be used to analyze pension fund growth across economies.

INTRODUCTION

Social security is crucial for the well-being of citizens, particularly the elderly, as it provides financial security against unforeseen circumstances such as unemployment. While prior research has investigated the performance and governance of pension funds, this study aims to identify the key macroeconomic determinants of pension fund growth. Existing OECD reports offer descriptive analyses of pension fund factors but lack detailed insights into the specific impacts of asset allocations (e.g., equities, bonds, real estate) on fund growth.

Pension funds serve as institutional investors, pooling contributions from sponsors and beneficiaries to provide future pensions (Davis, 1995). These institutions facilitate individual savings during working life for retirement. In most countries, early withdrawal from pension funds is restricted, enabling long-term investment strategies aimed at maximizing returns. Pension firms allocate funds across various assets, including corporate equities, real estate, and government bonds, to enhance profitability. Considering the significant proportion of assets held by pension funds within OECD economies (OECD, 2017), understanding their governance and growth determinants is essential, especially given the context of aging populations.

This study analyzes the factors influencing pension fund growth in selected OECD countries, utilizing panel data from 24 nations over a 43-year period.

The OECD countries are categorized into two groups based on their pension fund assets-to-GDP ratio: higher-growth-oriented (AGING) for those above the median ratio and lower-growth-oriented (YOUNGER) for those below.

Study Layout

Literature Background and Hypotheses Development

Based up on the past academic literature the study highlights some macroeconomic variables that influence the growth of the pension fund, the section below (Table-1) develops plot of each variable into the shape of a hypothesis for analysis.

Table-1: Summary of Supporting Theories for Macro-Economic Factors and Growth of PFs

Macro-Economic Determinants of Pension Funds in Selected-OECD Countries

Symbol	Variable	Expected Relation	Literature Review	Supporting Theory
PFG	Pension Funds Growth	PN	Roce, Kaminker, & Stewart (2011); Casey, (2014); Alonso, et al. (2010); Singh & Mehta, (2015); Açıkgöz, Uygurtürk, & Korkmaz, (2015)	Utility Theory+ Institutionists Approach+ Theory of Immunization
DR	Dependency Ratio	N	Magnus, (2012); Lee, (2011); Horioka, & Wan, (2007); Godlee, (2013); Horioka, & Terada-Hagiwara, (2012)	Theory of Contribution Density
RR	Replacement Rate	N	Worrall, & Appel, (1982); Lin, & Ding, (2007); Zaigui, (2008); Gustman, & Steinmeier, (1999); Yang, (2009); Aldrich, (1982)	Theory of Contribution Density
AGW	Average Wage	PN	Galí, & Monacelli, (2016); Daly, & Hobijn, (2017); Feldstein, (2018); Ruhs, & Vargas-Silva, (2015); Adrjan, & Bell, (2018)	Theory of Pooling
WRK	Working Age	PN	Hinrichs, (2018); Vogel et al. (2017); Drucker, (2017); Curran, & Blackburn, (2001); Scherger, (2016)	Life-Cycle Theory
ER	Employment Rate	P	Evensen et al. (2015); Möhring, (2015); Beveridge, (2014); Banerjee, & Blau, (2016); Laun, & Wallenius, (2015)	Theory of Pooling
SR	Saving Rate	P	Imrohoroğlu, & Zhao, (2018); Lachowska, & Myck, (2018); Blau, (2016); De Freitas, N. E. M., & Martins, (2014); Börsch-Supan et al. (2015)	Theory of Pooling
PTR	Personal Income Tax Rate	PN	Parker, (2018); Grubert, & Altshuler, (2015); Karamcheva, & Sanzenbacher, (2014); Feldstein, (2018); Collins, & Hughes, (2017);	Welfarists Approach

GDPG	GDP Growth Rate	P	Scharfstein, (2018); Been et al. (2017); Heer, & Irmen, (2014); Bijlsma, Van, & Haaijen, (2014); Frost et al. (2018); Arbatli (2017); Cingano, (2014)	Growth-Led Finance
EXR	Exchange Rate	N	Galí, & Monacelli, (2016); Gabaix, & Maggiori, (2015); Ezeanyeji (2016); De Vita, (2014); Adeniran, Yusuf, & Adeyemi, (2014); Dimpfl, & Schmidt, (2018)	Purchasing Power Parity
CPI	Consumer Price Index	PN	Budd, & Seiders, (1971); Pensions Commission. (2004); Thompson, (1978); Heller, (1980); Prammer, & Reiss, (2015); Bivens, (2015)	Theory of Immunization

Data and Methodology

This research adopts a comparative framework based on demographic structures, categorizing OECD countries into "aging" and "younger" economies. Aging economies—such as Japan, Italy, France, Sweden, and Finland—face rising old-age dependency ratios, increasing fiscal pressure on pension systems. In contrast, younger economies—including the United States, Mexico, Turkey, and Australia—exhibit lower dependency ratios, offering relatively favorable conditions for pension fund accumulation. This classification enables a nuanced analysis of how demographic composition influences the responsiveness of pension funds to macroeconomic variables like working wage, inflation, and personal income tax. Understanding these dynamics helps tailor pension policies to the demographic realities of each group.

Techniques used for Analysis

This study employs dynamic panel data techniques alongside pooled ordinary least squares (OLS), random-effects, and fixed-effects models to comparatively analyze the financial sustainability of pension funds in selected OECD countries. The analysis focuses on contrasting aging economies with younger economies.

The following model presents the general economic functions used in this study.

$$PFG = (PFG_{t-1}, DR, RR, AGW, WRK, ER, SR, PTR, GDPG, EXR, INF)$$ ~~~~~~ Equation (1)

Based on the above-described model, dynamic panel data approach was used.

Where:

- PFG = Pension Funds Growth
- DR = Dependency Ratio
- RR = Replacement Rate
- AGW = Average Wage
- WRK = Working Age
- ER = Employment Rate
- SR = Savings Rate
- PTR = Personal Tax Rate
- GDPG = Gross Domestic Product Growth
- EXR = Exchange Rate
- CPI = Consumer Price Index
- D_{it} = Dummy for time fixed effect
- ε = the error term

Results Analysis and Discussion

The following table 2 shows the descriptive statistics of the variables used in this study. Table 3, presented at the appendix of this study that describes the correlations among variables of this study for whole sample, young, and aging countries.

Table-2: Summary Statistics

	Whole-Sample Countries		Aging-Countries		Young-Countries	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
PFG	13.67	7.52	12.5	7.19	13.69	8.71
DR	12.73	5.81	14.82	6.21	15.82	6.46

RR	65.01	3.03	65.76	6.02	62.85	5.29
AGW	11.47	1.06	17.68	3.49	15.18	3.79
WRK	65.95	2.43	43.59	3.41	64.75	4.58
ER	65.23	5.31	45.57	4.61	61.47	5.67
SR	6.3	4.93	12.57	4.01	8.04	4.7
PTR	41.93	7.63	34.67	6.38	45.13	7.82
GDPG	4.24	6.11	5.06	1.89	2.15	3.75
EXR	46.21	140.98	44.52	104.7	41.46	256.93
CPI	3.413	3.021	2.387	3.189	7.698	2.461

Table 4 in the appendix shows that for the entire sample, the R-squared values of the FE, RE, and pooled OLS models explain the variance in pension fund growth, with values of 19.8%, 19.20%, and 18.11%, respectively. The F-test results indicate that all three models are significant at the 1% level, with values of 61.05, 58.12, and 54.30. For the AGING-Countries sample, the R-squared values for the same models are 37.35%, 36.28%, and 37.12%, respectively, also explaining changes in pension fund growth. These models are also significant at the 1% level, with F-test values of 17.97, 10.23, and 9.89. Similarly, for the YOUNGER-Countries sample, the R-squared values are 35.03%, 35.19%, and 35.76%, and the models are significant at the 1% level with F-test values of 20.75, 23.79, and 21.20. The analysis using AIC and BIC criteria suggests that the fixed effect model is the most suitable for the whole sample and AGING-countries, while the random effects model is more appropriate for YOUNGER-countries.

Table-3: Correlation Matrix

Macro-Economic Factors and Their Relationships

Variables	VIF	PFG	DR	RR	AGW	WRK	ER	SR	PTR	GDPG	EXR	CPI
PFG		1										
DR	7.25	-0.491*	1									
RR	7.37	-0.307*	0.013	1								
AGW	6.22	0.443*	0.780*	0.094	1							
WRK	5.12	0.424*	-0.069*	-0.024	-0.110*	1						
ER	5.11	0.580*	0.029	-0.056	0.051*	-0.245*	1					
SR	4.89	0.601*	-0.016	-0.075	-0.059	-0.047*	-0.052	1				
PTR	3.76	0.751*	-0.037	0.051*	-0.056	0.012	-0.046	0.042	1			
GDPG	2.96	0.871*	-0.114*	-0.562*	0.123*	-0.139*	0.536*	-0.611*	0.467*	1		
EXR	2.44	-0.931*	0.021	-0.033	-0.063	-0.027	-0.061	-0.054	0.051	-0.021	1	
CPI	1.36	0.401*	0.035	-0.051	-0.072	-0.031*	-0.029	-0.055	0.061	-0.026	0.036*	1

* Shows significance at the .05 level

Pension Funds Growth (PFG)

Table 4 shows that, for the entire sample, the PFG from the previous year and the PFG from this year are positively and significantly correlated at 10%, 5%, and 5%, respectively. Furthermore, if the PFG from the previous year is raised by 1%, the PFG from this year will likewise be raised by 0.222%, 0.223%, and 0.235% in FE, RE, and pooled-OLS,

respectively. Table 4 for the AGING Countries sample indicates that the PFG from the previous year and the PFG from this year are positively and significantly correlated, at 1%, 5%, and 1%, respectively. Furthermore, if the PFG from the previous year is raised by 1%, the PFG from this year will likewise be raised by 0.219%, 0.227%, and 0.271% in FE, RE, and pooled-OLS, respectively. Table 4 indicates that, for the YOUNGER-Countries sample, the PFG from the previous year and the PFG from this year have a negative and significant connection of 1%, 10%, and 1%, respectively. Furthermore, it can be explained as follows: if the PFG from the previous year were to increase by 1%, the PFG from this year would fall by 0.255%, 0.145%, and 0.111% in FE, RE, and pooled-OLS, respectively.

It is clear by comparing AGING and YOUNGER countries that the former have a positive association with the PFG from the previous year, while the latter have a negative relationship. This could be because the increase of last year's pension funds in YOUNGER countries isn't drawing in more and more clients under the social security pension fund system. In contrast, the market in AGING countries is developed enough to draw in an increasing number of customers, as seen by the growth in pension funds last year.

Table-4: Dynamic Panel Models (DV= Pension Funds)

	Fixed Effect			Random Effect			Pooled-OLS		
Variables	All Sample	Aging	Young	All Sample	Aging	Young	All Sample	Aging	Young
PFG (L1)	0.222*	0.219***	-0.255***	0.223**	0.227**	-0.145*	0.235**	0.271***	-0.111***
	(0.13)	(0.14)	(0.07)	(0.05)	(0.11)	(0.09)	(0.03)	(0.13)	(0.04)
DR	-0.169**	-0.263***	-0.340***	-0.324**	-0.275**	-0.685*	-0.125**	-0.206**	-0.434***
	(0.15)	(0.05)	(0.07)	(0.06)	(0.14)	(0.1)	(0.37)	(0.01)	(0.02)
RR	-0.465*	-0.359***	-0.348**	-0.135**	-0.215*	-0.138*	-0.128*	-0.175**	-0.127**
	(0.04)	(0.01)	(0.01)	(0.01)	(0.04)	(0.03)	(0.02)	(0.03)	(0.01)
AGW	0.222*	0.196***	-0.268***	0.248**	0.271**	-0.141**	0.134*	0.716***	-0.233***
	(0.13)	(0.05)	(0.07)	(0.05)	(0.1)	(0.09)	(0.03)	(0.03)	(0.04)
WRK	0.831**	0.692***	-0.187**	0.561*	0.123**	-0.226***	0.232***	0.649***	-0.143***
	(0.42)	(0.15)	(0.22)	(0.16)	(0.43)	(0.27)	(0.04)	(0.19)	(0.03)
ER	0.264**	0.324***	0.162***	0.154*	0.241**	0.201***	0.100***	0.344***	0.311***
	(0.11)	(0.02)	(0.02)	(0.02)	(0.13)	(0.03)	(0.07)	(0.02)	(0.37)
SR	0.394***	0.281**	0.112**	0.133**	0.221***	0.150**	0.330**	0.288***	0.177*
	(0.04)	(0.1)	(0.02)	(0.01)	(0.01)	(0.02)	(0.37)	(0.09)	(0.07)
PTR	0.665***	0.206***	-0.685***	0.306*	0.426**	-0.201**	0.101*	0.163**	-0.412**
	(0.03)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.07)	(0.05)	(0.01)
GDPG	0.208**	0.753**	0.592**	0.312*	0.428***	0.396*	0.196**	0.357***	0.228**
	(0.1)	(0.03)	(0.04)	(0.03)	(0.09)	(0.06)	(0.02)	(0.01)	(0.07)
EXR	-0.319**	-0.516***	-0.550***	-0.233*	-0.169**	-0.375**	-0.345**	-0.109**	-0.112***
	(0.08)	(0.03)	(0.03)	(0.03)	(0.07)	(0.05)	(0.22)	(0.05)	(0.22)
CPI	0.213***	0.303**	-0.124**	0.206*	0.322**	-0.201**	0.202**	0.269**	-0.129**
	(0.02)	(0.03)	(0.11)	(0.02)	(0.03)	(0.04)	(0.07)	(0.05)	(0.11)
Cons	5.751***	5.409***	4.964***				2.231***	4.692**	4.263***
	(0.77)	(0.19)	(0.37)					(0.15)	(0.02)
R-squared	0.1985	0.3735	0.3503	0.1920	0.3628	0.3519	0.1811	0.3712	0.3576
F-Model	61.05***	17.97***	20.75***	58.12***	10.23***	23.79***	54.30***	9.89***	21.20***

Hetero	0.0978	0.0765	0.0867	0.0825	0.0567	0.0599	0.0948	0.0777	0.0788
Serial	0.0899	0.0782	0.077	0.0933	0.0685	0.0744	0.0845	0.0732	0.0624
AIC	215.7120	144.9504	147.5712	223.7760	167.5296	143.5392	368.9280	217.7280	165.3120
BIC	212.1168	142.5346	145.1117	220.0464	164.7374	141.1469	362.7792	214.0992	162.5568

Table 4 indicates that, for the entire sample, DR exhibits a negative and statistically significant relationship with PFG at the 5% level across three instances. Furthermore, an increase of 1% in DR is associated with a decrease in the current year's PFG by 0.169%, 0.324%, and 0.125% in FE, RE, and pooled-OLS, respectively. Table 4 indicates that for the AGING-Countries sample, DR exhibits a negative and statistically significant relationship with PFG at the 1%, 5%, and 5% levels, respectively. Furthermore, an increase of 1% in DR is associated with a decrease in the current year's PFG by 0.263%, 0.275%, and 0.206% in FE, RE, and pooled-OLS, respectively. DR exhibits a negative and statistically significant relationship with PFG at the 1%, 10%, and 1% levels, respectively. Furthermore, a 1% increase in DR is associated with a decrease in the current year's PFG of 0.340%, 0.685%, and 0.434% in FE, RE, and pooled-OLS, respectively. Comparative analysis reveals that the coefficients of DR for AGING countries are lower than those for YOUNGER countries. YOUNGER countries exhibit a higher dependency ratio, which adversely impacts the growth of pension funds relative to AGING countries.

Table 4 indicates that for the YOUNGER-Countries sample, the RR exhibits a negative and statistically significant relationship with PFG at the 5% and 10% levels. Furthermore, an increase of 1% in RR is associated with a decrease in the current year's PFG by 0.348%, 0.138%, and 0.127% in FE, RE, and pooled-OLS, respectively. Comparative analysis reveals that the coefficients of RR for AGING countries are significantly higher than those for YOUNGER countries. AGING countries exhibit higher replacement rates, negatively impacting the growth of pension funds relative to YOUNGER countries.

AGW exhibits a negative and significant relationship with PFG at the 1%, 5%, and 1% levels, respectively. Furthermore, an increase of 1% in AGW is associated with a decrease in the current year's PFG of 0.268%, 0.141%, and 0.233% in FE, RE, and pooled-OLS, respectively. Comparing AGING and YOUNGER countries reveals that AGING countries exhibit a positive relationship, whereas YOUNGER countries demonstrate a negative relationship between AGW and the current year's PFG. The lower average wage in YOUNGER countries restricts workers' participation in pension schemes compared to those in AGING countries.

WRK exhibits a negative and statistically significant relationship with PFG at the 5%, 1%, and 1% levels, respectively. Furthermore, an increase of 1% in WRK is associated with a decrease in the current year's PFG by 0.187%, 0.226%, and 0.143% in FE, RE, and pooled-OLS, respectively. Comparative analysis of AGING and YOUNGER countries reveals that AGING countries exhibit a positive correlation between working age (WRK) and current year's PFG, whereas YOUNGER countries demonstrate a negative correlation. This may be attributed to the lower average working age in YOUNGER countries compared to AGING countries.

ER demonstrates a positive and statistically significant relationship with PFG at the 1% level across all instances. Furthermore, an increase of 1% in ER is associated with a rise in the current year's PFG by 0.162%, 0.201%, and 0.311% for FE, RE, and pooled-OLS, respectively. Comparative analysis reveals that the coefficients of AGING countries exceed those of YOUNGER countries. The employment rate is higher in AGING countries, while YOUNGER countries present fewer opportunities.

SR exhibits a positive and statistically significant relationship with PFG at the 5%, 5%, and 10% levels, respectively. Furthermore, an increase of 1% in SR is associated with a rise in the current year's PFG by 0.112%, 0.150%, and 0.177% in FE, RE, and pooled-OLS, respectively. Comparative analysis reveals that the coefficients of AGING countries exceed those of YOUNGER countries. In AGING countries, higher income levels contribute to a greater propensity for individuals to save for future

benefits. Conversely, in YOUNGER countries, individuals have lower incomes and exhibit reduced tendencies to save for future retirement plans.

PTR exhibits a negative and statistically significant relationship with PFG at the 1%, 5%, and 5% levels, respectively. Furthermore, an increase of 1% in PTR is associated with a decrease in the current year's PFG by 0.685%, 0.201%, and 0.412% in FE, RE, and pooled-OLS, respectively. Comparing AGING and YOUNGER countries reveals that AGING countries exhibit a positive relationship, whereas YOUNGER countries demonstrate a negative relationship between PTR and the current year's PFG. This may be attributed to the lower average PTR in YOUNGER countries, resulting in fewer opportunities for individuals to save in social security contributions.

GDPG exhibits a positive and statistically significant relationship with PFG at the 5%, 10%, and 5% levels, respectively. Furthermore, an increase of 1% in GDPG is associated with increases of 0.592%, 0.396%, and 0.228% in the current year's PFG for FE, RE, and pooled-OLS, respectively. Comparative analysis reveals that the coefficients for AGING countries exceed those of YOUNGER countries. The GDP rate is comparatively higher in AGING countries.

The exchange rate (EXR) exhibits a negative and significant relationship with public financial governance (PFG) at the 1%, 5%, and 1% significance levels, respectively. Furthermore, an increase of 1% in EXR is expected to result in a decrease of 0.550%, 0.375%, and 0.112% in the current year's PFG for FE, RE, and pooled-OLS, respectively. Comparative analysis reveals that the coefficients of AGING countries are lower than those of YOUNGER countries. The explanation lies in the fact that exchange rates in YOUNGER countries are relatively elevated.

Table 4 indicates that for the YOUNGER-Countries sample, the Consumer Price Index (CPI) exhibits a negative and statistically significant relationship with the Price of Food Grains (PFG) at the 5% level across all instances. Furthermore, an increase of 1% in CPI is associated with a decrease in the current year's PFG by 0.124%, 0.201%, and 0.129% in FE, RE, and pooled-OLS, respectively. Comparative analysis of AGING and YOUNGER countries reveals that AGING countries exhibit a positive relationship, whereas YOUNGER countries demonstrate a negative relationship between CPI and the current year's PFG. This may be attributed to the higher inflation rates in YOUNGER countries compared to AGING countries, which hinders the growth of pension funds.

Conclusion

This study analyzes the significance of macroeconomic factors in an economy, specifically focusing on pension-related factors and other factors that influence the growth of pension funds. Data for the empirical analysis of this study was collected from various sources, including the OECD data repository and the statistical profiles of individual countries.

A dynamic panel data regression model was utilized employing the fixed, random, and pooled effect technique. The results demonstrate that DR, RR, and EXR exhibit negative and significant outcomes, while ER, SR, and GDPG display positive and significant results concerning the growth of pension funds in AGING and YOUNGER countries. Last year's PFG, including AGW, WRK, PTR, and CPI, demonstrated mixed results. Specifically, these indicators exhibit positive and significant behavior in AGING countries, while showing negative and significant results in YOUNGER countries. It indicates that in YOUNGER countries, there are lower wage rates, a younger working age, reduced personal tax rates, and elevated inflation rates, all of which adversely affect the growth of pension funds. Conversely, AGING countries exhibit the opposite trends.

For comparative analysis, three approaches were utilized: fixed effect, random effect, and pooled-OLS. The results included R-square, F-test value, AIC, and BIC. The p-values for testing heteroskedasticity and serial correlation indicate the absence of these issues in the data, as the null hypothesis of no heteroskedasticity and no serial correlation is not rejected. The VIF column in the correlation matrix indicates that there is no evidence of multicollinearity among the observed variables. The results corroborate existing literature and theories regarding their significant relationships with the growth of pension funds. In summary, the

aforementioned macroeconomic factors significantly contribute to the growth of pension funds in selected OECD countries. The coefficients for AGING countries are distinct from those of YOUNGER countries.

Research Implication or Contribution

This study enhances the literature by categorizing OECD countries into high growth (AGING) and low growth (YOUNGER) based on the growth patterns of their pension funds. YOUNGER countries exhibit distinct characteristics regarding last year's PFG, average wage, working age, personal tax rates, and inflation rate when compared to AGING countries. A comparative analysis of AGING and YOUNGER countries was conducted using three approaches: fixed effect, random effect, and pooled OLS. Additionally, AIC and BIC were computed to determine the optimal model selection. Economic factors were categorized into pension-related factors (DR, RR, AWG, WRK, SR, and PTR) and miscellaneous factors (Inflation, ER, GDPG, and EXR), both of which significantly relate to the growth of pension funds in AGING and YOUNGER countries.

This study presents several practical implications as outlined below:

This study enables OECD analytical officers to discern the patterns of pension growth in AGING and YOUNGER countries. The OECD pension outlook can present findings that illustrate the differing behaviors of YOUNGER countries in relation to last year's PFG, average wage, working age, personal tax rates, and inflation rate when compared to AGING countries. Pension fund authorities can analyze the changing patterns of macroeconomic factors in AGING and YOUNGER countries and provide policy recommendations to pension fund management companies to benefit retired employees.

Research Limitations and Recommendations

This study categorizes OECD countries according to the growth of pension funds; however, alternative classifications can be made based on other metrics, such as income equality, utilizing the Gini coefficient. Additional research may be undertaken to examine the bidirectional causal relationship between PFG and various macroeconomic variables, including GDP and the savings rate.

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