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Pension Reform and Stock Market Development

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Pension Reform and Stock Market Development

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ABSTRACT: We highlight the strong connection between developing fully-funded, individually-owned, collectively-managed, mandatory/incentivized (FICMI) pension schemes and the development of domestic stock markets. We do so by building a stylized model and complementing the analysis with cross-country empirical analysis and case studies. We also highlight the challenges of individual impatience, network externalities, and coordination failure in long-term equity investments, which are crucial for stock market development and technological innovation. We find that FICMI pension schemes—when sufficiently wide in coverage and large in size—can serve as coordination devices to support long-term equity investments. Such investments will not only promote domestic stock market development and make it easier for *firms* to raise long-term equity capital, therefore supporting long-term economic growth, but also enhance financial inclusion and enable more *households* to benefit from the overall economic development, therefore contributing to inclusive growth. Moreover, we find that the introduction of FICMI pension schemes can impact household savings in two ways: first, FICMI pension can increase household savings through "forced/incentivized" savings channel, where households save too little without FICMI pension (such as in many EMDEs); and second, FICMI pension can decrease household savings and increase household consumption by reducing non-pension savings and decreasing precautionary savings, where households save too much without FICMI pension (such as in China). In both cases, FICMI pension schemes can help move the economy closer to the optimal *level* of household savings, and may also help improve the *structure* of such savings. Finally, we discuss the enabling conditions (such as a strong political commitment to the reform and a well-designed fiscal strategy for financing the transition) and policy design for FICMI pension schemes.

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I. INTRODUCTION

A. Motivations and Summary of Main Channels

Pension reforms are urgently needed to address the challenges of population aging. According to the 2019 World Population Prospects, one in six people in the world by 2050 will be over age 65, up from one in eleven in 2019. It has been argued that, in countries like China, weak social security systems can lead to a higher level of household savings, posing challenges to the rebalancing from investment to consumption, a point emphasized by the China Article IV staff reports of the IMF in recent years (IMF, 2022a; IMF, 2023a). Moreover, in a number of emerging market and developing economies (EMDEs), two critical driving forces for persistent housing boom/bust cycles and resource misallocations are: first, weak social security systems, which necessitate increased household savings for future retirement; and second, underdeveloped domestic capital markets (particularly stock markets), resulting in a lack of attractive non-housing financial products and leading to savings being disproportionately allocated to housing (see Bayoumi and Zhao, 2021). But *how* can social security systems be strengthened and domestic stock markets be developed?

This paper proposes that a potential solution is to promote the development of fully-funded, individually-owned, collectively-managed, and mandatory/incentivized (FICMI) pension schemes, such as the 401(k) scheme in the U.S. Through stylized models, empirical analysis, and case studies, we underscore several important benefits of developing FICMI pension schemes beyond ensuring security of retirement incomes. The *first contribution* of the paper is that it empirically and theoretically establishes a strong connection between developing FICMI pension schemes and developing stock markets. In particular, FICMI pension schemes impact stock market development—and therefore economic growth, income distribution, and household savings—through several channels.

- *Long-term equity capital channel*: Being *patient* investors, FICMI pension funds can afford to make long-term investments in capital markets (especially stock market) due to their steady cash inflows (pension contributions) and relatively predictable/remote cash outflows (future pension payments). Being *large* investors, FICMI pension funds can also (partially) internalize positive externalities of equity investments and effectively diversify away some of the idiosyncratic risks of individual stocks. As such, FICMI pension schemes would make it easier for firms to raise long-term equity capital through capital markets, which in turn promotes R&D, innovation, and technological advancement, ultimately enhancing the TFP and boosting economic growth. Note that our paper focuses on the impact of FICMI pension funds on stock market development, given the extensive literature about the impact of stock market development on the macroeconomy.

- *Financial inclusion channel*: While the previously mentioned channel operates through the corporate sector, this channel operates through the household sector. Specifically, FICMI pension funds improve access to stock markets and expand the investment options for households, particularly for households with limited direct access to financial instruments such as corporate equities and government/corporate bonds. By indirectly investing in a broader set of asset classes through FICMI pension funds, such households would be able to benefit more broadly from future economic growth and from the higher TFP generated by the aforementioned corporate channel. As a result, more households would be able to reap benefits from the broader economy.[2] [3]
- *Intertemporal optimization channel*. This is the second household channel, which has two sub-channels.
    - *Forced/incentivized savings sub-channel*. For households with insufficient savings, such as households in many EMDEs, FICMI pension schemes will force/incentivize them to save more and become indirect investors on stock markets. This will move the insufficient households' savings closer to the optimal level and also increase the supply of long-term and patient capital, thereby contributing to economic growth.
    - *Portfolio rebalancing sub-channel*. By acting as patient institutional investors and collective investment managers, FICMI pension funds can potentially promote healthy development of stock market and increase the attractiveness of, and access to, corporate equities and government/corporate bonds. This, in turn, would decrease the over-reliance on bank deposits or housing as savings vehicles, and help households achieve a more balanced savings portfolio. This would lead to higher or more sustainable investment returns, consequently reducing the amount of savings needed to reach a specific future consumption target (in cases where income effect dominates the substitution effect, as detailed in our modeling section). This, in turn, would free up resources for immediate consumption. For countries where there are excessive household savings (such as some countries in East Asia), this sub-channel could help decrease savings and increase current

[2] To be sure, without FICMI pension, households can also access corporate equities and government/corporate bonds indirectly through, for example, mutual funds and ETFs (and continued capital market innovations have lowered the transaction cost and made it easier for households to access financial instruments). The difference, however, is that the impatience of individual households could force mutual funds and other non-pension collective investment schemes behave impatiently, much the same as retail investors, which seems to be the case in China and some other EMDEs. Therefore, such schemes will be very limited in size, just like the entire capital market.

[3] Note that simply improving financial inclusion alone will not eliminate the inefficiencies we have emphasized. Providing full access to all financial assets will merely transform this group into 'Agent 1' as described in our 'Extended Model' section, who is still subject to the externalities we emphasize.

consumption.[4] [5] Indeed, our model simulations indicate that, upon introducing a FICMI pension scheme and up to a certain threshold, the more a FICMI pension fund invests in corporate equities, the higher the current consumption would be. Furthermore, the greater the return on these equities, the more pronounced this consumption-boosting effect becomes.

The *second contribution* of the paper is that it highlights the challenges of individual impatience, network externalities, and coordination failure in long-term equity investments and stock market development. First, given the riskiness of equity investments and the presence of information transaction costs, small retail investors will not find equity investments attractive unless there are many investors pooling their funds together, allowing for adequate diversification of investment risk across many different stocks. Second, and more importantly, mutual funds and other non-pension collective investment schemes can potentially play a coordination role, but the impatience of individual investors and the associated redemption pressure could force such institutional investors behave impatiently as well, severely limiting the effectiveness of such collective investment schemes in promoting stock market development. FICMI pension funds, by investing collectively and patiently, could go a long way in helping alleviate the challenges of network externalities, coordination failure, and individual impatience in equity investments.

A related question is: why do governments intervene in the provision of retirement savings? Many rationales have been offered by existing literature, including myopic individuals or individuals with bounded rationality (see, for example, Angeletos et al., 2001, Benartzi and Thaler, 2007, and Beshears et al., 2018), collective risk-sharing (Hunt and Caliendo, 2022, and references therein), as well as income redistribution (Fullerton and Mast, 2005). This paper tries to offer another important reason, which is: due to network externalities of long-term equity investments, multiple equilibria exist in a country's long-term equity investment level, and the "good" equilibrium is not robust to noisy signals and misperceptions in the market, as shown in our game-theoretical model in Appendix 3. Government policies in designing, implementing, and/or incentivizing FICMI pension schemes could serve as an important coordination device to move the country to a higher level of equilibrium long-term equity investments, which in turn could help enhance the country's growth potential and income distribution.

[4] Although both the forced/incentivized saving sub-channel and the portfolio rebalancing sub-channel are present in theory, the latter may dominate the former in these cases.

[5] Note that we do not consider asset allocations abroad by pension funds; if we do, then this channel would be even stronger because households can then benefit from not only domestic assets (of relatively high returns) but also foreign assets. Of course, from a domestic capital market development perspective, it would be desirable for pension funds to focus its investments on domestic markets.

Of course, excessive government intervention in pension design and operation could lead to governance issues, such as directing pension savings into politically favored investments. Therefore, it is crucial to establish a robust governance framework (e.g., prohibiting politicians from selecting, or exerting influence on, specific investment products). We will explore these issues further in the case study and policy implications sections.

Finally, the *third contribution* of our paper is to shed light on some practical policy issues. For example, through discussions of country cases, enabling conditions, and various considerations, the paper presents policymakers with insights into the practical challenges—such as the fiscal cost associated with this transition to funded pension schemes—in pension reforms and explores strategies to address them. Furthermore, there is a clear link between our paper and the IMF's recent emphasis on domestic resource mobilization. Indeed, it is difficult to imagine how to raise $2.2 trillion of domestic resources every year in EMDEs[6] without developing domestic capital markets. This is especially the case because public resources are already stretched. The pension reform proposed in this paper is helpful for developing domestic capital markets and mobilizing private savings. Additionally, our model results, such as the finding that an excessively high contribution rate can lead to suboptimal outcomes, offer some qualitative guidance for addressing the practical challenge of determining an optimal contribution rate.

As a side note, we would like to offer some rationales for our focus on stock market development. First, the literature indicates that for young and innovative firms, "information problems, skewed and highly uncertain returns, and lack of collateral value likely make debt a poor substitute for equity finance" (Brown, Fazzari, and Petersen, 2009)—and we focus on R&D because innovation is crucial for enhancing productivity, a key issue in many countries today. Second, some countries, such as China, have shown that bond market can develop with the support of banks, whereas stock market cannot. Of course, pension reform does also influence bond market development[7] and could bring financial stability benefits, a topic that we will leave for future research.

Our analysis shows that FICMI pension schemes not only help achieve the optimal *level* of household savings, but also help improve the *structure* of such savings. Specifically, through the portfolio rebalancing sub-channel, households with FICMI pension could allocate part of their savings to stock markets for long-term equity investments, and they do so through collectively

[6] From Table 1 of the IMF (2024b) Policy Paper. The paper was also referenced in the IMF Managing Director's Global Policy Agenda presented during the 2024 Spring Meetings.

[7] For example, Arslanalp and Tsuda (2014) examine the role domestic nonbanks (pension funds, insurance companies, and investment funds) in sovereign debt markets. They find that these investors improve the "resiliency" of the sovereign debt markets across a variety of emerging markets and advanced economies.

managed pension funds with balanced and diversified portfolios, which could help achieve much better risk-return balances than investing directly in individual stocks. Through this sub-channel, households could diversify part of their savings away from bank deposits and housing markets, support innovation and productivity growth by investing in long term equity, and also benefit from broader productivity gains and economic growth through a healthy stock market.

B. Institutional Background and Terminology

This subsection provides some institutional background on pension schemes, drawing from the *OECD Pensions Outlook 2018*, Chapter 1. Pension payments can be financed by either general government revenues or earmarked levies on a pay-as-you-go (PAYG) basis. Alternatively, they can be fully funded through individual contributions and assets accumulated from such contributions. Pension payments could be pre-defined according to a formula (defined benefit, DB). Or, they can depend on the amount of assets accumulated, while the pension contributions are pre-defined (defined contribution, DC). And pension participation can be mandatory or voluntary.

Traditionally, a number of countries put in place PAYG DB pension plans, typically administered by public agencies. However, increased longevity and the declining ratio of actively employed contributors to retired beneficiaries pose threats to the financial sustainability of PAYG DB systems. In response, many countries have introduced supplementary pensions or are considering doing so in order to reduce the pressure on public finances. Typically, these supplementary pensions take the form of funded, defined contribution pensions, with individual ownership and usually managed by professional fund managers (either public or private).[8] As such, these supplementary pensions are often FICMI schemes.

Relatedly, IMF (2022b) finds that "public pension spending is often one of the largest single public expenditure items, especially in developed and emerging economies, often representing a double-digit share of GDP… Even relatively small and gradual changes can materially impact public finances in the long run…" Given that FICMI pension schemes involve relatively low fiscal costs compared with PAYG schemes, they hold the potential to effectively complement the public pension system.[9] [10] However, it is worth noting that, in some countries (regions), FICMI

[8] It is not always the case that funded pensions are managed by private entities, as exemplified in Singapore and Hong Kong.

[9] This is consistent with the OECD's advice, which encourages countries to diversify the sources of retirement income and to strengthen the degree of funding in the overall pension mix through a combination of PAYG and funded, or a combination of public and private provision (OECD, 2016, Chapter 1).

[10] The IMF's ongoing model refinements for the external balance assessment (EBA) also examine the impact of various pension system features on the current account gap.

pension schemes are not supplementary or complementary to PAYG DB public pension system. Instead, they are the primary (or the only) pension available. Examples include Singapore, Chile, and Hong Kong. In other countries like the U.S., FICMI pension schemes (such as 401(k)) play a very important role in supporting stock market development and also providing a significant source of retirement security.

More precisely, by "*fully-funded*", we mean that for each individual, upon retirement, accumulated pension assets fully match expected pension payouts; in other words, for each individual, expected pension payments will come entirely from such accumulated pension assets, without the expectation for any intra- or inter-generational transfer or any government intervention. By "*individually-owned*", we mean that there will be full property rights to each individual's pension contributions and related investment returns, except that governments can regulate investment options and mandate withdrawals only after the individual reaches a certain retirement age; relatedly, households would not be able to withdraw from FICMI prematurely without some penalty. By "*collectively-managed*", we mean that there is one or a number of professional investment managers, possessing the necessary qualifications and governed by sound practices, who manage the accumulated pension contributions either as one pension fund or as multiple collective investment schemes. This contrasts with private retirement savings, where individuals are allowed to have full control over their investments. And by "*mandatory/incentivized*", we mean that pension contributions are mandated by law, or strongly incentivized by tax benefits or other government regulations. Note that the design of auto-enrollment can also be regarded as partially satisfying this criterion in the sense that it mandates participation unless an explicit decision is made to opt out.[11] Auto-enrollment is one of the successful initiatives in recent decades with a significant impact on supplementary pension savings, as illustrated by the U.S. example in the subsequent case study section.

C. Selected Literature Review

Our paper broadly relates to four strands of literature. First, given the paper's implications for equity financing, it is related to the extensive literature on capital structure. The classic Modigliani–Miller Theorem (Modigliani and Miller, 1958) states that in the absence of taxes, bankruptcy costs, agency costs, and asymmetric information, and in an efficient market, the enterprise value of a firm is unaffected by how that firm is financed. Subsequent literature examines the optimal capital structure when these frictions do exist, and it includes at least two

[11] The design of auto-enrollment aims to leverage behavioral economic principles, particularly inertia. Many people fail to enroll in pension schemes due to procrastination, lack of knowledge, or the perceived complexity of making such decisions. Auto-enrollment simplifies the decision-making process by defaulting employees into saving for retirement, while still allowing them the freedom to choose not to participate if they decide it is not in their best interest.

competing schools of thought: The *"Trade-off Theory"*, initially proposed by Kraus and Litzenberger (1973), states that the optimal share of debt financing (hence equity financing) depends on the trade-off between the dead-weight costs of bankruptcy and the tax-saving benefits of debt. By contrast, the *"Pecking Order Theory"* proposed by Myers and Majluf (1984) states that firms first prefer internal financing, then debt, and lastly raise equity only as a "last resort". This theory is grounded on the assumption of asymmetric information, i.e., managers know more about their company's prospects, risks, and value than outside investors. Empirical evidence for both theories is mixed, and Fama and French (2002) criticize both theories in different ways. Moreover, Brealey, Myers, and Allen (2008) argue that the Pecking Order Theory does *not* apply to *high-tech* industries where equity financing is preferable due to the high cost of debt financing as assets are intangible. This argument is particularly relevant in our context because the main mechanism in our model involves the impact of equity financing (and pension schemes) on R&D.

Second, our paper connects to the literature on equity financing and innovation. Brown, Fazzari, and Petersen (2009) provide empirical evidence that young, high-tech, publicly-traded firms finance their R&D investment almost entirely through internal cash flow and external equity markets. They argue that "information problems, skewed and highly uncertain returns, and lack of collateral value likely make debt a poor substitute for equity finance", and thus, to the extent that these firms face financing constraints, exogenous changes in the supply of external equity should have significant effects on R&D. In this context, our paper establishes that well-calibrated pension fund reforms can indeed boost the supply of external equity and thus alleviate these *financing constraints*.

Further supporting evidence is reported in other studies. For example, using data on publicly traded UK firms, Aghion et al. (2004) find that firms that report positive R&D are more likely to use equity finance than firms that report no R&D. Using firm-level data, Garcia-Macia (2013) finds that innovation intensity predicts lower debt financing and argues that even if equity financing has other costs, it will be preferentially used as a source of external financing by the innovation-intensive firms that do not have internal funds. Using data on 32 developed and emerging countries, Hsu, Tian, and Xu (2014) find that industries that are more dependent on external finance and that are more high-tech intensive exhibit a disproportionally higher innovation level in countries with better-developed *equity* markets.[12]

[12] Using the US data from 1976 to 2006, Acharya and Xu (2017) find that public firms in external finance-dependent industries spend more on R&D and generate a better patent portfolio than their private counterparts. Kerr and Nanda (2015) provide a comprehensive review of literature on financing innovation.

Third, our paper contributes to the literature on pension reforms. For example, Amaglobeli et al. (2019) find that "countries with an enabling macroeconomic and legal environment and sufficiently developed financial systems could consider complementing the public pension scheme with a funded defined contribution scheme," and that "the ability of households to save for retirement and to diversify retirement-related risks will depend on the availability of a wide array of relevant financial products." We reach a similar conclusion, with one of our contributions being the emphasis on the *mutually reinforcing* feedback between the development of FICMI pensions and that of the stock market. In addition, Fouejieu et al. (2021) examine Europe's reforms on public pension systems and present a novel measure of the balance between pension benefits and contributions.[13] Furthermore, our paper is related to the large literature about the transition from PAYG to a funded system, such as Huang, Imrohoroglu, and Sargent (1997), Rudolph and Rocha (2009), Kudrna, Tran, and Woodland (2019), and Heer, Polito, and Wickens (2020).

Fourth, our paper is related to the literature on patient and long-term capital. Cremers and Petajisto (2009) find that funds with a high "active share"—defined as the proportion of the fund's holdings that significantly differ from those of its benchmark index (e.g., the S&P 500), indicating a higher degree of active management—in the U.S. tend to outperform the benchmarks. Moreover, Cremers and Pareek (2016) find that this outperformance is stronger among the high-active-share funds that can also be identified as "*patient*", meaning with holding durations of over two years.[14] And Ivashina and Lerner (2019) note that "in many cases, despite the abundance of capital and substantial need for returns, long-term investments have been problematic at best." They outline the key challenges facing long-term investments and suggest ways to address them. Finally, in a study closely related to ours and using a comprehensive Danish dataset, Beetsma et al. (2024) find that following a pension fund equity investment, firm productivity has experienced a substantial increase, averaging between 3 percent and 5 percent; the effect is particularly pronounced for unlisted and small firms. Additionally, they find that pension funds tend to invest for longer periods than other institutional investors, such as private equity. They interpret these findings as being consistent with pension funds engaging in long-term financing commitments and enabling firms to make productivity-enhancing investments.

[13] Focusing on the Central, Eastern, and Southeastern Europe, Batog et al. (2019) find that fiscal pressures from rapidly-shrinking working-age populations could displace public or private investment through a combination of increases in taxation and spending compression, or if accommodated by increased public debt and higher borrowing costs.

[14] Cremers, Fulkerson, and Riley (2019) provide a comprehensive review of the past 20 years of academic literature on actively managed mutual funds and conclude that the conventional wisdom is too negative on the value of active management.

The rest of the paper is structured as follows. Section II conducts empirical analysis using OECD data; Section III presents a stylized model and its extension to illustrate the main propositions; Section IV presents several country case studies, which also cover non-OECD countries to expand the scope of our analysis; Section V discusses enabling conditions and further considerations; Section VI concludes and discusses policy implications. The appendices collect some technical details.

II. EMPIRICAL ANALYSIS

A. Empirical Approaches

Our main empirical approach is cross-country panel regression, which we complement with another method—local projections (see Appendix 1). It is natural to regress an indicator of stock market development on an indicator of funded pension assets and other controls. However, doing so may be subject to endogeneity concerns. For example, there may be an issue of reverse causality because stocks are usually part of the funded pensions' portfolios. To mitigate this concern, we instead regress indicator of stock market development (stock market capitalization-to-GDP ratio) on pension *contributions* to "funded and private pension schemes" (FICMI schemes) as a percent of GDP. We focus on the contributions rather than the assets of pension funds to avoid the reverse causality—many pension funds invest in stocks, so a higher stock market capitalization-to-GDP can increase the assets of these pension funds. Specifically:

$$Stock\_Mktcap\_GDP\_Ratio_{i,t} = \beta_0 + \beta_1 Contribution\_GDP\_Ratio_{i,t} + \beta_2 L.Contribution\_GDP\_Ratio_{i,t} + \eta Z_{it} + \alpha_i + \gamma_t + \epsilon_{i,t}$$

Where:

- $Stock\_Mktcap\_GDP\_Ratio_{i,t}$ is the stock market capitalization-to-GDP ratio in country i and year t, in percentage points. It measures the development of a country's equity market. Note that this indicator captures both the *price channel* (the impact of the pension system reform on stock price) and the *quantity channel* (the impact on the issuance of new equities).
- $Contribution\_GDP\_Ratio_{i,t}$ is the annual contribution (i.e., the flow of contribution) to funded and private pension schemes in country i and year t, as a percent of GDP. The larger this ratio is, the more prominent such pension funds are in the country. Note that this does not include contributions to PAYG pensions or social security taxes. $L.Contribution\_GDP\_Ratio_{i,t}$ is the lag term, aimed to capture the lagged response of the stock market to changes in pension contributions.
- Z_{it} is a vector of control variables, including real GDP growth (GDP_G), short-term deposit rate ($DepRate\_ST$), population growth (Pop_G), and the first lags of these

variables.

- α_i is the country fixed effect (FE). We also conduct the random effect (RE) analysis and use the Hausman test to compare the FE and RE results.
- γ_t is the year fixed effect. It is aimed at capturing impact of other time-specific forces, including business cycles, reforms that directly affect the stock market, and other relevant omitted variables.
- $\epsilon_{i,t}$ is the error term.

To further examine the link between pension reform and stock market development, we then incorporate government *regulations* on pension funds' investment strategies. The motivation is that if a more developed pension fund system indeed benefits a country's stock market development, then allowing pension funds to invest a larger share of their portfolios on equities would raise the country's stock market capitalization, provided such investment limits are a binding constraint.[15] Specifically, we conduct the following panel regression:

$$Stock\_Mktcap\_GDP\_Ratio_{i,t} = \beta_0 + \beta_1 Contribution\_GDP\_Ratio_{i,t} + \beta_2 L.Contribution\_GDP\_Ratio_{i,t} + \beta_3 EquityLimit_{i,t} + \beta_4 L.EquityLimit_{i,t} + \eta Z_{it} + \alpha_i + \gamma_t + \epsilon_{i,t}$$

where the $EquityLimit_{i,t}$ is the maximum share of portfolios that pension funds are allowed to invest in equities in country i and year t, and $L.EquityLimit_{i,t}$ is the lag term. In one empirical specification, we also include the lagged dependent variable as another regression to account for potential reverse causality.

We perform all regressions with and without *clustering* standard errors at the country level. Such clustering can account for serial correlation within countries, given that errors associated with a given country might be correlated over time.

It could be interesting to examine whether the impact of FICMI differs in low- vs. high-interest rate environments because, for example, pension funds' incentive of search for yield would be stronger in a low-rate environment. However, there are some practical constraints. First, as shown by Antolin et al. (2011) and some follow-up studies, the insolvency pressure and thus incentive of search for yield would be stronger for defined-benefit (DB) pension funds than defined-contribution (DC) pension funds because the former need to keep the promises of the pre-determined benefits. Second, the same paper shows that the extent of search for yield is also affected by whether the country has solvency regulations on pension funds or not. Given that our main focus is not on the difference between DB and DC, but rather on the "funded" nature (i.e.,

[15] Doing so could also mitigate endogeneity concerns about the previous empirical design, as these regulations (and their changes) on pension funds' investment strategies are potentially exogenous with respect to stock market development.

the impact of funded pension schemes, regardless of being DB or DC), we will leave this analysis to future research.

B. Data

The pension contribution data are from OECD, covering the annual data from 2001 to 2020 for 36 OECD countries.[16] We use the contribution data only for funded pensions to directly test our propositions, given our focus on funded pensions rather than all types of pensions. And to prevent the results from being disproportionally influenced by extreme values, we drop the bottom 1 percentile and the top 1 percentile values of the pension contribution-to-GDP data; note that doing so does not lead to a smaller number of countries with available pension contribution-to-GDP data. Our results are not affected qualitatively after dropping other percentiles; but due to the relatively small sample, our main results are obtained after dropping the bottom and top 1 percentiles. Meanwhile, after merging with the data on the controls (from the IMF's WEO database)—real GDP growth (GDP_G), short-term deposit rate ($DepRate\_ST$), and population growth (Pop_G), we obtain 30 countries with available data in our sample.

In addition, we manually compile and merge with the equity limit data based on the text tables in OECD (2022)'s *Annual Survey of Investment Regulation of Pension Funds and Other Pension Providers (2022)*.[17] The survey report not only contains information on the *current* (as of 2021) portfolio limits on pension funds' investment in selected asset categories (such as equity and real estate) for OECD countries, but also information on the major changes to these limits during the period 2002-2021. To the extent that these investment limits are exogenous to domestic stock market developments, such data provide a valuable perspective for analyzing the impact of pension fund investment regulations on domestic stock market development. Appendix 2 presents the summary statistics (including the year and country distributions) for the final dataset used in our main regression tables (i.e., Tables 1-3).

C. Empirical Results

Results from the panel regressions are presented in Table 1. As shown in the table, the contemporaneous funded pension contribution-to-GDP ratio exhibits a positive and statistically significant association with the stock market capitalization-to-GDP ratio. This is evident across the majority of specifications we consider, such as including the year dummies (to account for, e.g., business cycles) and clustering standard errors. Note that the lagged pension contribution-to-GDP ratio is not statistically significant, probably because one period in our specification

[16] Ireland and Sweden are the only two OECD countries that do not have this data.

[17] The merging with the equity limit data does not lead to a smaller number of countries with available data.

corresponds to one year, a period that seems long enough for pension funds to adjust their portfolio allocations.

We also employ both fixed-effect model and random-effect model and select between the two using Hausman tests (the low p-values of Hausman tests suggest a preference for the fixed-effect model). These results provide supportive evidence for the main propositions of our paper.

Table 1. Funded Pension Contribution-to-GDP and Stock Market Cap-to-GDP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	RE	Year Dummy, FE	Year Dummy, RE	Clustered, FE	Clustered, RE	Clustered, Year Dummy, FE	Clustered, Year Dummy, RE
Contribution_GDP_Ratio	5.408*	7.156**	4.180	5.485**	5.408***	7.156***	4.180***	5.485***
	(0.055)	(0.011)	(0.120)	(0.046)	(0.002)	(0.000)	(0.003)	(0.000)
L.Contribution_GDP_Ratio	-1.289	-0.735	-0.046	0.886	-1.289	-0.735	-0.046	0.886
	(0.644)	(0.793)	(0.986)	(0.747)	(0.555)	(0.721)	(0.979)	(0.594)
GDP_G	0.338	0.365	1.885**	1.150	0.338	0.365	1.885**	1.150**
	(0.522)	(0.488)	(0.015)	(0.123)	(0.384)	(0.385)	(0.025)	(0.048)
L.GDP_G	0.608	0.557	0.116	-0.383	0.608	0.557	0.116	-0.383
	(0.288)	(0.331)	(0.876)	(0.616)	(0.326)	(0.373)	(0.822)	(0.423)
DepRate_ST	5.665***	5.062***	7.374***	5.146***	5.665**	5.062**	7.374**	5.146**
	(0.000)	(0.002)	(0.000)	(0.005)	(0.022)	(0.020)	(0.021)	(0.040)
L.DepRate_ST	-6.460***	-7.144***	-4.046**	-5.978***	-6.460***	-7.144***	-4.046**	-5.978***
	(0.000)	(0.000)	(0.017)	(0.001)	(0.003)	(0.000)	(0.025)	(0.000)
Pop_G	-3.880	1.364	-0.737	4.457	-3.880	1.364	-0.737	4.457
	(0.577)	(0.845)	(0.913)	(0.518)	(0.488)	(0.780)	(0.865)	(0.287)
L.Pop_G	0.542	2.238	-2.271	-0.796	0.542	2.238	-2.271	-0.796
	(0.936)	(0.739)	(0.728)	(0.906)	(0.898)	(0.556)	(0.682)	(0.862)
Constant	66.611***	58.924***	30.805**	45.148***	66.611***	58.924***	30.805	45.148***
	(0.000)	(0.000)	(0.010)	(0.000)	(0.000)	(0.000)	(0.119)	(0.000)
Observations	458	458	458	458	458	458	458	458
R-squared	0.077		0.229		0.077		0.229	
Hausman Test P-Value	0.0003		0.0000					
Number of Countries	30	30	30	30	30	30	30	30

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. FE = fixed effect; RE = random effect.
Sources: OECD; Authors' calculations.

Reverse Causality and Equity Investment Limit

It is possible that the correlation we detected in the panel regressions is simply driven by reverse causality, that is, a more developed stock market enables pension funds to grow and thus to attract higher contributions from households. To account for this and other potential undetected endogeneity concerns, we use the Arellano-Bond estimation, a widely used Generalized Method of Moments technique designed for dynamic panel data. The Arellano-Bond estimator mitigates the potential endogeneity concerns by transforming the regression equation into first differences,

which eliminates unobserved time-invariant effects. Specifically, we use lagged levels of the dependent and endogenous independent variables as instruments for the differenced equation. It is worth noting that while the Arellano-Bond estimator transforms the original variables into first differences, the instruments remain in levels (or appropriately lagged levels), a typical practice in the literature (see, for example, Chernozhukov et al., 2024. This distinction ensures that our instrumentation strategy addresses endogeneity while retaining sufficient variation for estimation.

The results, reported in Table 2, are qualitatively the same as those without the dependent variable. In particular, the funded pension contribution-to-GDP is still positively associated with the stock market capitalization-to-GDP.

Note that, as is common in many applications, including the lagged dependent variable and estimating using the Arellano-Bond method has reduced the magnitude of the main variable of interest. Nevertheless, a one-percentage-point increase in funded pension contribution-to-GDP ratio corresponds to a 1.9 percentage point increase in the stock market capitalization-to-GDP ratio. This effect is more than one-for-one. One possible reason can be that equity investments by pension funds enhance the functionality of the stock market, prompting more firms to opt for equity financing and encouraging more households to invest in equities. That is, there may be some positive spillover from pension investments in the stock market.

Table 2. Funded Pension Contribution-to-GDP and Stock Market Capitalization with Arellano-Bond (AB) Estimation (Accounting for Reverse Causality)

	(1) AB	(2) Year Dummy, AB	(3) Robust SE, AB	(4) Robust SE, Year Dummy, AB
L.Stock_Mktcap_GDP_Ratio	0.347***	0.382***	0.347***	0.382***
	(0.000)	(0.000)	(0.000)	(0.000)
Contribution_GDP_Ratio	3.937	1.912	3.937***	1.912**
	(0.105)	(0.385)	(0.009)	(0.038)
L.Contribution_GDP_Ratio	-1.816	-1.039	-1.816	-1.039
	(0.407)	(0.608)	(0.310)	(0.413)
GDP_G	0.382	0.992	0.382	0.992
	(0.389)	(0.104)	(0.537)	(0.107)
L.GDP_G	0.256	0.293	0.256	0.293
	(0.593)	(0.618)	(0.519)	(0.549)
DepRate_ST	0.156	1.108	0.156	1.108
	(0.917)	(0.505)	(0.925)	(0.479)
L.DepRate_ST	-3.105**	-2.048	-3.105	-2.048
	(0.012)	(0.136)	(0.120)	(0.122)
Pop_G	-6.842	-4.457	-6.842	-4.457
	(0.256)	(0.419)	(0.264)	(0.312)
L.Pop_G	-0.523	-6.379	-0.523	-6.379
	(0.928)	(0.242)	(0.913)	(0.201)
Constant	53.987***	65.573***	53.987***	65.573***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	412	412	412	412
Number of Countries	30	30	30	30

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. AB=Arellano-Bond.
Sources: OECD; Authors' calculations.

As discussed above, we also study the impact of the equity investment limit that governments impose on pension funds. As shown in Table 3, the effect is generally statistically insignificant (except in Column (4), where the lagged equity investment limit is positively correlated with the stock market capitalization-to-GDP ratio). This might suggest that the equity investment limit does not act as a binding constraint for most OECD countries during the majority of the years in our sample. Moreover, after adding the extra variable of equity investment limit, the effect of the funded pension contribution-to-GDP ratio remains almost unchanged, with a one-percentage-point increase in the pension contribution-to-GDP ratio corresponding to a 2.1 percentage-point increase in the stock market capitalization-to-GDP ratio.

Table 3. Equity Investment Limit, Funded Pension Contribution-to-GDP, and Stock Market Capitalization with Arellano-Bond (AB) Estimation

	(1) Both Variables, AB	(2) Year Dummy, Both Variables, AB	(3) Robust SE, Both Variables, AB	(4) Robust SE, Year Dummy, Both Variables, AB
L.Stock_Mktcap_GDP_Ratio	0.343***	0.376***	0.343***	0.376***
	(0.000)	(0.000)	(0.000)	(0.000)
Contribution_GDP_Ratio	3.948	2.073	3.948***	2.073**
	(0.104)	(0.347)	(0.009)	(0.026)
L.Contribution_GDP_Ratio	-1.816	-1.005	-1.816	-1.005
	(0.408)	(0.619)	(0.317)	(0.436)
EquityLimit	-0.021	-0.101	-0.021	-0.101
	(0.942)	(0.706)	(0.925)	(0.189)
L.EquityLimit	0.292	0.451	0.292	0.451***
	(0.454)	(0.193)	(0.479)	(0.002)
GDP_G	0.426	1.094*	0.426	1.094*
	(0.341)	(0.076)	(0.482)	(0.061)
L.GDP_G	0.269	0.279	0.269	0.279
	(0.576)	(0.637)	(0.498)	(0.585)
DepRate_ST	0.351	1.601	0.351	1.601
	(0.817)	(0.348)	(0.841)	(0.331)
L.DepRate_ST	-3.141**	-2.130	-3.141	-2.130
	(0.011)	(0.121)	(0.118)	(0.112)
Pop_G	-7.123	-4.310	-7.123	-4.310
	(0.240)	(0.434)	(0.230)	(0.313)
L.Pop_G	-0.512	-6.305	-0.512	-6.305
	(0.930)	(0.247)	(0.915)	(0.205)
Constant	29.900	32.981	29.900	32.981*
	(0.365)	(0.292)	(0.328)	(0.085)
Observations	412	412	412	412
Number of Countries	30	30	30	30

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. AB=Arellano-Bond.
Sources: OECD; Authors' calculations.

Bank Financing

We now examine the impact of pension fund development on the other segment of the domestic financial market—bank financing. Our objective is to determine if the growth of funded pensions has transitioned corporate financing from relying on banks to favoring equity, and equivalently, if it has shifted household saving preferences from bank deposits to equity investments. For brevity, we focus on results from specifications that mitigate potential endogeneity concerns, i.e., those with the Arellano-Bond estimation.[18]

The results are presented in Table 4, where the first four columns do not control for the equity investment limit, and the second four columns do. Results in Column (4) and Column (8) are most robust because they control for year dummies, which account for potential omitted variables that are important for the left-hand-side variable (bank loan balance-to-GDP ratio). Both columns show a negative correlation between contributions to funded pensions and the bank-loan-to-GDP ratio, and the coefficients (of the Contribution_GDP_Ratio variable) in both columns are statistically significant almost at the 10 percent significance level, with the p-value being 11 percent without the equity investment limit and 12 percent with it. Moreover, the magnitudes of the key coefficient in these two columns (i.e., with and without controlling for the equity investment limit) are also very close, suggesting that a one-percentage-point increase in the pension contribution-to-GDP ratio corresponding to a 1.8 percentage point decrease in the bank loan balance-to-GDP ratio.

This indicates that as the funded pension system develops, there is a notable change in the *financing* landscape: a reduced reliance on bank loans (lower bank loan balance-to-GDP ratio) and an increased importance of stock market. Correspondingly, there should be a notable change in the *savings* landscape: a reduced reliance on bank deposits and an increased investment in the stock market. This change in household savings behaviors can represent an enhancement in households' savings composition, given the typically higher returns of stocks than bank deposits, and given that pension funds typically have a balanced, diversified portfolio. This is particularly pertinent for a number of countries (such as some countries in East Asia), where a significant fraction of household savings is invested in low-yielding bank deposits (and housing). And consistent with findings on equity, the investment limit remains statistically insignificant in the case of the bank financing.

[18] The bank financing data are from Haver. After merging with the data on pension contribution and other controls, we still obtain a final dataset for 30 countries with available data.

Table 4. Funded Pension Contribution-to-GDP and Bank Loan-to-GDP with Arellano-Bond (AB) Estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	AB	Year Dummy, AB	Robust SE, AB	Robust SE, Year Dummy, AB	Both Variables, AB	Both Variables, Year Dummy, AB	Robust SE, Both Variables, AB	Robust SE, Both Variables, Year Dummy, AB
L.BankLoan_GDP_Ratio	0.330***	0.601***	0.330***	0.601***	0.332***	0.601***	0.332***	0.601***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Contribution_GDP_Ratio	-0.682	-1.803	-0.682	-1.803	-0.689	-1.779	-0.689	-1.779
	(0.760)	(0.274)	(0.711)	(0.111)	(0.758)	(0.281)	(0.701)	(0.124)
L.Contribution_GDP_Ratio	-0.701	1.028	-0.701	1.028	-0.684	1.019	-0.684	1.019
	(0.726)	(0.489)	(0.661)	(0.380)	(0.733)	(0.495)	(0.663)	(0.374)
EquityLimit					0.092	0.008	0.092	0.008
					(0.688)	(0.962)	(0.655)	(0.962)
L.EquityLimit					-0.276	-0.017	-0.276	-0.017
					(0.324)	(0.934)	(0.245)	(0.906)
GDP_G	-4.453***	-2.343***	-4.453***	-2.343***	-4.522***	-2.339***	-4.522***	-2.339***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.GDP_G	-0.923**	-0.521	-0.923*	-0.521	-0.927**	-0.504	-0.927*	-0.504
	(0.033)	(0.215)	(0.093)	(0.282)	(0.033)	(0.238)	(0.078)	(0.273)
DepRate_ST	-1.226	1.850	-1.226	1.850	-1.497	1.849	-1.497	1.849
	(0.331)	(0.106)	(0.374)	(0.164)	(0.249)	(0.119)	(0.279)	(0.144)
L.DepRate_ST	-2.853**	-2.189**	-2.853***	-2.189**	-2.767**	-2.184**	-2.767***	-2.184**
	(0.015)	(0.036)	(0.002)	(0.038)	(0.019)	(0.039)	(0.005)	(0.042)
Pop_G	-8.097	-2.468	-8.097	-2.468	-8.158	-2.537	-8.158	-2.537
	(0.153)	(0.553)	(0.267)	(0.546)	(0.152)	(0.545)	(0.257)	(0.525)
L.Pop_G	8.562	3.481	8.562**	3.481	8.741	3.580	8.741**	3.580
	(0.118)	(0.394)	(0.015)	(0.140)	(0.112)	(0.383)	(0.014)	(0.139)
Constant	189.391***	102.233***	189.391***	102.233***	206.073***	102.921***	206.073***	102.921***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	388	388	388	388	388	388	388	388
Number of Countries	27	27	27	27	27	27	27	27

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. AB=Arellano-Bond.
Sources: OECD; Haver; Authors' calculations.

D. Robustness Checks

To check the robustness of our results, we conduct several other tests. First, we use an alternative measure of the equity investment limit. This matters because some governments impose different limits on equity investments for different types of pension funds. For example, in 2006, Mexico expanded its investment limit on equities for non-mandatory funds from 15 percent to 30 percent, while keeping the limit for mandatory funds at 15 percent (OECD, 2022). In such cases, the empirical results presented earlier take the highest limit as the ultimate equity investment

limit. But to check the robustness, we now take the simple average of the multiple equity investment limits for different types of pension funds.[19]

The results for panel regressions (Approach #1) are presented in Appendix Table 4 (for stock market capitalization) and Appendix Table 5 (for bank financing). These results are qualitatively the same as, and quantitatively similar with, those presented in previous sub-sections. Specifically, a one-percentage-point increase in the pension contribution-to-GDP ratio corresponding to a 2.1 percentage-point increase in the *stock market* capitalization-to-GDP ratio in both Table 3 (Column (4)) and Appendix Table 1 (Column (4)), whereas the lagged equity investment limit is positively correlated with the stock market capitalization-to-GDP ratio in some specifications. And a one-percentage-point increase in the pension contribution-to-GDP ratio corresponds to a 1.8 percentage point decrease in the *bank loan*-to-GDP ratio in both Table 4 (Column (8)) and Appendix Table 5 (Column (4)).

The robustness check results for local projections (Approach #2) are presented in Appendix Figure 4 (for stock market capitalization) and Appendix Figure 5 (for bank financing). These results are also qualitatively the same as, and quantitatively similar to, those presented in previous sub-sections (Appendix Figures 1-3), confirming the robustness of our main results.

Second, we include a COVID dummy for the 2020 data. This is because many countries experienced pension contribution freezing or pension withdrawals during the COVID crisis (usually starting in the second half of 2020). In addition, the massive fiscal and monetary easing during the COVID era contributed to stock market booms in many countries, potentially complicating our analysis. The results are presented in Appendix Table 6 for stock market capitalization and Appendix Table 7 for bank financing. The coefficients and their statistical significance levels for our main variables are the same as those without controlling for the COVID dummy. This is probably because the COVID effect has been sufficiently captured by the year dummy in our previous analyses.

Third, we use both the average equity investment limit and the COVID dummy. The results for the main variables are again the same as those presented in previous subsections.

[19] Ideally, we should use the weighted average, with the weight being the share of a particular type of pension funds in the total pension funds. However, we do not have such granular data, so we use a simple average as a proxy.

III. STYLIZED MODEL

A. Benchmark Model

Our benchmark model illustrates the welfare implications in a simple portfolio choice model in the presence of: (1) a FICMI pension fund that allocates a fraction of the agent's income between a risk-free and a risky asset; (2) unobserved excess returns on long-term risky assets, which result in investors' under-investments in equity and over-investment in debt. The model is also used to demonstrate the trade-offs faced by the social planner due to the introduction of a FICMI pension scheme.

Model Set-up

We consider a three-period model, but the main results carry over to the multiperiod problem as well. During the "young" period (period $t = 1$), a fraction $\tau \geq 0$ of the agent's initial endowment y is collected by a pension fund as pension contribution. The pension fund, in turn, allocates a fraction $\eta \geq 0$ of the pension contribution to a risky asset (which can be regarded as equity) and the remaining fraction $1 - \eta$ to a risk-free asset (which can be regarded as risk-free debt issued by the firm).[20] The risk-free asset has a gross return denoted by R and is realized at the beginning of Period 2 and Period 3.

However, unlike the risk-free asset (bond), the return on the risky asset (equity) $\widehat{R_3}$ is realized only in the terminal period $t = 3$. This assumption captures the long-term nature of equity investment, which is a crucial difference from the debt investment. The justification for this assumption is that equity financing can be used to engage in long-term R&D activities, which will only generate returns in the long run (say, in 15 years).

With the remaining endowment $(1 - \tau)y$, the agent decides on his/her period-1 savings share $\widehat{\tau_1} \geq 0$ and thus the *quantity* of consumption c_1. The agent also decides on the *structure* of his/her saving by choosing to invest a fraction $\widehat{\eta_1} \geq 0$ of the savings in the risky asset and the remaining share $1 - \widehat{\eta_1}$ in the risk-free asset.

In the "middle-age" period $t = 2$, the return on the risk-free asset is realized, which combined with an exogenous endowment y form the initial asset holdings for the agent in that period. The agent chooses $\widehat{\tau_2}$ and $\widehat{\eta_2}$. In the "old" or retirement period ($t = 3$), we assume that the agent does not receive any income endowment and consumes all resources available from the investments made in the previous period. Thus, for a given pension fund allocation (τ, η), the agent chooses the quantity and structure of his/her saving $(\widehat{\tau_1}, \widehat{\eta_1}, \widehat{\tau_2}, \widehat{\eta_2})$ to maximize the expected lifetime utility:

[20] For simplicity, we assume that the firm will not default on its debt.

$$u(c_1) + \beta \mathbb{E}\{u(c_2)\} + \beta^2 \mathbb{E}\{u(c_3)\}$$

The agent's total savings by the end-of-period t consist of two sources—one being the investment by the pension fund (a_t) on behalf of the agent, and the other by the agent itself ($\widehat{a_t}$). Specifically, the total savings by the end of each period are given by:

$$a_1 = \tau y$$

$$\widehat{a_1} = \widehat{\tau_1}(1-\tau)y$$

$$a_2 = \tau[y + R[a_1(1-\eta_1) + \widehat{a_1}(1-\widehat{\eta_1})]]$$

$$\widehat{a_2} = \widehat{\tau_2}(1-\tau)\,[y + R[a_1(1-\eta_1) + \widehat{a_1}(1-\widehat{\eta_1})]]$$

Accordingly, the consumption in period $t = 3$ is given by the total resources from these two sources of investments:

$$c_3 = (R_3)^2\,(a_1\eta + \widehat{a_1}\,\widehat{\eta_1}) + R_3(a_2\eta + \widehat{a_2}\,\widehat{\eta_2}) + R[a_2(1-\eta) + \widehat{a_2}\,(1-\widehat{\eta_2})],$$

where the first term is the compounded return from the risky investment (through the pension fund and directly) made in period-1, the second term is the return on the risky investment made in period-2, and the third term is the return on the short-term risk-free investment made in period-2. Note that in practice, funded DC schemes do not imply that an individual's withdrawals at the time of retirement are equal to their account balances. In most DC schemes, members are required to annuitize or partially withdraw their balances. However, we do not expect this feature to materially affect our main results.

On the corporate side, we assume that the firm issues risk-free bonds and (risky) equities to finance its investments (i.e., we abstract from bank financing). Ultimately, the total investments by the firm are equal to the total savings by the household modeled above.

Importantly, we assume that the return *perceived* by the agent ($\widehat{R_3}$) is lower than the *actual* return (denoted by R_3),[21] and that the two returns satisfy the following relationship:

$$R_3 = \widehat{R_3} + \delta,$$

where the "premium" $\delta > 0$. This assumption captures the *network externalities and coordination failure* discussed earlier. To see the intuition, consider a situation where the firm invests in a large innovation project, and where an economy of scale exists. That is, the actual return of the project (financed by the funds raised through equities) will be $\widehat{R_3} + \delta$ if the amount of the funds (and of the investment) is kept above a large threshold throughout the investment cycle, but it will only be $\widehat{R_3}$ otherwise. However, possibly due to noisy signals and

[21] The perceived return $\widehat{R_3}$ is assumed to follow a log-normal distribution, with mean r and variance σ_r^2.

misperceptions in the market, every individual equity investor believes that not all other investors will keep the full amounts of their equity holdings through to Period 3, and that the total investment will fall short of the threshold. As a result, the return *perceived* by each individual investor is $\widehat{R_3}$, even if the actual total amount of funds would have been above the threshold and a higher return of $\widehat{R_3} + \delta$ would have been achievable if all investors coordinate to not withdraw part of their equities early.[22] The game-theoretical model in Appendix 3 elaborates this further.

Consequently, such network externalities and coordination failure would lead to the agent having a bias towards *short-term* risk-free debt as the agent underestimates the true return of the risky equity. This result will play a role in determining the agent's saving structure, i.e., the portfolio allocation between equity and debt.

We would like to note some differences between our model and other models on coordination failures, such as the model by Diamond and Dybvig (1983). For example, in our model, the consumer has the option to make both the short-term and long-term investments; by contrast, there is only one type of consumer (not the early and late consumers) in Diamond and Dybvig (1983). In addition, our model does not have the risk of a bank run, whereas this is a crucial feature in Diamond and Dybvig (1983).

Pension system: In the model, we consider a FICMI defined-contribution (DC) pension fund. We consider a DC pension system rather than a defined-benefit (DB) system because a DC system faces less pressure to pursue a target return rate and thus less pressure to frequently switch its investment strategies. In addition, even though members in individual DC pension arrangements often have significant flexibility in choosing and switching their investment strategies, the majority of individuals do not regularly switch investments within their DC retirement savings accounts (OECD, 2020, Chapter 5).[23]

[22] Note that the friction is the coordination failure rather than incomplete information. Even if the premium δ is observable to all investors, the lack of trust on other investors would still lead to the perceived return being lower than the actual return under coordination.

[23] As described in OECD (2020, Chapter 5), over a four-year period in the late 1990s, 87 percent of the individuals in a sample of 401(k) participants made no trades, and only 7 percent traded more than once (Agnew, Balduzzi, and Sundén, 2003). Similarly, a later study on 401(k) participants shows that 80 percent of participants made no trades, and only 9 percent traded more than once over a period of two years (Mitchell et al., 2011). A more recent study by Villatoro et al. (2019) shows that in Chile, only 6.6 percent of participants made active changes to their pension investment from 2007 to 2016. Moreover, the existence of a default investment strategy within DC retirement savings arrangements may reinforce individuals' tendency to not actively make an investment choice. For example, in Sweden, around 99 percent of new participants in the Premium Pension stay in the default strategy and do not actively choose/change their investment strategy (Frankkila and Lantz, 2020).

Optimal Allocation

As is standard in related literature, we further assume that the agent has CRRA utility with constant risk aversion ρ. While we consider the exogenous asset allocation by the pension fund for technical tractability, parameters of the allocation (τ, η) can be varied to simulate different levels of the pension fund contributions and various shares of equity investment in the pension portfolio (i.e., a conservative versus a growth-oriented allocation). Doing so also allows us to study the welfare implications for households for different allocation rules of the pension fund.

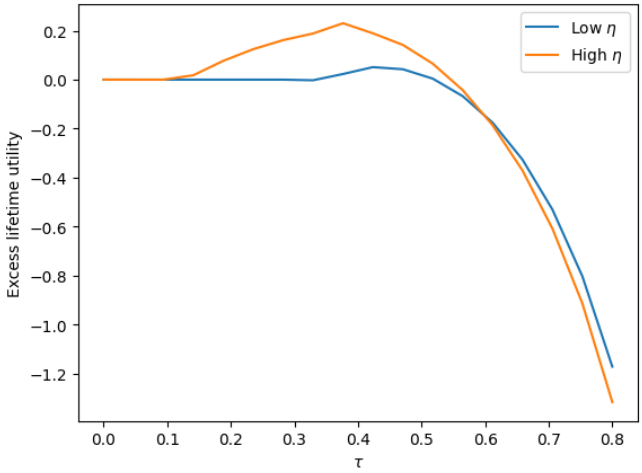
Our model simulations suggest that for low values of τ and η (i.e., low contributions to and conservative investment by the pension fund), there are no welfare gains from having a FICMI pension scheme, relative to a scenario without the pension scheme. This is because the low contribution requirement on the pension fund is non-binding for the agent; and by using the remaining financial resources (after paying the pension contribution), the agent can recreate the portfolio that he/she would have chosen to invest in the absence of the pension fund. This is depicted by the flat segment in Figure 1 (a), where the excess lifetime utility relative to the no-pension-scheme case is 0. Additionally, for excessively large values of pension contribution τ or equity allocation η, the agent is worse-off because the pension fund forces the agent to excessively contribute to the pension or excessively invest in the (risky) equity.

Nonetheless, our model simulations also suggest that there can be welfare gains from introducing a FICMI pension fund. This is because in the presence of the frictions, the agent chooses to save too little, and the portfolio allocation is too conservative due to an inefficiently high share of investment in (risk-free) debt.[24] This is depicted in Figure 1 (a), where the life-time utility with the FICMI pension is higher than that without it (i.e., the excess life-time utility is positive) for a certain range of the pension *contribution rate* under a proper share of equity investment. This can also be seen in Figure 1 (b), where the excess life-time utility is positive for a certain range of the *share of equity investment* in the portfolio under a proper rate of pension contribution. This result is intuitive: A properly designed[25] FICMI pension scheme would collect some household savings in a mandatory manner and invest a portion in equity, which mitigates the inefficiencies associated with the frictions discussed earlier, i.e., private agents underestimate the gains from long-term capital (equity) and thus underestimate the true return of equity relative to bond.

[24] Recall that for simplicity, we assume that the firm does not default on its debt.

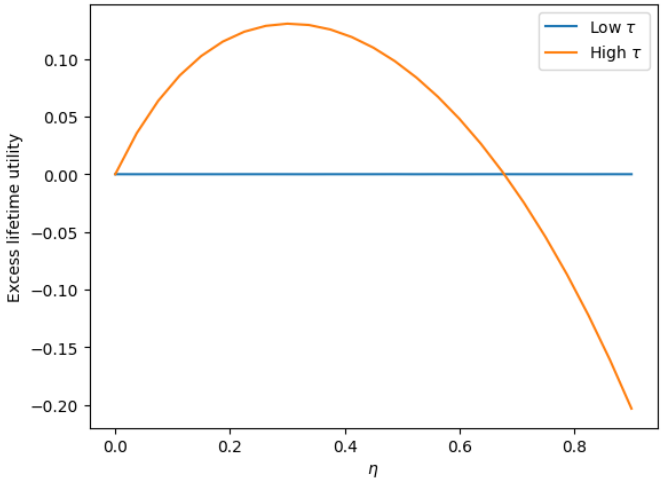
[25] For example, the contribution rate and share of equity investment should not be too high, otherwise it will "over-correct" the agents' choices and result in a lower welfare.

Figure 1 (a): Welfare Gain from Introducing a FICMI Pension Scheme as a Function of Pension Contribution for Low vs. High Equity Investment Shares



Source: Authors' calculations.

Figure 1 (b): Welfare Gain from Introducing a FICMI Pension Scheme as a Function of Pension Fund's Equity Investment for Low vs. High Pension Contribution

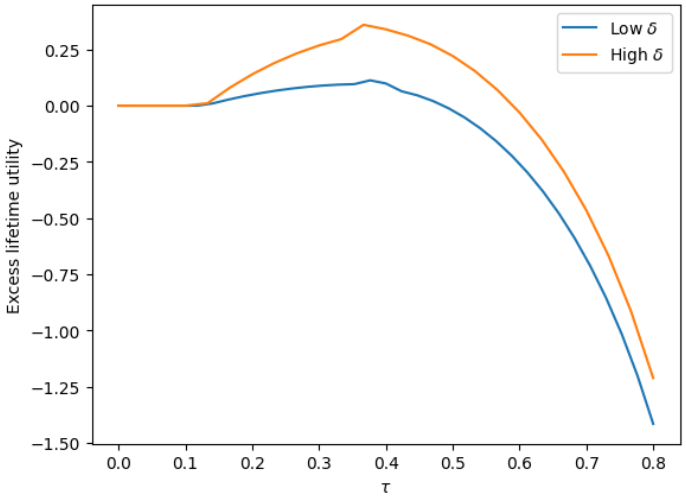


Source: Authors' calculations.

Moreover, our model simulations show that in general, the larger the size of the friction, the more likely the FICMI pension scheme will be able to improve the agent's welfare. As shown in Figure 2, an increase in the size of the friction (in this case, δ, which is the excess return of equity that is lost due to coordination failure) leads to an expansion in the range of pension contribution rates for which there is welfare improvement due to the pension scheme.

The analysis presented above also shows that while a FICMI pension scheme has the potential of improving agents' welfare by increasing the size of long-term capital and directing it towards productive assets (with the size of the welfare improvement dependent on the size of the friction), improper designs of the FICMI system could also lead to suboptimal outcomes, for example, when the mandatory contribution rate is too high or the portfolio allocation is too risky.

Figure 2: Welfare Enhancement through An Increase in Long-term Equity Capital



Source: Authors' calculations.

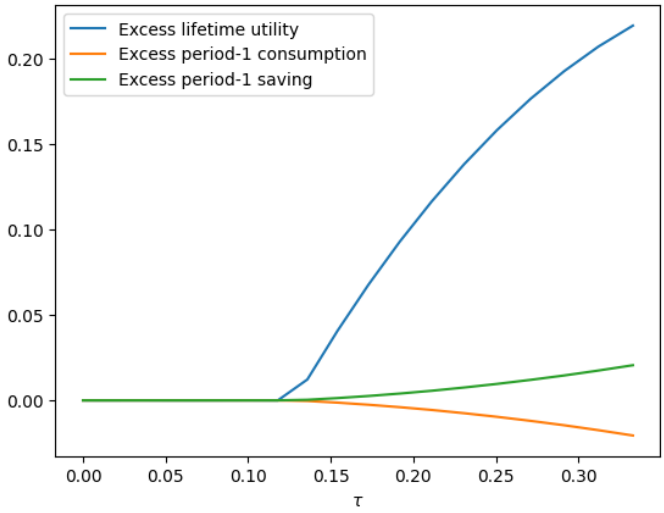
An Example of Welfare Enhancement through Forced/Incentivized Savings

Many EMDE countries face the challenge of inefficiently low (or negative) domestic savings and excessively high household consumption. Although this challenge is caused by many frictions, one important friction is the one considered in our model, that is, households do not fully internalize the benefits of saving more and enabling firms to build up their long-term capital. In such cases, a FICMI pension system can directly raise household savings, move the allocations closer to efficient levels, and improve households' welfare.

Figure 3 illustrates a numerical example for such a country. In this country, the aforementioned friction is so large that the household chooses an inefficiently high consumption in Period 1, and an inefficiently low saving, in the equilibrium without the pension scheme, resulting in a low welfare for the household. After the introduction of a FICMI pension system, and within a proper

range of contribution rates,[26] the investor raises his/her total savings (including the forced/incentivized saving through the FICMI pension and the "freely-chosen" savings), leading to lower period-1 consumption but higher overall welfare (as indicated by the positive excess utility in the figure).

Figure 3: An Example of Welfare Enhancement through Forced/Incentivized Savings



Source: Authors' calculations.

B. Extended Model

We now extend the benchmark model by introducing a second type of agent (Agent 2) who does not have direct access to investments in equity (i.e., the "risky asset"), that is $\widehat{\eta_t} = 0$. This agent can be broadly understood as representing the lower-and-middle-class households who usually invest little-to-zero in equities due to a lack of access to the equity markets, a lack of the necessary financial literacy, or even rational inattention.[27] If the agent had access to the risky asset, then his/her optimal share of risky investment would be positive and depend upon the agent's risk aversion, the riskiness of the asset, and the excess returns offered by the risky asset. Since this agent can only save via a low-return risk-free asset, his/her investment portfolio will

[26] That is, the contribution rate is high enough to impose a binding constraint on households but low enough to avoid too much saving.

[27] Such rational inattention exists not only in less developed countries but also in developed countries. For example, Agarwal et al. (2023) finds that even in the U.S., sophisticated consumers profit from reward credit cards at the expense of naive consumers, and that naive consumers also follow a sub-optimal balance-matching heuristic when repaying their credit cards.

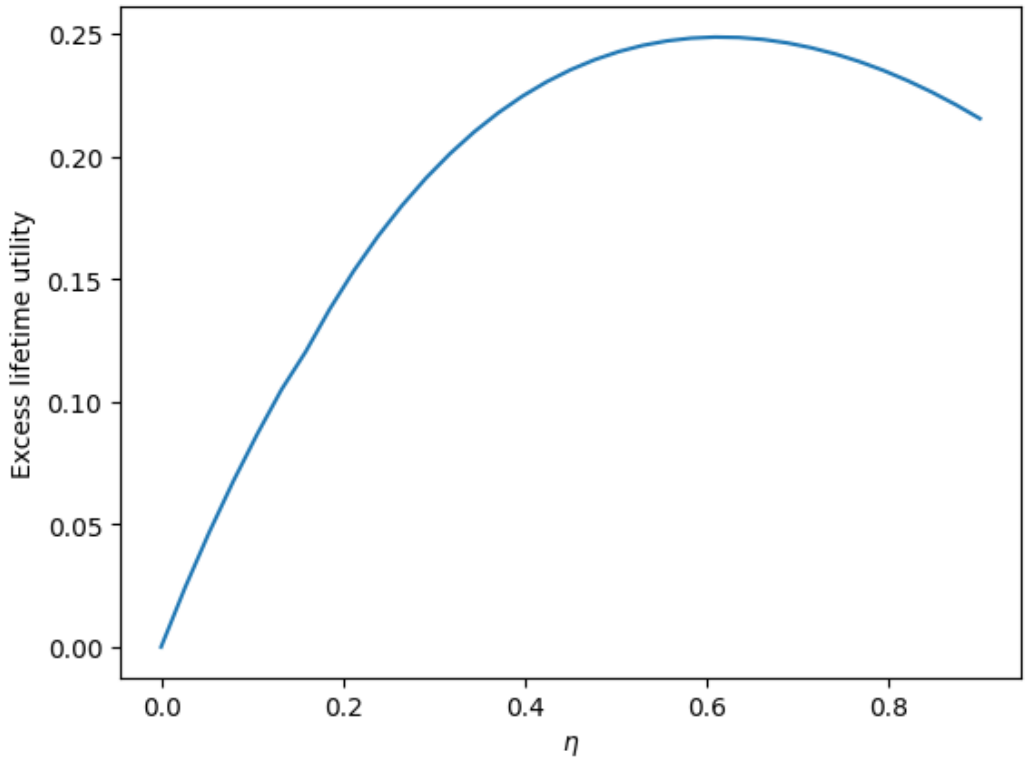
be sub-optimal. Moreover, his/her consumption will be suppressed due to excessive savings in the form of the low-return asset.

In this context, Agent 2 is more likely to benefit from a FICMI pension fund, which can indirectly provide the agent access to a broader set of asset classes and increase the likelihood of the agent's portfolio allocation moving closer to the optimal level of riskiness. This suggests that in economies where the financial sector is in a nascent stage, the introduction of a FICMI pension system can improve financial inclusion and increase the overall societal welfare.

An Example of Welfare Enhancement through Financial Inclusion and Portfolio Rebalancing

This argument can be illustrated in our stylized model. As illustrated in Figure 4, introducing the FICMI pension (with $\eta > 0$) raises the agent's lifetime utility relative to the case without the pension fund (in which case $\eta = 0$). Of course, this welfare-enhancing effect is present only up to a certain threshold because over-investment in the risky asset (equity) leads to excess risk-taking and thus a decline in the lifetime utility.

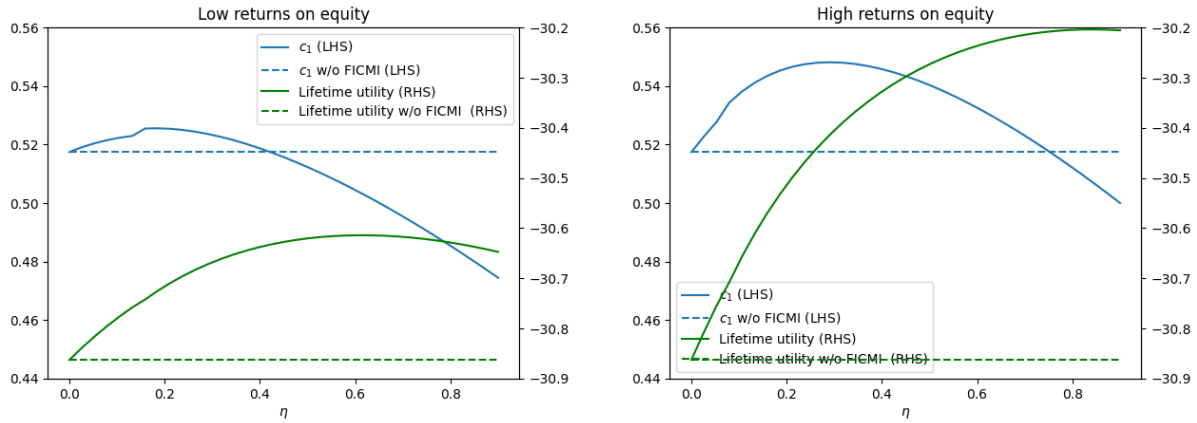
Figure 4: An Example of Welfare Enhancement through Financial Inclusion and Portfolio Rebalancing



Source: Authors' calculations.

We now examine the impact on consumption. As demonstrated in Figure 5, introducing the FICMI pension (with $\eta > 0$) raises the agent's period-1 consumption relative to the case without the pension fund (in which case $\eta = 0$).[28] Moreover, when the perceived return[29] from equity (i.e., the "risky asset") is high, a FICMI pension scheme that allocates a higher share of pension contributions to equity will also increase the consumption of the agent by a larger amount. To understand the intuition, note that after the introduction of a FICMI pension scheme, the agent can now access the higher-return equity investment through the pension fund. This portfolio rebalancing enhances the saving *structure* and raises the overall return of the agent's savings. This would raise the life-time income and increase current consumption (income effect); meanwhile, the higher return would also make the current consumption more costly and decrease current consumption (substitution effect). In our simulation below, the income effect dominates.[30] As a result, the agent can reduce the *amount* of savings needed to reach a specific future consumption target. This, in turn, would free up resources to increase consumption in the current period.

Figure 5: An Example of Welfare Enhancement and *Consumption* Boosting through Financial Inclusion and Portfolio Rebalancing



Source: Authors' calculations.

[28] This consumption-boosting effect is also present up to a certain threshold because excessive allocation to the risky asset leads to a decline in the risk-weighted expected utility from future consumption.

[29] An increase in the excess return δ on the risky asset (equity) would not alter the agents' consumption decision, as this does not enter the agents' optimization problem.

[30] But the net effect may turn out to be different under a different calibration, depending on country specifics.

This impact is most evident when comparing the right chart with the left one in Figure 5: as equity return increases, the current-period consumption will increase by more than the case of a lower equity return and over a wider range of the pension fund's equity investment. This is especially relevant for countries that seek to boost consumption and enhance GDP growth. It is worth mentioning that the portfolio rebalancing effect is particularly strong in countries where a large number of households invests mostly in low-return risk-free assets (such as bank deposits), as the introduction of FICMI pension can substantially improve the financial inclusion of such households (by investing in high-return equities on their behalf), as well as significantly raise the overall return of such households' savings.

However, as discussed previously, there is a countervailing force at play: the introduction of a FICMI pension system, through its mechanism of forced/incentivized savings, can increase household savings and thus reduce consumption, all else being equal. Therefore, the overall impact is determined by the relative strength of the two channels: the portfolio-rebalancing channel and the forced/incentivized-saving channel.[31] In countries where household saving rates are excessively high, the introduction of a FICMI pension system primarily *reallocate* savings—for instance, from bank deposits to pension funds, and subsequently to equities and bonds. In such countries, the portfolio-rebalancing channel tends to dominate the forced-saving channel, leading to reduced overall household savings and increased consumption. Conversely, in countries with excessively low household saving rates,[32] there are little-to-no savings to reallocate. Here, the forced-saving channel is more likely to dominate the portfolio-rebalancing channel, leading to an increase in total household savings and a decrease in consumption. In both cases, the introduction of a FICMI system has the potential to enhance resource allocations and improve household welfare.

IV. CASE STUDIES

A. Chile

In 1981, Chile became the *first* country to replace a traditional PAYG system with a fully funded pension system based on individual pension accounts managed by private fund managers (a FICMI pension scheme). The Chilean experience inspired some countries in Latin America and other emerging markets to launch pension reforms.

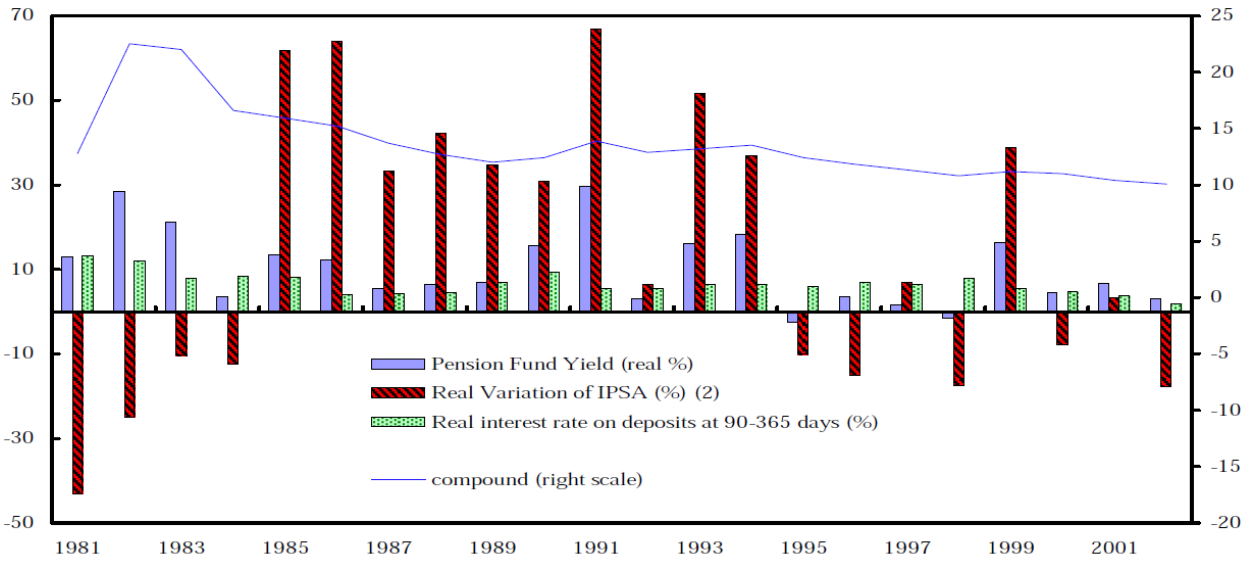
[31] The simulations in Figure 5 correspond to a case where the portfolio-rebalancing channel dominates the forced/incentivized-saving channel.

[32] In our model, the excessively low household savings can be caused by a large unobserved benefit of long-term (equity and debt) capital that is not internalized by households.

The initial stage of the Chilean experience provides a valuable *quasi-experiment* for understanding the effects of pension reform on the domestic stock market. From 1981 to 1985, Chile's FICMI pension funds were restricted to investing in government and corporate bonds, mortgage-backed securities, or bank deposits. However, in 1985, pension funds were allowed to invest up to 30 percent of their portfolios in *stocks*. This change led to a surge in stock prices, with an average annual growth rate of over 30 percent. Moreover, this rapid growth in stock prices stopped in 1994, one year after the 30 percent limit was reached (Roldos, 2007; see Figure 6, where both the pension fund yields and real growth rates of the IPSA stock price index were much higher than the real deposit rates). While several other factors may have played a role in this surge (such as the base effect due to the sudden stop and the associated negative real stock returns during the early 1980s), "most analysts agree that pension funds demand was a major driver" (Roldos, 2007). Although this episode suggests that pension reforms can, in certain situations, lead to heightened asset price fluctuations, it also convincingly demonstrates that pension funds can play a pivotal role in bolstering the domestic stock market.

Relatedly, the role of pension funds on Chile's stock market development is also evident when comparing their portfolio holdings to those of mutual funds. The Pension Fund Associations (Asociaciones de Fondos de Pensiones, AFPs)—private companies managing the pension funds—hold about 50 percent of their portfolio in equities as of September 2020, more than double the share of equities held by mutual funds, as documented in Superintendencia de Pensiones (2022) and IMF (2023b). In addition, the average maturity of assets held by AFPs is longer than those held by mutual funds across all asset classes, particularly for sovereign bonds (IMF, 2023b).

Figure 6. Chile: Pension Funds and Asset Returns (in percent)



Source: Roldos (2007) (Figure 8).

More broadly, beyond the stock market implications, Chile's pension reform also offers a few other lessons:

- *Complementing FICMI pension reform with fiscal adjustments proved to be beneficial in Chile.* Thanks to the fiscal adjustments at the early stage of the reform, the government was not forced to issue a large amount of government bonds. This allowed pension funds to somewhat diversify their investments away from government bonds and support the private sector already in the initial phases of the pension reform.
- *Chile initiated its pension reform aiming to transition from a PAYG system to a fully funded one, but adopted a multi-pillar framework in 2008.* Initially, most workers joined the funded system in the 1980s. Yet, many workers, particularly low earners or intermittently unemployed, could not consistently contribute or meet the 20-year requirement for a minimum pension. In 2008, the Bachelet government reformed the system again, replacing the minimum pension and Pensiones Asistenciales with a tax-funded solidary pension system (SPS). Now, citizens over 65, living in Chile for 20 years without a private pension above a set threshold, qualify for an SPS pension. This effectively established a multi-pillar pension system in Chile, where PAYG and funded systems coexist.
- *The Chilean FICMI pension system also faces some other challenges, such as low contribution rates, high informality, and low job tenure.* To boost participation, relatively low contribution rates were set in the beginning, leading to reduced replacement rates compared to initial projections and international norms (Barr and Diamond, 2016; IMF, 2021). Moreover, contribution densities and coverage are low, reflecting issues common to many emerging markets (EMs) such as high level of informality, a high proportion of self-employment, and short job tenures (IMF, 2021; McKiernan, 2021).
- *The pension withdrawals during COVID were substantial and are expected to further deteriorate the system's outcomes.* To assist households during the pandemic, the government permitted those contributing to the FICMI pension system to withdraw from their pension accounts. Chile's withdrawal magnitude was notably larger than in other OECD nations (OECD, 2020). The combined withdrawals in July 2020, December 2020, and April 2021 reduced pension assets by approximately 20 percent of GDP (Madeira, 2022). These withdrawals may further compromise the system: for current members, the average withdrawal could lead to a 7 percent reduction in retirement pensions (Evans and Pienknagura, 2021).[33]

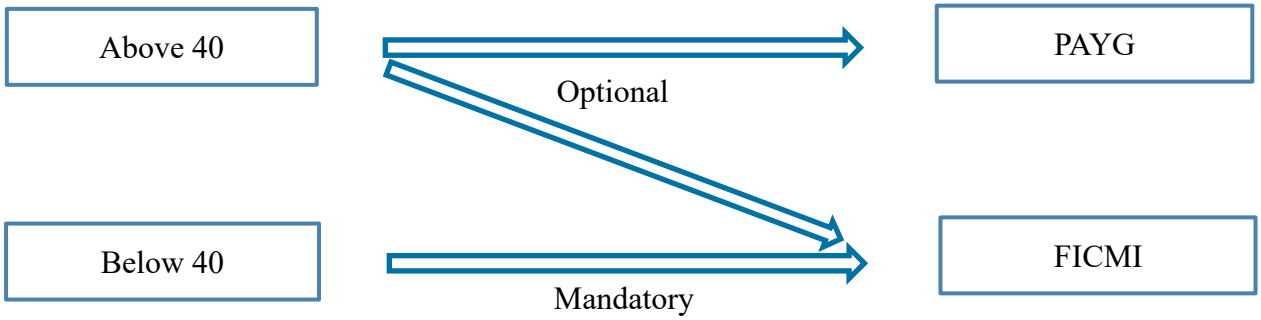
[33] During 2019-2022, a series of massive demonstrations and severe riots broke out in Chile. Among other things, many demonstrators protested against the privatized pension systems because of its low and often delayed payouts. As a result, a new government has proposed pension reforms that are aimed at fixing inadequacies in the current private pension system and include mandatory employer contributions.

- *Chile has recently introduced a minimum guaranteed pension (PGU).* To address old-age poverty risks, the coverage and amount of pensions were increased with the introduction of the PGU in 2022, which covers 90 percent of the population aged 65 and older.

B. Uruguay

In 1995, partly motivated by the successful experience of Chile, Uruguay launched far-reaching pension reforms. Unlike Chile, however, Uruguay started a *partial* transition away from the PAYG system and adopted a *multi-pillar* pension system in the first place, given its relatively old populations and mature PAYG pension programs. Specifically, as illustrated in Figure 7, the "middle-age" group (more than 40 years old at the time of reform) was given the option to remain in a reformed PAYG or shift to the new pension system (Roldos, 2007). And participants below 40 were required to participate in a FICMI pension scheme—a mandatory, private, individual saving accounts pillar under private management (Saldain, 2007).

Figure 7. Uruguay: Pension Reforms in 1995



Source: Authors based on Saldain (2007) and Roldos (2007).

Regarding the impact of the pension reform on financial markets, one crucial feature in the Uruguay case—and some other Latin American countries—is the high *concentration* of pension investments in government bonds, likely driven by *regulation* of pension funds' investment strategy. Following the pension reform, the share of total government bonds outstanding held by pension funds in Uruguay more than doubled from 6.5 percent in end-1998 to 14.8 percent in end-2005, with 59.5 percent of pension funds' portfolios in government bonds and a mere 0.1 percent in equities in end-2005 (Roldos, 2007). This high concentration was likely driven by the regulation that required these funds to allocate 40-60 percent of assets to government securities. Key reasons for this regulation include: (1) facilitating the transition to a funded system by allowing governments to manage residual PAYG system obligations (Campbell and Feldstein, 2001), and (2) fostering local bond market development by setting a yield curve and promoting indexed bonds (Mathieson et al., 2004). However, this concentration may have reduced fiscal

discipline due to easy bond market financing access for the government. Moreover, low yields of government bonds (combined with their high share in the portfolio) could negatively impact pension funds' overall returns, potentially undermining the funded pension system's sustainability.

More broadly, beyond the capital market implications, Uruguay's pension reform also offers a few other lessons:

- *Fiscal costs during the transition were higher than expected in Uruguay.* One reason was the unforeseen shift of members: for those who were given an option to remain in the PAYG system or shift to the new pension system, distrust in the old system caused a higher-than-expected shift and thus higher fiscal deficits during the transition (Roldos, 2007). Another reason is Uruguay's economic crisis in 2002, when Argentina's crisis at the end of 2001 spilled over to Uruguay, causing the worst economic and social crisis in the country since its 1985 democratic revival. By 2003, poverty rate in Uruguay more than doubled (World Bank, 2004). This crisis significantly decreased pension contributions, increased pension payments, and magnified the pension deficits during the transition period.
- *Generous pension benefits, low retirement age, and high coverage in Uruguay motivated another round of pension reforms in 2023* (IMF, 2023c). These factors resulted in Uruguay's pension expenditure reaching 12.9 percent of GDP in 2021. While the EU anticipates its peak pension spending at 12.8 percent in 2040 before a gradual decrease to 11.7 percent by 2070 (EC, 2021), Uruguay's spending was expected to climb unless reforms are introduced. As highlighted in the 2021 report by *Comisión de Expertos en Seguridad Social*, Uruguay's public spending aligned with Spain's, even though it had not reached Spain's aging levels. Furthermore, it surpassed countries known for their extensive social protection, including Denmark, Norway, the Netherlands, and Sweden.
- *The 2023 pension reforms involved strengthening of both the PAYG and the FICMI pillars.* In addition to raising the state retirement age from 61 to 65 (for individuals born in or after 1977), the even split of an employee's mandatory contributions between the two schemes will change: 66.7 percent will be directed to the BPS pension (the PAYG pillar), with the rest going to an AFAP fund (the FICMI pillar).[34] Additionally, starting August 1, 2023, every eligible worker was required to join the AFAP, irrespective of their earnings, whereas in the

[34] Specifically, AFAPs (Administradoras de Fondos de Ahorro Previsional) are private pension fund administrators introduced as part of Uruguay's 1995 pension reform. They operate within the second pillar of the pension system, managing mandatory individual savings accounts for workers. AFAPs complement the pay-as-you-go system by diversifying retirement income sources.

past, those with lower incomes were not mandated to contribute to an AFAP fund.[35] Such reforms are expected to largely stabilize spending in the long-term, maintain intergenerational equity, and create space for other spending priorities (IMF, 2023c).[36]

C. Kazakhstan

The pre-reform pension system in Kazakhstan originated from the Soviet Union and was a PAYG system, with most workers being in state industries or collective farms and 80 percent beneficiaries being old-age pensioners. The transition to a market economy, coupled with the end of Soviet subsidies, strained the pension system financially. Economic challenges led many businesses to defaulted on their pension obligations. By end-1996, pension payment arrears reached about 2.5 percent of GDP, causing the pension system's near collapse and resulting in social unrest.

In response, in June 1997, the government introduced a law to transform the pension system from PAYG to a *fully funded defined contribution* model, following the Chilean approach. This shift aimed to foster self-reliance, cut government expenses, boost savings, and stimulate capital market growth. The revised system consisted of three parts: a residual PAYG system supported by a 15 percent employer payroll tax, a mandatory defined-contribution plan funded by 10 percent wage contributions from employees (a FICMI pillar), and a voluntary private scheme for additional pension benefits (Asian Development Bank, 2009).

In a policy shift in 2013, the Kazakh government *nationalized* the management of the FICMI pension system and moved the funds accumulated in the private pension funds into a single pension savings fund, managed by the central bank. It is still a FICMI system, except that there is now only one manager, which is the central bank. The President stated that this decision aimed to obtain "long-term, cheap finance" to "credit the real economy, to promote industrialization and help develop entrepreneurship." In addition, both government and private sector employers were required to pay an extra 5 percent in pension taxes for their workers, who already contributed 10

[35] LOCKTON Global Compliance News, July 28, 2023. "Uruguay Passes Sweeping Pension Reforms with the Creation of a Common Pension System."

[36] In addition to the 2023 pension reform, two smaller-scale reforms in 2007 and 2017 also played some roles. The 2007 Reform, promulgated on October 24, 2008, aimed to "flexibilize" the system for access to retirement benefits, facilitating broader coverage and easing eligibility criteria for retirees. In addition, the 2017 Reform, enacted on December 28, 2017, enabled a procedure for disaffiliation from the mandatory individual savings pillar established in the 1995 reform. This procedure targeted individuals aged 50 or older as of April 1, 2016, who faced specific disadvantages under the existing framework.

percent of their monthly wages. Women's retirement age was also raised from 58 to 63 years, ensuring full equality with the working male population.[37]

The Kazakh experience offers a few lessons for capital market development:

- *Tight portfolio restrictions led to over-concentration of FICMI pension fund portfolios and limited benefit to capital market development.* Even during the 1997 reform, investment decisions by pension funds were strictly regulated (Table 5). Both government and private funds were mandated to invest at least half of their assets in government securities. The State Accumulation Fund was allowed by law to allocate up to 40 percent of its assets in specific national bank deposits (which are state-owned), while it was not allowed to invest in corporate securities. On the other hand, non-state funds could allocate up to 30 percent in "Class A" corporate securities, which are listed and are required to have at least a year's worth of financial statements audited by international standards.

Table 5. Pension Fund Portfolio Restrictions in Kazakhstan

	Government bonds	Designated state-owned bank deposits	"Class A" corporate securities
State funds	Minimum of 50 percent	Maximum of 40 percent	Not allowed
Non-state funds	Minimum of 50 percent	Maximum of 40 percent	Maximum of 30 percent

Source: Authors, based on data from Andrews (2001).

- *Favorable external conditions complicated domestic capital market development.* As a major exporter of commodities, including oil, Kazakhstan enjoyed a sustained rise in commodity prices. This resulted in substantial fiscal surpluses, reducing the need for issuing government debts and hindering the creation of a benchmark yield curve. Furthermore, private entities refrained from issuing instruments in the domestic financial market due to the ready availability of affordable funding from both local banks and international sources. As a result, the limited domestic investment options drove pension funds to predominantly invest in foreign assets, leading them to experience low or even negative returns in the local currency because of its appreciation (Rudolph and Rocha, 2009; OECD, 2017).
- *Consolidation of pension assets in the single pension fund following the 2013 reform led to inactivity of domestic capital markets*. The 2013 policy shift prompted major institutional investors overseeing private pension funds to exit the domestic capital markets, leading to stagnant and non-liquid markets (OECD, 2017). Additionally, the channeling of the pension

[37] Financial Times, January 25, 2013, Kazakh Pension "Nationalisation" Plan Worries Fund Managers. And Central Asia-Caucasus Analyst, Field Reports, June 28, 2013, Kazakhstan Adopts Controversial Pension Reform.

fund assets to finance large-scale investment projects has also reduced the remaining investable funds, limiting its capacity to invest in domestic financial markets.

More broadly, beyond the capital market implications, Kazakhstan's experience also underlines the importance of sound *governance* for successful pension reforms. As noted above, in 2013, the government assigned the central bank to oversee the Unified Accumulative Pension Fund (UAPF). This setup, however, raises concerns about potential conflicts of interest (IMF, 2014). This is because the central bank leads both the UAPF board and its investment policy council. There is also the risk that the central bank and the UAPF might be influenced to use the pension funds to support the national budget, rather than maximizing long-term investment returns (OECD, 2017). Since December 2015, the authorities have been seeking to remove the UAPF from the central bank control, and the central bank is advised to "continue strengthening its independence, including by swiftly phasing out its… non-core mandates…" (IMF, 2022c).

D. Singapore

Singapore's pension system is often regarded as one of the best in Asia, or even globally.[38] Singapore laid the foundation of its retirement system with the Central Provident Fund (CPF) in 1955—a funded pension system, although only since 1968 have a variety of preretirement asset-accumulation schemes been introduced (Asher and Bali, 2014). Over the decades, the CPF underwent significant expansions, diversifications, and innovations like the CPF LIFE in 2009, ensuring lifelong monthly payouts. The current CPF structure comprises three key accounts: Ordinary (for housing/education), Special (for retirement), and Medisave (for health care),[39] with supplementary schemes such as the Silver Support Scheme introduced in 2016.

CPF contributions are utilized by the CPF Board to exclusively purchase Special Singapore Government Securities (SSGS). The proceeds of such SSGS issuance go into the Government's past reserves. Given the limited availability of data, empirically evaluating CPF's impact on Singapore's stock market development presents challenges. However, the Singapore experience offers some valuable lessons for other countries:

- *A funded pension system with individual property rights (a FICMI system):* Singapore's CPF system underscores the advantages of a funded pension mechanism emphasizing individual property rights. Lee Kuan Yew, a prominent leader in Singaporean politics, articulated these advantages. He argued that an inherent sense of property rights exists in people, and pension

[38] For example, see Mercer.com, October 11, 2022.

[39] CPF's versatility is evident in its housing-related provisions. Members can use up to 90 percent of their Ordinary Account for housing purchases. However, after securing a property, a stipulated amount must remain in their CPF accounts before any withdrawals post age 55, ensuring that CPF's flexibility does not compromise the integrity of retirement savings.

systems entirely run by governments can often lead to inefficiencies and resource wastage. He further posited that sustainable financial well-being in retirement is best achieved when individuals and families shoulder primary saving responsibilities.

- *Complemented by various PAYG social programs:* For the vulnerable groups, the government should ensure a basic retirement income through transfer payments to foster inclusivity and social stability. Consequently, the Singapore government complements its funded pension system with unfunded programs, notably the Silver Support Scheme (introduced in 2016, which offers automatic quarterly cash supplements to the bottom 20% of Singaporeans aged 65 and above).
- *A phased approach to strengthen a funded system:* At the time of its establishment in 1955, Singapore's CPF began with a modest contribution rate of 5 percent, equally shared between employers and employees. During the rapid economic development of the 1960s to 1980s, this rate increased progressively to around 25 percent by the late 1970s, with employers bearing a higher proportion. Adjustments continued post-1990s in response to economic and demographic changes, and as of 2022, the total contribution rate was 37 percent for workers up to age 55, comprising 17 percent from employers and 20 percent from employees.
- *Compulsory savings:* The CPF also builds on the principle of mandatory savings. This was influenced by Lee Kuan Yew. Lee expressed concerns about the myopic financial behaviors among households, particularly the propensity to spend without adequately preparing for the future. To mitigate this, the CPF ensures both employers and employees regularly contribute to individual accounts, promoting long-term financial security.
- *Diversified investments:* CPF's adaptations in the 1980s and 1990s, notably the 1986 CPF Investment Scheme, highlight the importance of providing members with diversified investment options, ranging from stocks and bonds to property funds.

E. China

China has not established any significant funded pension scheme yet, so it is infeasible to empirically evaluate the impact of funded pension on China's stock market development. As such, we focus on the description of the main characteristics of China's current pension system and its stock market.

- *Population aging and pension deficits:* According to the projections by United Nations (2023), China's total population started declining in 2022 and is expected to decline by about 8 percent to 1,313 million in 2050 (relative to 2023). And according to Zheng (2019), China's support ratio (inverse of dependency ratio) is likely to decrease from under 2.65 workers per retiree in 2019 to 1.03 in 2050. The Basic Old Age Insurance (BOAI) pension, which is the most important pillar in China, is expected to have a flow deficit (i.e., contribution inflows falling short of benefit payments) in 2028 and a stock deficit (i.e., a

negative balance) in 2035 (Zheng, 2019), leaving little-to-no room for accumulating long-term pension assets.[40]

- *High concentration in PAYG:* China has attempted to establish a multi-pillar pension system (Fang and Feng, 2018). Pillar I pension schemes aim to provide basic social security to all residents for their old ages, regardless of their employment status when young. This pillar mainly consists of the mandatory PAYG public pension schemes (Basic Old Age Insurance, BOAI). Pillar II consists of employer-sponsored annuity schemes, provided voluntarily by employers as a supplement to Pillar I schemes. Pillar III consists of household savings-based annuity insurance schemes. As shown in Table 6, the Pillar I PAYG pension schemes play an overwhelmingly dominant role in China, accounting for 98.9 percent of the total pension payouts during 2021.[41] The Pillar II pension schemes, consisting of the Enterprise Annuity (introduced in 1991) and the Occupational Annuity (introduced in 2015), currently account for a very small share in terms of pension payouts. The Pillar III pension schemes, consisting of the Tax-Deferred Commercial Endowment Insurance (introduced in 2018) and Tax-Deferred Individual Retirement Account (introduced in 2022), currently account for a negligible share of pension payouts and are governed by government "announcements" rather than laws. The accumulated assets by funded pension schemes in China were 4.43 trillion RMB in end-2021 (including 2.64 trillion RMB from enterprise annuity and 1.79 trillion RMB from occupational annuity[42]), around 3.9 percent of China's 2021 GDP. By contrast, the funded and private pension plans in OECD countries accumulated $58.9 trillion in end-2021,[43] corresponding to 100.5 percent of OECD's 2021 GDP.
- *Inadequate compliance with contribution requirements* for the basic Pillar I PAYG pension, contributing to a *funding* gap (IMF, 2022). Many employers fail to fully pay social insurance premiums for employees, partly due to high contribution rate to the compulsory Pillar I. In addition, employers and employees may collude to make social insurance contributions based

[40] Recently, China has started to raise retirement ages for the population. The retirement age for men will be raised from 60 to 63, Women in blue-collar jobs will see an increase from 50 to 55, and those in white-collar roles from 55 to 58. The change will take place gradually every few months over the next fifteen years, starting in January 2025. To the best of our knowledge, currently there is no publicly available assessment of the impact of higher retirement ages on the financial sustainability of China's pension system.

[41] This excludes payouts by Occupational Annuity due to lack of data. In this context, payout is more informative than end-year pension balance because PAYG pensions have little balance left after paying pensioners.

[42] Sources: Ministry of Human Resources and Social Security of China (for Enterprise Annuity and Occupational Annuity, respectively). The amount of Pillar III's assets is negligible compared with other pillars, and the precise data is unavailable.

[43] Source: OECD Pension Markets in Focus 2022, Chapter 1.

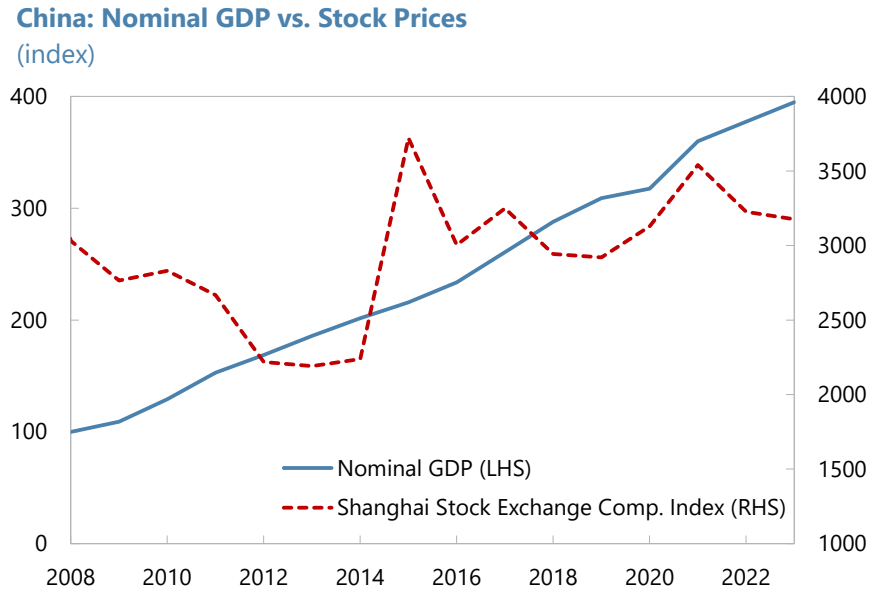
on wages that are lower than the actual wages (Cousins 2021; Zhou 2021). In many regions, the real contribution rate (contributions as a percentage of earnings) has been much lower than the statutory rate (Zhao and Mi, 2019), with 70 percent firms paid less than the required rate (Zheng, 2016).

- *High household savings and reliance on bank deposits/housing:* Over a long period of time, the household savings rate in China has been multiple times higher than the median rate among OECD emerging markets (IMF, 2022, Figure 1, Panel 2). As for the composition of savings, the real estate sector is central store of household savings in China (IMF, 2024a), accounting for about 59.1 percent of total household assets in 2019 (People's Bank of China, 2020). The other major component is bank deposits, accounting for 8.0 percent of total household assets.[44]
- *Underdeveloped stock markets:* For the last 15 years, China's Shanghai stock exchange composite index has hovered around a level of 3,000, even though its GDP is four times as large as it was in 2008 (Figure 8). One striking feature of the Chinese stock market is the prevalence of short-term transactions in the stock market, with a median annual turnover ratio of 207 percent during 2001-2020 compared with a median of 61 percent among OECD countries during the same period.[45] Not only retail investors typically have short investment horizons and often engage in momentum trading, but many Chinese mutual funds and other institutional investors also behave somewhat like impatient retail investors, partly because there are very few long-term investors on the market and there is constant redemption pressure for many institutional investors.

[44] This is inferred from the survey results as follows: share of financial assets in total household assets (20.4 percent), multiplied by the sum of current deposits (16.7 percent within financial assets) and term-deposits (22.4 percent within financial assets).

[45] Source: World Bank Open Data (link). Turnover ratio is defined as the percentage of a portfolio's holdings that have been replaced in a given year.

Figure 8. China: Stock Market Index Relative to Nominal GDP



Source: CEIC; Authors' calculations.

Table 6. Overview of China's Pension System

Pillar	Pension Schemes	Introduced	Payout (2021, Billion RMB)	Participants (2021, Million)	Financing	Enforcement	Legal Framework
I	Basic Old Age Insurance (BOAI, 基本养老保险)	1951	6,019.70	1,028.71	PAYG (20 percent by employer + notional acct 8 percent by employee) /1	Compulsory (Voluntary for informal sector)	Social Insurance Law
II	Enterprise Annuity (企业年金)	1991	68.44	28.75	Funded	Voluntary	Enterprise Annuity Regulations
	Occupational Annuity (职业年金)	2015	---	---	Funded	Voluntary	---
III	Tax-Deferred Commercial	April 2018 (Pilot;	Negligible	Negligible	Partly funded and	Voluntary	Announcement by Ministry of Finance

	Endowment Insurance	merged to IRA in 2022)			partly notional		and four other agencies
	Tax-Deferred Individual Retirement Account (IRA)	April and November 2022 (36 pilot cities)	Negligible	About 30.00	Funded	Voluntary (max 12,000 RMB per year)	Announcements by State Council, Ministry of Finance, and State Admin. of Tax.

/1: 12 percent plus 8 percent for informal-sector employees. "---" means no available data.
Sources: Li, Chen, and Zheng (2023); Fang and Feng (2018); EY (2023); Ministry of Human Resources and Social Security of China (for BOAI and Enterprise Annuity, respectively); Authors.

F. The U.S.

The 401(k) plan in the U.S., introduced in 1981, is a prime example of a FICMI pension scheme. The scheme is *fully funded* by employee contributions, often with employer matching. Participants in a 401(k) plan have *individual* accounts where their contributions and the investment returns are accumulated. Typically, although participants can choose where their contributions are invested within the options offered by the plan, the overall management of the available investment options is handled by professional fund managers ("*collectively-managed*"). And participation is typically *incentivized* through tax benefits.

The proliferation of 401(k) plans has significantly shaped the retirement savings landscape in the U.S., mobilizing personal savings for long-term investments in the capital markets and enhancing financial market stability. These plans have also been instrumental in promoting financial literacy by involving individuals in the management of their investments through options such as mutual funds, stocks, and bonds. The U.S. experience offers several valuable lessons for other countries considering similar pension reforms:

- *Effective use of tax incentives to encourage participation:* Tax incentives play a pivotal role in influencing participation rates and the amount individuals are willing to contribute to pension plans. The U.S. provides tax deferrals on contributions and earnings in 401(k) plans, which not only defer taxes until retirement but also potentially lower the participant's tax bracket in retirement.
- *Automatic enrollment to enhance participation:* Simplifying the investment decision process through features like automatic enrollment and target-date funds can lead to higher participation rates and more optimal savings behaviors. According to Vanguard's 2023 report of *How America Saves*, the participation rate in 401(k) plans reached a record-high of 83 percent. One of the leading catalysts, according to the report, is that the automatic enrollment

more than tripled since the passage of the Pension Protection Act in 2006 (76 percent of plans with at least 1,000 participants right now have adopted automatic enrollment).[46]

- *Robust regulatory oversight to ensure trust and stability:* Effective regulatory oversight, as enforced through U.S. laws like the Employee Retirement Income Security Act, is crucial for protecting the integrity of pension plans and maintaining participant trust. These regulations ensure that plans are managed with a high fiduciary standard, focusing on the best interests of the participants.
- *Adapting to demographic and economic changes:* The U.S. 401(k) system has continuously evolved to address changing demographic trends and economic conditions through several strategic adjustments in both policy and plan design. One example is the introduction of Target-Date Funds: As the target retirement date approaches, the fund gradually shifts from riskier investments (like stocks) to more conservative options (like bonds). Another example is the catch-up contributions for older workers: Individuals aged 50 and over are allowed to make catch-up contributions above the standard 401(k) contribution limits.[47]
- *Addressing disparities in pension wealth accumulation:* Despite its success, the 401(k) plan in the U.S. has revealed significant disparities in pension wealth accumulation across different demographic groups. Some studies, such as Choukhmane et al. (2023), show that high-income individuals benefit the most from the tax incentives and employer matching subsidies (associated with 401(k) plans), which channel more resources to the rich and amplify the differences in savings between the rich and the poor.

V. ENABLING CONDITIONS AND FURTHER CONSIDERATIONS

A. Some Enabling Conditions

We now turn to some practical constraints and the necessary conditions for enabling change. Historically, many countries have seen their private pension reserves invested in government debt (which is largely equivalent to PAYG financing), SOE securities (which are effectively underwritten by the state as owner), or illiquid assets without mark-to-market valuations (such as land, direct investments in real estate, or major infrastructure projects). As such, while FICMI

[46] Relatedly, Horneff, Maurer, Mitchell (2019) show that automatically enrolling retirees using only a small portion of their 401(k) assets can substantively enhance retirement security and improve welfare.

[47] According to a release by the Internal Revenue Service, in 2024, the contribution limit for employees who participate in 401(k), 403(b), and most 457 plans, as well as the federal government's Thrift Savings Plan is increased to $23,000 (up from $22,500 in 2023). Moreover, the catch-up contribution limit for employees aged 50 and over who participate in these plans is *$7,500* for 2024, the same as in 2023. Therefore, participants in these plans can contribute up to $30,500, starting in 2024.

may be a necessary condition for the development of domestic stock markets, it is not sufficient on its own, highlighting the need to fulfill the enabling conditions.

Some studies, such as Holzmann and Hinz (2005) and Rudolph and Rocha (2009), provide a comprehensive list of such enabling conditions for FICMI pension schemes. These include: a sound financial infrastructure (including legal framework, institutional framework such as a payments system, availability of financial instruments, etc.); adequate regulatory and supervisory capacity; commitment of the authorities to the reform; and fiscal and macroeconomic stability. We would like to highlight and expand on the following conditions:

- *A strong and lasting political commitment to the reform.* Some studies, including Rudolph and Rocha (2009), identify this as the most crucial precondition. This is reflected in institutional arrangements to oversee the reform implementation. The success of the reform requires not only strong political support at the time of the reform, but also constant monitoring of the reform during the implementation period, possibly through the creation of a permanent committee or the appointment of a designated official. Indeed, a more effective arrangement tends to have a more permanent nature. For example, in the case of Chile, the reform has been consistently monitored by the Capital Markets Committee, orchestrated by the Ministry of Finance and encompassing all oversight bodies.
- *A well-designed fiscal strategy for financing the transition.* In most cases, the transition from PAYG to a funded system involve fiscal costs. Issuing debt to finance such costs has pros and cons. On the one hand, some issuance of government debt would help develop a yield curve, thereby bolstering domestic capital markets. On the other hand, an excessive reliance on debt issuance can trigger another *vicious circle*: the government issues debt instruments for transition financing, prompting pension funds to over-invest in government bonds. This heavy allocation to low-yielding government bonds can subsequently reduce the overall returns of pension funds, leading to further losses. Consequently, the government may find itself in a position where it must issue even more bonds to offset the transitional losses, perpetuating the cycle. Hence, a mixed strategy with debt issuance, tax adjustments, and expenditure re-prioritizations might be most fruitful. In this regard, the "Laffer-like effect" is worth noting. As shown by McGrattan and Prescott (2017), a reduction in the payroll tax rate boosts the total labor supply due to enhanced work incentives. This increase in labor supply more than offsets the reduced tax rate, leading to higher tax revenue. This shift enhances welfare when transitioning from a PAYG system to a funded system that does not rely on high payroll taxes.[48]

[48] A large literature examines the transition from PAYG to a funded system, including Kotlikoff (1996); Huang, Imrohoroglu, and Sargent (1997); Kotlikoff, Smetters, and Walliser (2001); Rudolph and Rocha (2009); Kudrna, Tran, and Woodland (2019); and Heer, Polito, and Wickens (2020).

- *A sound financial infrastructure:* The literature suggests that having a core group of trustworthy banks and insurance companies is essential for the early phases of reform. This ensures proper management of contributions, payments, and individual accounts, as well as the provision of custodial services. It's also crucial to have accurate and transparent accounting, financial reporting, and valuation systems that advocate for the fair valuation of instruments. Additionally, the presence of independent and skilled auditors is vital to foster self-regulation.

However, we would like to emphasize that it would be best *not* to treat deep capital markets as an enabling condition. This is due to a potential "chicken-and-egg" dilemma, as discussed earlier: Policymakers want to have a well-functioning capital market (especially stock market) before starting the pension reform; but having such a stock market would require long-term and rational institutional investors such as a private pension fund. Indeed, one goal of our paper is to establish that policymakers should start now and try to activate the positive feedback loop between stock market development and pension reform.

B. Further Considerations

We would like to offer some remarks on further relevant considerations.

First, voluntary pension funds and financial incentives. For simplicity, we focus on a mandatory pension system. In reality, many countries also have voluntary pension schemes where households can decide whether and how much to contribute to the pension funds. Moreover, according to a comprehensive OECD study (OECD, 2018, *Financial Incentives and Retirement Savings*), all countries covered by the study provide financial incentives to promote savings for retirement, with the most common approach exempting contributions and returns on investment from taxation and taxes withdrawals. However, considering voluntary pension schemes and financial incentives may not fundamentally change the main results of our paper. This is because: 1) OECD (2018) finds that financial incentives, tax and non-tax, turn out to be effective tools to promote savings for retirement; hence, even if pension funds are voluntary, the existence of the financial incentives are still likely to attract households to participate. 2) OECD (2018) finds that the total fiscal cost of financial incentives varies greatly across countries, but remains in the low single digits of GDP; hence, it seems unlikely that the voluntary nature will fundamentally change our main result that the funded and private pension funds can well complement the public pension system without significantly raising the fiscal cost. As noted by the Dutch Federation of Pension Funds, "Mandatory participation also ensures a good pension provision for all employees and prevents competition on the basis of salary at the expense of a pension provision." Meanwhile, for some countries, some studies argue that tax incentivized voluntary arrangements could be expensive and regressive, with potentially dubious impact on incentives of savings (such as in Biggs, Munnell, and Wicklein 2024). Hence, country-specific

analysis is needed to determine the desirability of mandatory versus tax-incentivized pension arrangements.

Second, government subsidy or bailout. One could also explicitly study the role of the government by further extending our modeling framework. One extension is to assume that when a negative aggregate shock realizes in Period 2, the government subsidizes households and pays contributions to pension funds for households (so that the corporate sector can also continue to have stable equity financing). Doing so would inevitably increase the fiscal burden, but it could mitigate the distortion to consumption smooth caused by the mandatory pension funds; and if the benefits from the stable equity financing and R&D are sufficiently high, the ultimate equilibrium may still be better off than the no-pension-fund equilibrium because the benefits of households (and pension fund) may outweigh the fiscal costs.

Third, more complete financial markets via saving channels other than those considered in the model (corporate bonds, corporate equities, and government bonds). Doing so would allow for more risk-sharing, and thus the role of pension funds in smoothing the lifetime consumption may be quantitatively smaller. However, our assumption that one typ/e of household has risk-free future endowments effectively captures that some households are able to smooth consumption through other financial instruments, so considering other saving channels is unlikely to qualitatively change our results. Moreover, the corporate channel (i.e., pension reforms promoting innovation of the corporate sector) is less affected by this assumption.

Fourth, diverting household savings and raising SOEs' financing costs. One may argue that in some EMDEs, the excessive household savings and the associated low interest rate have supported firms (usually SOEs or real estate developers), which have access to such financial resources. Hence, introducing funded and private pension funds could divert household savings away from these firms and thus raise SOEs' financing costs, which in turn raises the implicit fiscal costs (e.g., when an SOE runs into a liquidity problem due to the higher financing cost, the government may need to provide fiscal support). However, exactly for this reason, the "entry" of funded and private pension funds has the potential of enhancing resource allocation from some inefficient SOEs to more efficient private firms, or from excessive real estate investments to more efficient high-tech investments that are made possible by pension funds' (long-term) equity investments.

VI. CONCLUSION AND POTENTIAL POLICY IMPLICATIONS

Drawing on empirical evidence (from panel regressions and local projections), stylized models, and case studies, this paper underscores some important benefits of FICMI pension schemes. We argue that such pension schemes can foster innovation by channeling household savings towards long-term equity capital, bolstering domestic stock markets by introducing patient institutional

investors, improving financial inclusion by providing access for some segments of the population to sophisticated financial assets, and enhancing the intertemporal optimization of households. Together, the introduction of FICMI pension could lead to efficiency gains and welfare enhancements. Notably, for households that lack access to financial markets and save too much, we illustrate that the adoption of FICMI pension schemes could provide an immediate boost to domestic consumption, highlighting the important role of structural reforms (typically viewed as medium-to-long-term strategies) in boosting (short-term) consumption and growth, consistent with Budina et al. (2023).

Our findings point to five *considerations* that are potentially relevant for developing a viable FICMI pillar of the pension system:

First, the FICMI pillar has to be sufficiently large. To reap the various benefits illustrated in this paper, a FICMI pillar needs to be established and needs to account for a significant share in a country's overall pension system.

Second, to benefit from a FICMI pillar, a country needs to implement vigorous structural reforms to meet some necessary enabling conditions. These include, in particular, designing a robust fiscal strategy and developing a sound financial infrastructure.

Third, it is imperative for policymakers to act promptly, decisively, and persistently. A strong and long-lasting political commitment may be a prerequisite to activate the virtuous circle among FICMI pensions, stock market development, technological innovation, and economic growth.

Fourth, younger nations, including some low-income EMDEs, stand to benefit considerably from developing a FICMI pension pillar early. This advantage is supported by the relatively low current burden of supporting an older generation.

Fifth, for a number of emerging market economies such as China, technological innovation is essential to escaping the middle-income trap in the next twenty years. Pension reform that focuses on building a significant FICMI pillar can play a vital role in supporting stock market development, which in turn will be key for providing long-term equity financing that is crucial for technological innovation.

Note that as discussed in the case study section, some countries have set up a multi-pillar system, primarily relying on FICMI pension funds and complementing with PAYG social safety net to protect the vulnerable. The benefits of such a multi-pillar system are also articulated in Li, Chen, and Zheng (2023). In this paper, we do not explicitly analyze the desirability of the multi-pillar system; instead, we focus on illustrating the benefits of the FICMI pillar.[49] However, we would

[49] Westerhout et al. (2022) develop an analytical framework to assess the desirability of PAYG vs. funded schemes, building on the so-called "Aaron rule" by Aaron (1966): PAYG is preferred if the economy's

like to stress that despite the development of FICMI pension schemes, it is crucial to ensure the protection of vulnerable groups through the PAYG social safety net, even if for households who have made no contributions to the FICMI pillar.

Based on the above five considerations, the following *specific policy measures* can be helpful:

First, re-optimize the pillar composition to increase the weight of the funded pillar relative to the PAYG pillar. Countries looking to reform their pension systems should prioritize the re-optimization of their pillar compositions. By increasing the prominence of the funded pillar, countries can tap into a mechanism that not only bolsters compliance but also fosters the growth of stock markets. This strategic shift towards the funded pillar can effectively align pension systems with the modern-day challenges posed by demographics and evolving economic landscapes.

Second, for the funded pillar, a FICMI system is preferred. Unlike the notional account that offers a semblance of ownership, a FICMI system emphasizes direct and tangible ownership, mirroring the insights from Feldstein and Liebman (2006). This clear distinction of property rights can catalyze participation, ensuring that individuals have a vested interest in their retirement savings. Moreover, in addition to a mandatory participation requirement, countries could also introduce both tax and non-tax incentives that motivate individuals to participate actively in the system.

Third, take a multi-pronged approach to ensure a smooth transition. The transition from PAYG to a funded pension system necessitates a multi-faceted, well-thought-out strategy. A blend of debt financing, tax adjustments (among income, capital, and consumption taxes), and expenditure re-prioritization can ease this transition. Moreover, countries should explore new options besides raising the retirement age. For example, in the case of China,[50] there exist several potential options, which could be the primary options for countries like China: (1) currently, 10 percent of proceeds from SOEs' IPO *sale* in China is being transferred to National Social Security Fund (Fang and Feng, 2018), and this portion can be much higher ; (2) a portion of

growth rate exceeds the return on capital market, and vice versa. However, this "rule" has omitted population aging; moreover, as acknowledged by the authors, Westerhout et al. (2022) do not consider population aging either. Separately, in the current environment of high inflation, funded pension schemes arguably have another advantage over PAYG schemes. This is because the value of equity investments in funded pension schemes tends to rise with inflation, whereas it is more challenging and less timely for PAYG schemes to increase pension contributions to compensate for the erosion of pensioners' purchasing power caused by high inflation.

[50] Under the baseline scenario considered by Zheng (2019), China's urban Basic Old Age Insurance (BOAI)—which operates as a PAYG system and represents the most crucial pension pillar in China—will begin to experience a negative net inflow starting in 2028. Consequently, the BOAI fund balance is projected to turn negative by 2035.

existing *stock* of government-owned equities can be channeled to pension funds that are owned by current-or-soon-to-be retirees (Li, 2021); (3) SOE dividend payments can be increased and transferred to pension funds, given that Chinese SOEs' payout ratio has been far below the norm (World Bank, 2012)—The average dividend payout for mature and established industrial firms in the United States is 50-60 percent, whereas SOEs in China only paid about 9.4 percent of profit to central and local governments in 2016 (Fang and Feng, 2018).

Fourth, governance is crucial. For all countries, the governance of pension funds must be strengthened: as observed by Giannetti and Laeven (2008), firms' valuation improves only if large *independent* private pension funds increase shareholdings. In this regard, it is essential to establish a robust safeguard framework, for instance, by prohibiting the government from selecting specific investment products. In countries with a high share of SOEs, the governance challenge could be particularly acute. In such cases, particular attention should be paid to the proper sequencing of the reforms and the design of the governance structure.

Fifth, expand the coverage of the FICMI pillar through a variety of strategies and a holistic reform package. To this end, it is crucial to enhance public awareness (through educational campaigns) and promote financial literacy. A transparent regulatory framework also helps ensure fund safety and boost public confidence, while the introduction of flexible pension products caters to diverse needs of households. Utilizing digital platforms for easy enrollment and management can also boost participation. In addition, policymakers need to adopt strategies to tackle issues such as informality, as suggested by McKiernan (2021); and to strengthen the financial infrastructure, such as the accounting and auditing systems. By adopting a broad-based reform strategy that simultaneously tackles diverse challenges, countries can activate and reinforce the virtuous circle among FICMI pension, stock market development, and economic growth.

Future research can focus on policy measures to address some important implementation challenges. These include, for example, setting appropriate contribution rates to ensure adequate replacement ratios, determining a country-specific policy mix to facilitate the transition to FICMI, and determining the optimal mix between non-contributory pensions (to provide minimum pensions for the vulnerable groups) and FICMI pension schemes.

APPENDICES

Appendix 1. Local Projections

Methodology

Our second empirical approach is local projections *a la* Jorda (2005). This approach will trace down the dynamic effects of the development in funded pension on domestic stock market development. Specifically:

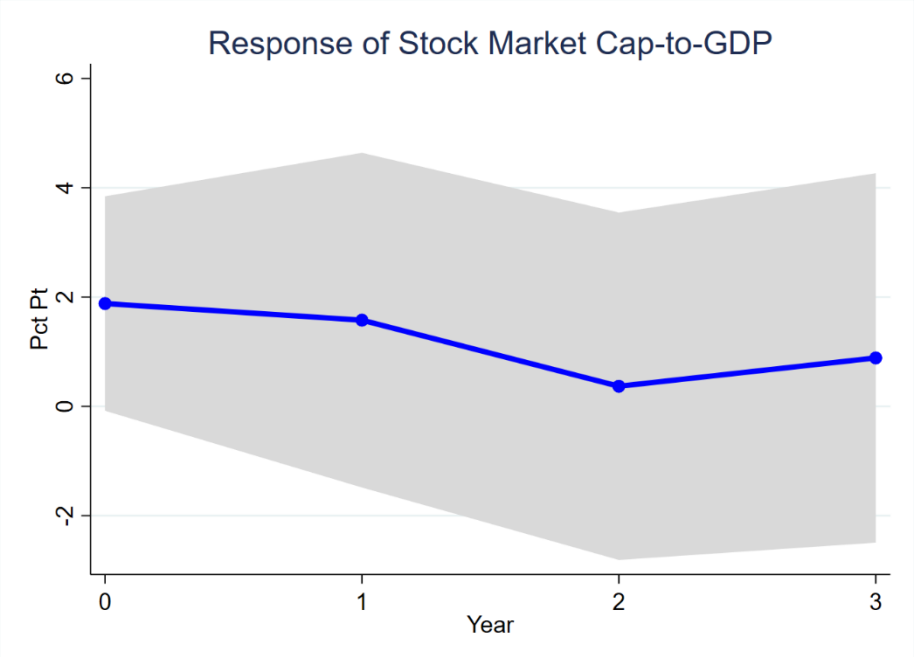
$$Stock\_Mktcap\_GDP\_Ratio_{i,t+h} = \beta_0 + \beta_1 L.Stock\_Mktcap\_GDP\_Ratio_{i,t} + \beta_2 Contribution\_GDP\_Ratio_{i,t} + \beta_3 EquityLimit_{i,t} + \eta Z_{it} + \alpha_i + \gamma_t + \epsilon_{i,t}$$

where $Stock\_Mktcap\_GDP\_Ratio_{i,t+h}$ is the h-year-ahead stock market capitalization-to-GDP ratio *(h = 0, 1, 2, 3)*; $Contribution\_GDP\_Ratio_{i,t}$ is the contribution to funded and private pension schemes in country i and year t, as a percent of GDP; and other variables are defined similarly as above. The lagged dependent variable is again included to account for potential reverse causality. Note that we do not include the lagged $Contribution\_GDP\_Ratio_{i,t}$ because the left-hand-side variable already accounts for the dynamic responses of $Contribution\_GDP\_Ratio_{i,t}$.

Results

The benchmark local projection results are presented in Appendix Figure 1, which includes the pension contribution-to-GDP ratio (and other controls) but not the equity investment limit. As evident from the figure, as the funded pension contribution increases, stock market capitalization in the same year also increases, although this effect is insignificant for outer years. Moreover, a one-percentage-point increase in the former is approximately associated with a two-percentage-point increase in the latter, a very similar magnitude to the panel regression result obtained from the Arellano-Bond method.

Appendix Figure 1.
Local Projections of Stock Market Cap onto Funded Pension Contribution



Note: The empirical specification underlying this chart does not control for the equity investment limit. Shaded area = 90 percent confidence intervals.
Source: Authors' calculations.

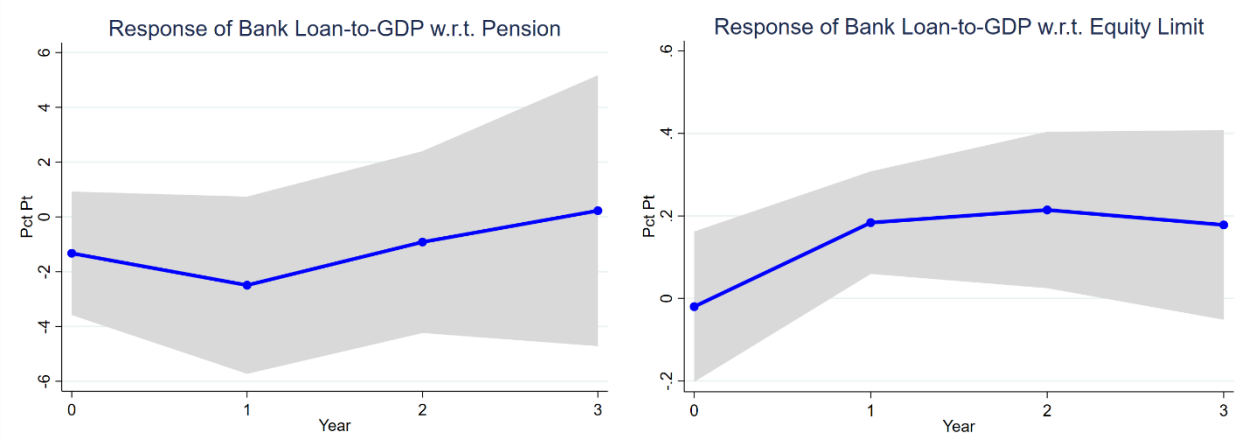
After including the equity investment limit, the statistical significance and economic magnitude of the pension fund contribution-to-GDP does not change much, and the equity limit itself is statistically insignificant. See Appendix Figure 2. These results, including the estimated economic magnitude, align closely with those from the panel regressions conducted using the Arellano-Bond method.

Finally, we conduct local projections using bank loan-to-GDP ratio as the dependent variable. We find that it drops somewhat in the same year when the pension contribution increases and more so in the subsequent year, although the results are not statistically significant at the 10 percent level, as shown in Appendix Figure 3.

Appendix Figure 2. Local Projections of Stock Market Cap onto Funded Pension Contribution and Equity Investment Limit

Note: The left chart is the response to pension contribution-to-GDP in an empirical specification that also includes the equity limit as another regressor; the right chart is the response to the equity limit itself. Shaded area = 90 percent confidence intervals.
Source: Authors' calculations.

Appendix Figure 3. Local Projections of Bank Loan onto Funded Pension Contribution and Equity Investment Limit



Note: The left chart is the response to pension contribution-to-GDP in an empirical specification that also includes the equity limit as another regressor; the right chart is the response to the equity limit itself. Shaded area = 90 percent confidence intervals.
Source: Authors' calculations.

Appendix 2. Summary Statistics of Data Used in the Main Regressions

This Appendix consists of three tables:

Appendix Table 1. Summary Statistics of Main Variables

Variable	Observations	Mean	Standard Deviation	Min	Max
Year	499	2011	5.6	2001	2020
Stock_Mktcap_GDP_Ratio	499	73.4	52.3	2.8	393.0
Contribution_GDP_Ratio	499	2.2	2.5	0.0	9.8
GDP_G	499	4.1	4.2	-9.8	20.3
DepRate_ST	499	2.5	2.7	-0.8	19.6
Pop_G	499	0.6	0.6	-0.7	3.0
EquityLimit	499	88.6	20.8	0.0	100.0

Sources: OECD; IMF WEO; Authors' calculations.

Appendix Table 2. Year Distribution

Year	Frequency	Percent	Cumulative
2001	17	3.4	3.4
2002	21	4.2	7.6
2003	23	4.6	12.2
2004	24	4.8	17.0
2005	24	4.8	21.8
2006	23	4.6	26.5
2007	23	4.6	31.1
2008	26	5.2	36.3
2009	27	5.4	41.7
2010	28	5.6	47.3
2011	28	5.6	52.9
2012	27	5.4	58.3
2013	28	5.6	63.9
2014	28	5.6	69.5
2015	26	5.2	74.8
2016	25	5.0	79.8
2017	24	4.8	84.6
2018	25	5.0	89.6
2019	26	5.2	94.8
2020	26	5.2	100.0
Total	499	100.0	

Sources: Authors' calculations.

Appendix Table 3. Country Distribution

Country	Frequency	Percent	Cumulative
Australia	19	3.8	3.8
Austria	17	3.4	7.2
Belgium	20	4.0	11.2
Canada	20	4.0	15.2
Chile	18	3.6	18.8
Czech	18	3.6	22.4
Denmark Republic	15	3.0	25.5
Finland	18	3.6	29.1
France	8	1.6	30.7
Germany	20	4.0	34.7
Greece	6	1.2	35.9
Hungary	19	3.8	39.7
Iceland	18	3.6	43.3
Italy	20	4.0	47.3
Japan	6	1.2	48.5
Korea	17	3.4	51.9
Luxembourg	17	3.4	55.3
Mexico	20	4.0	59.3
Netherlands	20	4.0	63.3
New Zealand	13	2.6	65.9
Norway	19	3.8	69.7
Poland	14	2.8	72.6
Portugal	20	4.0	76.6
Slovak Republic	17	3.4	80.0
Slovenia	16	3.2	83.2
Spain	20	4.0	87.2
Switzerland	20	4.0	91.2
Turkey	6	1.2	92.4
United Kingdom	18	3.6	96.0
United States	20	4.0	100.0
Total	499	100.0	

Sources: Authors' calculations.

Appendix 3. Game-Theoretical Models to Illustrate FICMI As A Coordination Device

This appendix illustrates the role of FICMI as a coordination device for stock market participants to achieve a better equilibrium. To that end, we examine three models: A simple game theoretical model with two Nash equilibria (in which there exists a "good" equilibrium under coordination), a model with a small probability of deviation (in which a noisy signal can break down the "good" equilibrium), and a model with FICMI (in which FICMI can restore the "good" equilibrium).

Model #1: Simple Game with Two Nash Equilibria

In this model, each stock market participant faces a coordination game. Each player, representing an individual investor, has two strategies: (1) Stay: Remain invested in the stock market. (2) Run: Exit the stock market by selling their stock. The payoffs for each investor depend on their own strategy and the strategy adopted by the other investors. Specific payoffs are listed in the following payoff matrix:

		Investor B	
		Run	**Stay**
Investor A	**Run**	(1, 1)	(2, 0)
	Stay	(0, 2)	(2, 2)

It can be shown that there exist two Nash equilibria:

- (Run, Run): Both players choose to run because given that Investor B will run, Investor A's optimal choice is to run as well, and vice versa. In this equilibrium, both players receive 1 as a payoff.
- (Stay, Stay): Both players choose to stay because neither has an incentive to deviate unilaterally. In this equilibrium, both players are better off than the (Run, Run) equilibrium and receive 2 instead.

In this model, if all the investors can manage to coordinate, they can achieve the "good" equilibrium of (Stay, Stay).

Model #2: Game with A Small Probability of Deviation

We now introduce a small probability ϵ that each player may deviate from their intended strategy, representing *noises or misperceptions* in the market. The expected utility for each strategy combination now incorporates the probability ϵ of making an error in strategy execution. For example, if a player intends to stay, there is still an ϵ chance they might run. We will now examine the changes to the equilibria under these adjustments in Model #2.

Regarding the Nash equilibrium (Stay, Stay) of Model #1: For Investor A, the expected payoff from "Stay" equals

$$\epsilon \cdot 0 + (1- \epsilon) \cdot 2$$

And the expected payoff from deviating to "Run" equals

$$\epsilon \cdot 1 + (1- \epsilon) \cdot 2$$

Therefore, for all positive values of Investor B's deviation probability ϵ (regardless of how small it is), Investor A will find it optimal to deviate to "Run". Similarly, for all positive values of Investor A's deviation probability ϵ (regardless of how small it is[51]), Investor B will find it optimal to deviate to "Run". Therefore, (Stay, Stay) is no longer an equilibrium in the sense of the trembling hand perfect equilibrium (THPE).

By contrast, regarding the other Nash equilibrium (Run, Run) of Model #1: For Investor A, the expected payoff from deviating to "Stay" equals (note that ϵ is now the probability of Investor B deviating to "Stay")

$$\epsilon \cdot 2 + (1-\epsilon) \cdot 0$$

Meanwhile, the expected payoff from remaining in "Run" equals

$$\epsilon \cdot 2 + (1-\epsilon) \cdot 1,$$

which is always higher than "Stay". Hence, (Run, Run) remains an equilibrium in the sense of the THPE, which is robust to the probabilities of the other player making an error in strategy execution.

Therefore, in Model #2, the "good" equilibrium (Stay, Stay) in Model #1 cannot be sustained as long as there is a small chance that the other player makes an error in strategy execution. This can also be interpreted as that the coordinated equilibrium (Stay, Stay) in Model #1 cannot be sustained as long as an individual investor observes a noisy signal that leads him/her to believe that the other investor will not coordinate. In this context, given the large number of investors and the complexity of coordination in reality, there are always such *noisy* signals and misperceptions that will almost surely break down the (Stay, Stay) equilibrium in the absence of credible coordination devices.

[51] Similar insights still hold for other "reasonable" payoff structures. For example, if the payoffs of (Run, Stay) are (1.8, 0) instead of (2, 0), and those of (Stay, Run) are (0.1.8) instead of (0,2), we can show that (Stay, Stay) will not be an equilibrium as long as the deviation probability $\epsilon > \frac{1}{6}$.

Model #3: Game with A Small Probability of Deviation and with FICMI Pension

We now introduce the FICMI pension to the model. Specifically, we add an additional term γ to the payoff to the investor who chooses to stay in the stock market. This is consistent with the arguments in the main text that the FICMI will invest a portion of its financial resources in equities, which will enable firms to conduct more R&D and thus raise the overall return of the stock market. The revised payoff matrix becomes:

		Investor B	
		Run	**Stay**
Investor A	**Run**	(1, 1)	(2, 0+γ)
	Stay	(0+γ, 2)	(2+γ, 2+γ)

We now revisit Nash equilibrium (Stay, Stay) in Model #1. For Investor A, the expected payoff from "Stay" equals

$$\epsilon\cdot\gamma + (1- \epsilon)\cdot(2+\gamma)$$

And the expected payoff from deviating to "Run" equals

$$\epsilon\cdot 1 + (1- \epsilon)\cdot 2$$

Therefore, the expected payoff from "Stay" will exceed that from deviating to "Run" if

$$\epsilon\cdot\gamma + (1- \epsilon)\cdot(2+\gamma) > \epsilon\cdot 1 + (1- \epsilon)\cdot 2$$

That is,

$$\gamma > \epsilon$$

This condition boils down to simply $\gamma > 0$ when the deviation probability ϵ approaches 0. Hence, as long as we introduce FICMI and as long as FICMI can increase the stock return (which is the case according to the main text of the paper), (Stay, Stay) remains an equilibrium in the sense of the THPE that is robust to small probabilities of the other play deviating from "Stay".

Therefore, in Model #3, the introduction of the FICMI pension can effectively act as a coordination device, under which the "good" equilibrium (Stay, Stay) can be sustained, which are robust to noisy signals and misperceptions in the market.

Appendix Table 4. Average Equity Investment Limit, Funded Pension Contribution-to-GDP, and *Stock Market Capitalization* with Arellano-Bond (AB) Estimation

	(1) Both Variables, AB	(2) Year Dummy, Both Variables, AB	(3) Robust SE, Both Variables, AB	(4) Robust SE, Year Dummy, Both Variables, AB
L.Stock_Mktcap_GDP_Ratio	0.335***	0.370***	0.335***	0.370***
	(0.000)	(0.000)	(0.000)	(0.000)
Contribution_GDP_Ratio	4.025*	2.121	4.025***	2.121**
	(0.097)	(0.335)	(0.010)	(0.025)
L.Contribution_GDP_Ratio	-1.854	-1.037	-1.854	-1.037
	(0.397)	(0.607)	(0.315)	(0.427)
AvgEquityLimitLevel	-0.059	-0.055	-0.059	-0.055
	(0.842)	(0.843)	(0.815)	(0.616)
L.AvgEquityLimitLevel	0.676	0.575	0.676*	0.575**
	(0.108)	(0.128)	(0.068)	(0.037)
GDP_G	0.509	1.147*	0.509	1.147**
	(0.257)	(0.063)	(0.404)	(0.044)
L.GDP_G	0.286	0.318	0.286	0.318
	(0.550)	(0.591)	(0.485)	(0.541)
DepRate_ST	0.613	1.715	0.613	1.715
	(0.685)	(0.313)	(0.729)	(0.331)
L.DepRate_ST	-3.162**	-2.122	-3.162	-2.122
	(0.010)	(0.122)	(0.116)	(0.120)
Pop_G	-7.526	-4.631	-7.526	-4.631
	(0.213)	(0.401)	(0.194)	(0.274)
L.Pop_G	-0.784	-6.513	-0.784	-6.513
	(0.893)	(0.231)	(0.868)	(0.194)
Constant	2.733	20.847	2.733	20.847
	(0.934)	(0.506)	(0.938)	(0.410)
Observations	412	412	412	412
Number of Countries	30	30	30	30

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. AB=Arellano-Bond.
Sources: OECD; Authors' calculations.

Appendix Table 5. Average Equity Investment Limit, Funded Pension Contribution-to-GDP, and *Bank Loan-to-GDP* with Arellano-Bond (AB) Estimation

	(1)	(2)	(3)	(4)
	Both Variables, AB	Both Variables, Year Dummy, AB	Robust SE, Both Variables, AB	Robust SE, Both Variables, Year Dummy, AB
L.BankLoan_GDP_Ratio	0.331***	0.603***	0.331***	0.603***
	(0.000)	(0.000)	(0.000)	(0.000)
Contribution_GDP_Ratio	-0.678	-1.781	-0.678	-1.781
	(0.762)	(0.280)	(0.710)	(0.123)
L.Contribution_GDP_Ratio	-0.700	1.023	-0.700	1.023
	(0.727)	(0.492)	(0.654)	(0.374)
AvgEquityLimitLevel	-0.082	-0.058	-0.082	-0.058
	(0.723)	(0.736)	(0.703)	(0.756)
L.AvgEquityLimitLevel	-0.109	0.088	-0.109	0.088
	(0.713)	(0.689)	(0.682)	(0.534)
GDP_G	-4.516***	-2.301***	-4.516***	-2.301***
	(0.000)	(0.000)	(0.000)	(0.000)
L.GDP_G	-0.942**	-0.519	-0.942*	-0.519
	(0.030)	(0.223)	(0.074)	(0.259)
DepRate_ST	-1.308	1.990*	-1.308	1.990
	(0.313)	(0.093)	(0.336)	(0.121)
L.DepRate_ST	-2.922**	-2.260**	-2.922***	-2.260**
	(0.014)	(0.032)	(0.002)	(0.034)
Pop_G	-7.640	-2.418	-7.640	-2.418
	(0.182)	(0.566)	(0.288)	(0.540)
L.Pop_G	8.731	3.473	8.731**	3.473
	(0.112)	(0.397)	(0.013)	(0.150)
Constant	205.592***	98.939***	205.592***	98.939***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	388	388	388	388
Number of Countries	27	27	27	27

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. AB=Arellano-Bond.
Sources: OECD; Haver; Authors' calculations.

Appendix Figure 4. Local Projections of Stock Market Cap onto Funded Pension Contribution and *Average* Equity Investment Limit

Note: The left chart is the response to pension contribution-to-GDP in an empirical specification that also includes the average equity limit as another regressor; the right chart is the response to the average equity limit itself. Shaded area = 90 percent confidence intervals.
Source: Authors' calculations.

Appendix Figure 5. Local Projections of Bank Loan onto Funded Pension Contribution and *Average* Equity Investment Limit

Note: The left chart is the response to pension contribution-to-GDP in an empirical specification that also includes the average equity limit as another regressor; the right chart is the response to the average equity limit itself. Shaded area = 90 percent confidence intervals.
Source: Authors' calculations.

Appendix Table 6. Results for *Stock Market Capitalization* with COVID Dummy

	(1)	(2)	(3)	(4)
	Both Variables, AB	Year Dummy, Both Variables, AB	Robust SE, Both Variables, AB	Robust SE, Year Dummy, Both Variables, AB
L.Stock_Mktcap_GDP_Ratio	0.305***	0.370***	0.305***	0.370***
	(0.000)	(0.000)	(0.000)	(0.000)
Contribution_GDP_Ratio	4.158*	2.121	4.158***	2.121**
	(0.085)	(0.335)	(0.007)	(0.025)
L.Contribution GDP Ratio	-1.779	-1.037	-1.779	-1.037
	(0.414)	(0.607)	(0.353)	(0.427)
AvgEquityLimit	-0.078	-0.055	-0.078	-0.055
	(0.792)	(0.843)	(0.761)	(0.616)
L.AvgEquityLimit	0.740*	0.575	0.740*	0.575**
	(0.078)	(0.128)	(0.059)	(0.037)
GDP G	0.998*	1.147*	0.998	1.147**
	(0.065)	(0.063)	(0.119)	(0.044)
L.GDP_G	0.279	0.318	0.279	0.318
	(0.558)	(0.591)	(0.489)	(0.541)
DepRate_ST	0.594	1.715	0.594	1.715
	(0.693)	(0.313)	(0.733)	(0.331)
L.DepRate ST	-2.716**	-2.122	-2.716	-2.122
	(0.031)	(0.122)	(0.190)	(0.120)
Pop_G	-6.274	-4.631	-6.274	-4.631
	(0.300)	(0.401)	(0.252)	(0.274)
L.Pop_G	-1.311	-6.513	-1.311	-6.513
	(0.821)	(0.231)	(0.786)	(0.194)
COVID	10.838*	0.461	10.838**	0.461
	(0.097)	(0.956)	(0.021)	(0.971)
Constant	-3.268	20.847	-3.268	20.847
	(0.921)	(0.506)	(0.926)	(0.410)
Observations	412	412	412	412
Number of Countries	30	30	30	30

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. AB=Arellano-Bond.
Sources: OECD; Authors' calculations.

Appendix Table 7. Results for *Bank Loan-to-GDP* with COVID Dummy

	(1)	(2)	(3)	(4)
	Both Variables, AB	Both Variables, Year Dummy, AB	Robust SE, Both Variables, AB	Robust SE, Both Variables, Year Dummy, AB
L.BankLoan_GDP_Ratio	0.324***	0.603***	0.324***	0.603***
	(0.000)	(0.000)	(0.000)	(0.000)
Contribution_GDP_Ratio	-0.720	-1.781	-0.720	-1.781
	(0.745)	(0.280)	(0.672)	(0.123)
L.Contribution_GDP_Ratio	-0.536	1.023	-0.536	1.023
	(0.787)	(0.492)	(0.759)	(0.374)
AvgEquityLimit	-0.123	-0.058	-0.123	-0.058
	(0.593)	(0.736)	(0.585)	(0.756)
L.AvgEquityLimit	0.005	0.088	0.005	0.088
	(0.988)	(0.689)	(0.988)	(0.534)
GDP_G	-3.486***	-2.301***	-3.486***	-2.301***
	(0.000)	(0.000)	(0.000)	(0.000)
L.GDP_G	-1.126***	-0.519	-1.126**	-0.519
	(0.009)	(0.223)	(0.038)	(0.259)
DepRate_ST	-1.697	1.990*	-1.697	1.990
	(0.186)	(0.093)	(0.205)	(0.121)
L.DepRate_ST	-1.715	-2.260**	-1.715*	-2.260**
	(0.155)	(0.032)	(0.074)	(0.034)
Pop_G	-5.200	-2.418	-5.200	-2.418
	(0.360)	(0.566)	(0.468)	(0.540)
L.Pop_G	9.049*	3.473	9.049***	3.473
	(0.096)	(0.397)	(0.006)	(0.150)
COVID	22.805***	36.500***	22.805***	36.500***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	192.507***	98.939***	192.507***	98.939***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	388	388	388	388
Number of Countries	27	27	27	27

Note: P-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1. AB=Arellano-Bond.
Sources: OECD; Haver; Authors' calculations.

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