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8 June 2011

Online at https://mpra.ub.uni-muenchen.de/31395/
MPRA Paper No. 31395, posted 10 Jun 2011 13:46 UTC

Would Emerging Market Pension Funds Benefit from International Diversification: Investigating Wealth Accumulations for Pension Participants

by

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Abstract

In recent years, investment portfolio selection is growing in importance for many emerging market pension funds, as pension reforms replace traditional pay-as-you-go systems with advanced funding systems. Various investment regulations are applied to the funded pensions, particularly in the form of portfolio limits for equities and international assets. With a bootstrap simulation approach, this paper attempts to quantify the impacts on retirement benefits of restricting international assets from the investment portfolios of emerging market pension funds. We find that, on average, over half of the pension portfolios of emerging market countries should be in international assets in order to maximize the expected utility of moderate and conservative pension fund participants. More generally, international assets can play a significant role in the investment portfolios for workers with risk aversion varying from aggressive to conservative. With few exceptions, the entire probability distribution of wealth accumulations at retirement could be shifted higher with the inclusion of international assets.

Keywords: Emerging Market Pension Funds, International Diversification, Bootstrapping, Monte Carlo Simulations.

JEL Classification Codes: H55, G11, G23

Acknowledgements: The authors are grateful for financial support from the Japan Society for the Promotion of Science Grants-in-Aid for Young Scientists (B) #23730272.

Introduction

Pension reforms in developed and emerging market countries have generally been motivated by the need to address the issue of demographic pressures, including the shrinking of working-age populations, lengthening life spans, falling fertility, and the shortcomings of existing means for elderly support. The main objective of pension reforms should be to ensure income security for the elderly with a least cost approach. Traditionally, pension plans were pay-as-you-go systems which provided employees with a stable and generous pension income stream throughout retirement. In recent years, especially in emerging market countries, these systems are being replaced by advanced funding systems, such as defined-contribution pension plans, in which income at retirement depends on investment decisions and is not guaranteed. Concurrently in emerging market countries, pension funds may increasingly be considered as large and important institutional investors with rapidly growing asset bases (OECD, 2008). In this context, effective fund management with carefully designed asset allocation strategies can play a pivotal role in ensuring income security for retirees.

But pension funds in developed and emerging market countries are largely characterized by investment restrictions such as portfolio ceilings for stocks and international assets. These restrictions are relatively strict in emerging market countries (Solnik and McLeavey, 2009). They have important impacts on the investment performance for pension funds, and ultimately on retirement benefits. Roldos (2004) indicates that one of the key policy issues that arises in this context is whether emerging markets should liberalize restrictions on portfolio limits and move to the "prudent person rule", which provides more flexibility for the pension fund manager to decide investment strategies in the context of how an investment affects the overall risk of the portfolio.

According to the fundamental justification provided by the modern portfolio theory, the objective of international diversification is to improve the risk-return tradeoff of the portfolio by choosing complementary assets with low correlations (Markovitz, 1952). The mean-variance techniques from modern portfolio theory have been used in various studies about international diversification. For instance, Bhargawa et al. (2004) use a mean-variance framework to show that returns per unit of risk are increased for a typical U.S. investor with international diversification. Pfau (2011) uses mean-variance optimization to show that about half of the portfolios of emerging market pension funds

should be in world assets, though the impact of international diversification differs from country to country. In examining the rationale and implications of various approaches to pension fund regulations in OECD countries, Davis (2002) suggests that the "prudent person rule" is better suited to the regulation of defined-contribution pension funds than investment restrictions.

There should also be reasonably developed and sufficiently deep and liquid domestic financial markets for growing pension funds to invest domestically. However, domestic markets in emerging market countries are not in a position to provide the amount of financial assets required by rapidly growing institutional investors like pension funds (Chan-Lau, 2005). Based on 2008 data, Figure 1 compares the size of pension fund assets to the size of domestic financial markets.

//Figure 1 About Here//

Chile has the largest pension fund on a relative basis with assets totaling 52.8 percent of GDP. Also, the pension funds of Malaysia, Israel, Egypt, South Africa, Jordan, and Morocco have large relative asset holdings, with 46.3 percent, 42.8 percent, 32.6 percent, 31 percent, 30 percent, and 28.8 percent of GDP, respectively. Pension assets in Brazil, Columbia, Mexico, Peru, Poland, and Sri Lanka are between 10 and 15 percent while pension assets in the remaining countries are less than 10 percent of their respective country's GDP.

Pension fund assets can be compared to the size of the stock market to have an understanding about the domestic investment potential for pension funds. The asset holdings of pension funds in Chile, Egypt, Hungary, Israel, Malaysia, and Poland are more than half of the stock market capitalization of their respective countries. Moreover, in 2008, pension fund assets in Sri Lanka exceed the country's stock market capitalization and the stock volume traded. If these pension funds invest too much in their stock markets, they would become a key player which could have a significant impact on asset prices through their transactions.

One argument against international diversification is that a pension fund's local investment raises the total volume of stock traded, stimulates the financial infrastructure, and promotes national savings. However, Meng and Pfau (2010) estimate that the positive impacts of pension funds on financial market development are only significant for countries with highly developed financial markets already. Countries with less

developed financial markets tend not to benefit from pension fund investments. Regardless, Bodie and Merton (2002) argue that if it is important to keep pension assets at home, the use of swap contracts between pension funds and foreign institutional investors will allow these pension funds to diversify internationally without moving large amounts of assets away from domestic markets.

The objective of this paper is to provide an analysis of the potential role for international assets in the investment portfolios of 25 emerging market pension funds. We extend the findings in Pfau (2011) in important ways, as that paper only considered traditional single-period mean-variance optimization techniques. The contribution of this paper is to use a Monte Carlo bootstrap method with newly updated historical data to consider pension fund asset allocation from a long-term perspective. In determining the optimal portfolio, we use a utility-based approach which assesses how pension fund participants evaluate portfolio performance while taking into account their risk aversion. We provide simulations to show optimal asset allocation and the impacts of investment restrictions for investors with various attitudes toward risk. We find that retirement benefits could be increased by including international assets in the investment portfolios of emerging market pension funds in all but three of 25 countries. We provide strong evidence to support international diversification for the investments in the majority of emerging market pension funds.

Current Investment Limits of Emerging Market Pension Funds

Regulations provide a major barrier for international diversification in many emerging market countries. Pension funds are often subject to investment regulations, which are based on quantitative portfolio restrictions. These restrictions are applied to pension funds as portfolio ceilings, particularly on international investment and stocks (OECD, 2010). Figure 2 depicts the current portfolio limits for international investment and equity investment for emerging market pension funds.

//Figure 2 About Here//

The pension funds of Turkey and Israel are the most liberal in terms of portfolio ceilings imposed on international assets and equities, as there are no limits currently imposed. On the other hand, India's pension fund does not allow international assets or equities. Also, the pension funds of Sri Lanka, Pakistan, Morocco, Indonesia, and Egypt do not

allow international investment. Quantitatively, we can observe that the restrictions on international assets are stricter than the restrictions on equities for the majority of emerging market pension funds.

Methodology

In order to determine the optimal asset allocation for pension funds, we employ a bootstrap procedure for a common hypothetical pension participant in each country. We assume that this participant starts a 40-year career path with an annual gross salary of 100 in each country's local currency, though the findings will be presented in such a way that the salary level does not matter. Salary grows by one percent in real terms annually. The pension savings rate differs between countries, and our purpose is not to determine the optimal savings rate but to evaluate the role for international assets in enhancing retirement benefits. Hence, for simplicity, we assume a pension savings rate of 10 percent of gross salary. We further assume that there will be an annual administrative fee of 0.3 percent for domestic investments and 0.5 percent for international investments charged by each country's pension fund management. Income from assets is assumed to be reinvested without deducting for taxes. Also, the portfolio will be rebalanced at the end of each year so as to maintain a fixed asset allocation over time.

For each country, we consider 258 fixed asset allocation strategies for four assets [domestic fixed income, domestic stocks, world fixed income, and world stocks] by varying each asset in 10 percentage point increments from zero to 100 percent. This process creates 11 constrained portfolio strategies using only two domestic assets. We simulate 10,000 scenarios, each of which consists of real returns for a particular country's four assets over a 40-year period. For the bootstrap procedure, asset return data for each simulation are randomly drawn with replacement from the historical data. The simulated returns match the average returns, volatilities, and contemporaneous correlations present in the historical data. However, this re-sampling method does not capture any serial correlation present in each time series. When compared with the traditional mean-variance framework, the biggest advantage of the bootstrap approach is that it is a multi-period optimization procedure, which allows us to consider the asset allocation issue from a long-term perspective. Also, the bootstrap procedure is non-

parametric, and does not make any distributional assumptions about the normality of returns.

Allowing for diminishing marginal utility of wealth, the standard constant relative risk aversion [CRRA] utility function is used to compute the expected utility of wealth over the distribution of terminal wealth accumulations:

$$E[u(w_i)] = \sum_{i=1}^{N}\left(\frac{1}{1\text{-}\gamma} w_i^{1-\gamma}\right) \text{ for } \gamma > 0,\ \gamma \neq 1$$
$$= \ln(w_i) \qquad \text{for } \gamma = 1$$

where w_i represents the wealth accumulation at retirement in each of N=10,000 simulations. The variable γ is the investor risk aversion, which we consider for a range from one to 10. A value of zero represents risk neutrality, and increasingly positive values indicate increasing risk aversion. Pension fund investors are relatively risk averse, and for our baseline results about the optimal asset allocations and the impacts of investment constraints, we consider a risk aversion coefficient of five as representative. For pension fund participants in each country, we estimate the expected utility of each strategy across the spectrum of risk aversion coefficients using 10,000 simulations. The optimal asset allocation strategy for each level of risk aversion is the strategy that provides investors with the highest expected utility for both the unconstrained [with international assets] and constrained [without international assets] portfolios. Nest-egg ratios are calculated as the wealth accumulations at retirement divided by the average income from the five years before retirement. For each country, the impacts of investment constraints are analyzed by comparing the distribution of nest-egg ratios with and without international assets.

Data

Data is available through the end of 2009 for all 25 countries. In order to avoid extremely high and low return outliers caused by hyperinflation, we consider the data since 1992 for Argentina and since 1995 for Brazil, in spite of the longer data availability for these countries. For all other countries, we use the longest time period in

which all the relevant data could be collected. The starting dates do differ across the 25 countries though, ranging from 1988 to 1998.

Domestic equity returns are calculated by taking the annual percentage change at year end in local currency for the MSCI standard core gross indices for each country. The domestic bank deposit rate represents the local fixed income component. The International Monetary Fund's International Financial Statistics [IMF IFS] is the source for most fixed income data. We consider the call money rate of Pakistan as a proxy for its domestic deposit rate. Also, the Sri Lankan deposit rate from 2007 to 2009 is taken from the Central Bank of Sri Lanka. In Poland, the methodology for calculating deposit rates changed in 2002. Data from 2007 to 2009 are available from the National Bank of Poland. New data on Polish deposit rates are transformed to the old version using a scaling factor between the old and new versions.

The world stock market is represented by the MSCI developed market [DM] world index while the world bond market data through 2008 is from the updated dataset first described in Dimson, Staunton, and Marsh (2002). For 2009, world bond index data is from the Citigroup world government bond index for G10 countries. As for other relevant data, the exchange rate is defined as the amount of US dollars that can be purchased with a unit of local currency. The monthly exchange rate data, available from the IMF IFS database, is used to compute the annual percentage changes at the year end. The returns on the world assets are converted into the domestic currency using this exchange rate data, because we assume that pension funds in each country will not hedge currency risk. The annual consumer price index data, provided in the IMF IFS database, is used to compute inflation. Since our results are provided in real terms, the inflation data allows us to calculate real returns for the assets.

Results

Characteristics of Historical Economic Data

Table 1 includes the means and standard deviations of unhedged local currency real returns for four financial assets, exchange rates, and inflation for each country.

//Table 1 About Here//

Among the four assets, local stocks reported the highest mean return with the highest volatility for all the countries except Argentina, China, Jordan, Poland, and Russia. In

the respective time periods, world bonds reported the highest mean return in Argentina, while world stocks reported the highest mean return in China and Jordan. Bank deposits provided Poland's highest mean asset return. Turkey's domestic stock market was the most volatile with a standard deviation of 120.6 percent for real returns. The domestic stock markets of Morocco and South Africa were the least volatile, though their 22.8 percent standard deviation of returns is still high by developed market standards. Generally, the domestic stock markets of emerging market countries were highly volatile with standard deviations greater than 30 percent for all the countries except for Chile, Jordan, Morocco, and South Africa. Meanwhile, local bank deposits reported the lowest mean return and volatility among the four assets, except in Brazil, Columbia, and Poland.

For the unhedged real returns of world assets, the returns and risks of world stocks and world bonds vary from country to country because of differences in exchange rates, inflation, and varying periods of data availability. World stock returns were less volatile than domestic stock returns except in Russia. However, unhedged real returns for world stocks were lower than for domestic stocks except in China and Jordan. As for world bonds, it is important to note that, ex post, they enjoyed higher returns with lower risk when compared to world stock returns for Chile, Columbia, India, Indonesia, Korea, Mexico, Morocco, Philippines, Russia, South Africa, and Turkey. World bonds generated the same returns but with lower risk in Poland and Thailand.

Regarding exchange rates, except for Morocco, all of the countries experienced average depreciation against the US dollar during their respective historical periods. This boosts the unhedged returns from world assets. Turkey and Russia reported the most extreme average depreciations. As for inflation, countries with double-digit average inflation rates include Brazil, Columbia, Hungary, Indonesia, Mexico, Russia, Sri Lanka, and Turkey. As the hyperinflation periods were removed for Argentina and Brazil, during the respective time periods, Turkey and Russia experienced the highest inflation rates as well as the strongest depreciations.

//Table 2 About Here//

Table 2 provides the correlations among the four assets in each country. The correlations among asset returns are generally low, allowing for diversification benefits. The mean correlation between the returns of local stocks and world stocks is +0.31.

Except for Korea and Russia, returns from local stocks and world stocks are positively correlated. Most of the countries exhibit a negative correlation [the average is -0.26] between local stocks and world bonds, with the exceptions of Argentina, Egypt, and Jordan. Local bank deposits have an average correlation of +0.30 with world stocks and +0.17 with world bonds.

Optimal Asset Allocation

Table 3 provides the simulation results for the optimal unconstrained and constrained asset allocations using real data for a conservative pension fund participant with a risk aversion coefficient of five.

//Table 3 About Here//

On average, the optimal unconstrained portfolio should include 54.8 percent world bonds, 28.8 percent local stocks, 15.6 percent local bank deposits, and 0.8 percent world stocks. In other words, 55.6 percent of the total portfolio should be in world assets and 29.6 percent in stocks, on average. More broadly, there is no role for international assets in the optimal pension fund portfolios of Brazil, Columbia, and Poland. Mexico's unconstrained optimal portfolio consists of 30 percent international assets, while Argentina, Chile, South Africa, and Turkey optimize with 40 percent international assets. The remaining 17 of 25 countries optimize with 50 percent or more international assets. At the extreme, Jordan's optimal portfolio consists of only world assets. Other countries with relatively high international allocations of at least 80 percent include China, Israel, Pakistan, and Sri Lanka. When pension funds are constrained from holding international assets, the average allocations are 27.6 percent for local stocks and 72.4 percent for local bank deposits.

Table 4 provides more information on international allocations for each emerging market pension fund, for a wider spectrum of risk aversion coefficients.

//Table 4 About Here//

The average allocation to international assets increases from 31.2 percent to 56.4 percent as the coefficient of risk aversion increases from one to four. Beyond this point, the average allocation to international assets decreases. But even for the most conservative investor whose coefficient of risk aversion is ten, the average allocation to international assets is 50 percent.

The optimal portfolio of Jordan's pension fund includes 100 percent world assets for all the included risk aversion coefficients. World assets for China range from 100 to 90 percent as conservatism increases. Despite the average inverted U-shape for allocations to world assets, world assets play an increasingly significant role for more conservative investors in Chile, Czech Republic, Egypt, India, Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, and Sri Lanka. On the other hand, Brazil and Poland are the only two countries where international assets do not play any role in their pension fund optimal portfolios under any level of risk aversion. In general, though, international assets may potentially play a significant role in the investment portfolios of emerging market pension regardless of participant attitudes toward risk.

Impacts of Investment Restrictions

According to the optimal asset allocation results in Table 3, pension fund participants in emerging market countries except Brazil, Columbia, and Poland, experience reductions to their expected utility when they are constrained from choosing world assets. Otherwise, they could have chosen the constrained portfolios in the unconstrained case. Table 5 provides more details about this by showing the distribution of nest-eggs accumulated at various percentiles in the optimal unconstrained and constrained cases, as well as the percentage differences between the distributions. Except for the three cases in which the optimal unconstrained portfolios did not include world assets, we observe that the distributions of the unconstrained outcomes stochastically dominate the constrained outcomes. In other words, the wealth accumulated across the distributions are larger in the unconstrained cases, which helps to alleviate any fears that world assets may be more risky. Across the distribution of outcomes, internationally diversified portfolio strategies provide larger nest-egg ratios for pension fund investors in those 22 emerging market countries.

//Table 5 About Here//

Conclusion

In 22 of the 25 emerging market countries, international diversification results in a distribution of wealth accumulations for pension fund participants that stochastically dominates the distribution of outcomes when world assets are excluded. This finding

adds to the existing literature by providing a stronger case for international diversification over a long horizon than seen with single-period mean-variance portfolio optimization models. Participants in emerging market countries with different attitudes toward risk can benefit from international diversification. This results in part because financial markets in emerging market countries tend to be quite volatile. However, our estimates, which are based on the historical data, assume fixed portfolio strategies for workers throughout their career paths. Fund managers should consider whether the historical data provide reliable information when looking forward. Also, the role of international assets in emerging market pension funds could be analyzed using lifecycle portfolio strategies in which stock allocations decrease as retirement approaches. Sometimes, the governments of emerging market countries may deliberately want to invest their pension fund assets domestically, with the objectives of creating employment opportunities for their youth, promoting domestic financial markets, or building domestic social infrastructure. However, this paper demonstrates that, for emerging market countries searching for ways and means to strengthen retirement benefits through the best practices of pension fund management, international diversification provides a reasonable contribution to practical answers.

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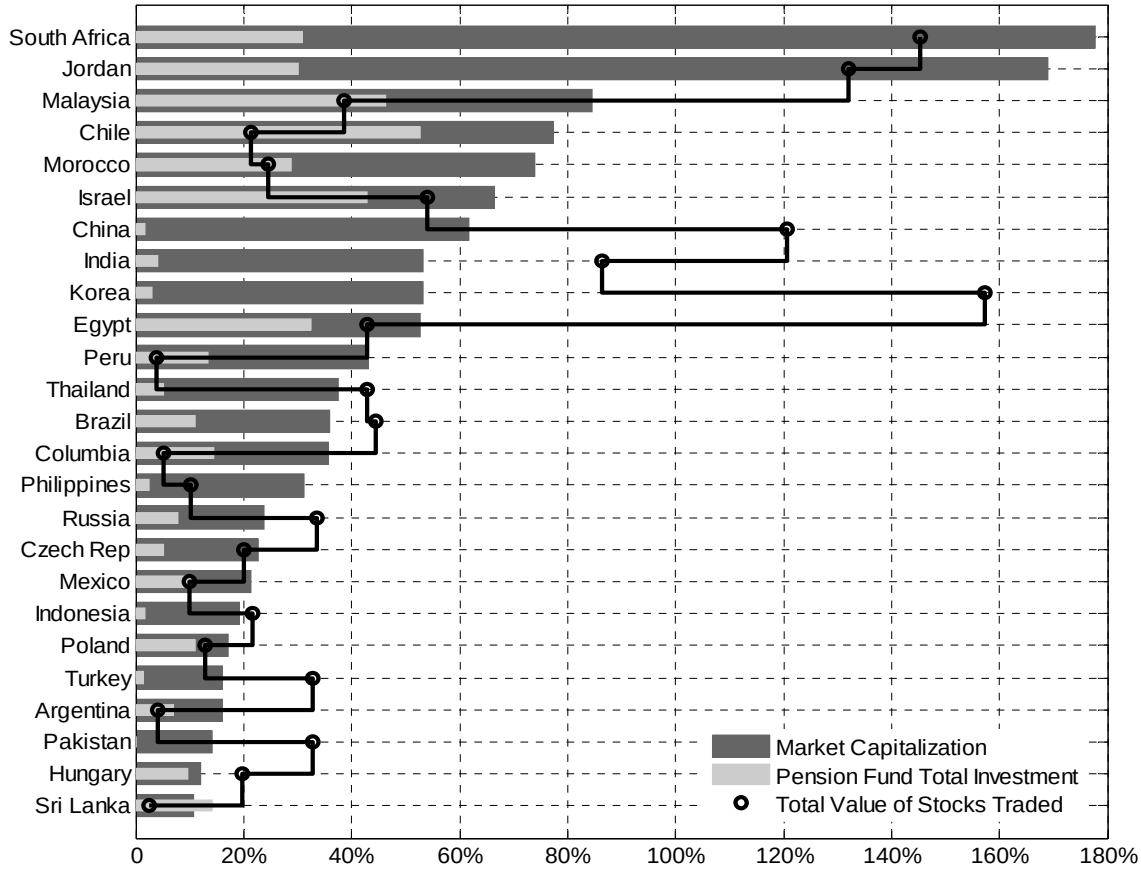
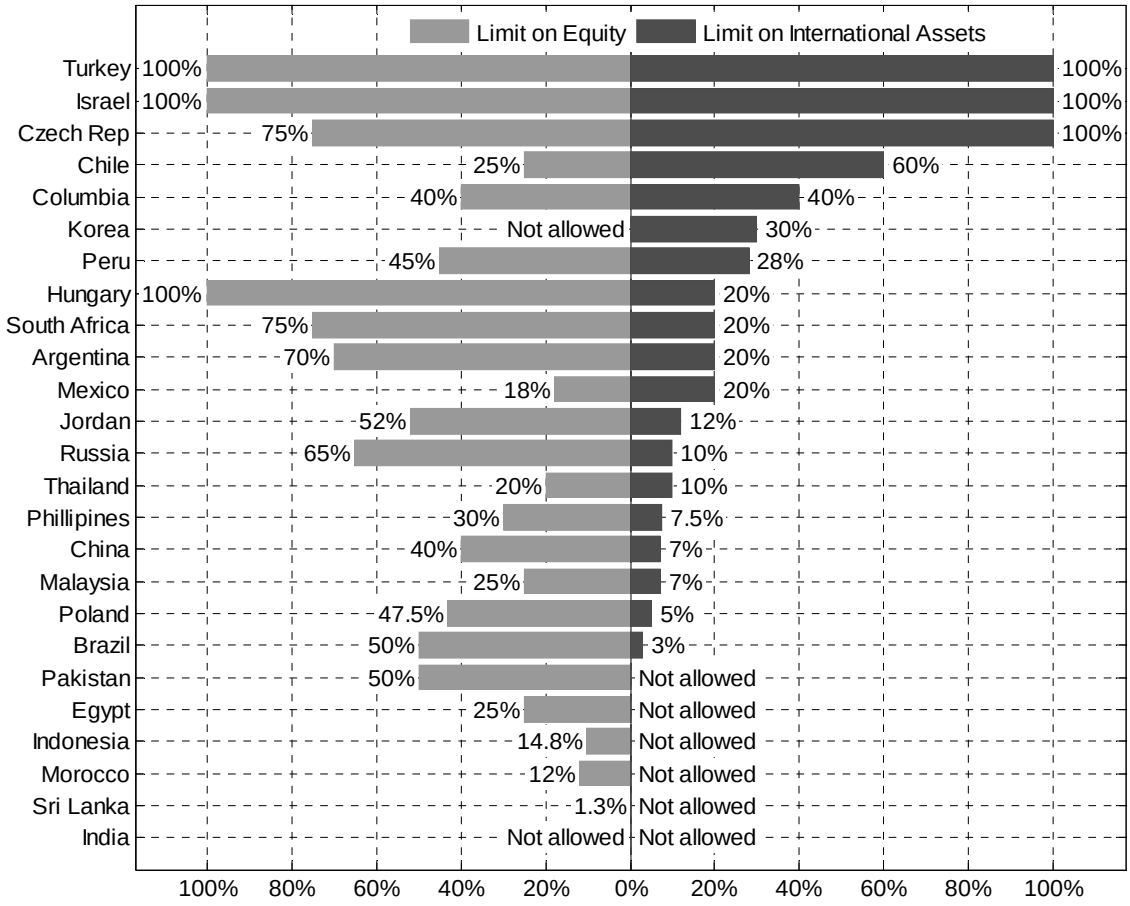
Figure 1: Emerging Market Countries in 2008: Pension Fund Size, Stock Market Capitalization, and Total Value of Stocks Traded (As a Percentage of GDP)



Sources: Stock Market data is from World Bank (2008). Pension Fund data is from EPF Sri Lanka (2009), EPF India (2009), Ministry of Finance of the Republic of Indonesia (2009), NSSF of China (2008), SSS of the Philippines (2008), GEPF of South Africa (2009), Demarco (2010), FIAP (2008), and OECD (2008).

Figure 2: Current Limits on Equity and International Investment in Emerging Market Pension Fund Portfolios (As a Percentage of Investment Portfolio)



Sources: Employees' Old-age Benefits Institution (EOBI) of Pakistan (2010), EPF India (2009), EPF Sri Lanka (2009), Government Pension Fund (GPF) of Thailand (2010), Loewe (2009), Ministry of Finance of the Republic of Indonesia (2009), OECD (2007), OECD (2010), Robalino (2005), Social Security Commission of the Philippines (2010).

Note: For Brazil and Hungary's pension funds, the figure shows the investment limit for shares of companies with good corporate governance ratings, and listed companies, respectively. Chile has four mandatory types of pension funds and a voluntary fund. The figure shows the average of the mandatory funds' investment limits for shares in domestic public limited companies. Mexico has five mandatory types of pension funds and a voluntary fund. The figure shows the average of the mandatory funds' investment limits for shares. In Peru's case, investment restrictions are provided for the private balanced pension fund.

Table 1: Summary Statistics for Real Asset Returns in Emerging Market Countries (%)

Country	Time Period		Local Stocks	Local Deposits	World Stocks	World Bonds	Exchange Rate	Inflation Rate
Argentina	1992-2009	Mean	11.5	3.6	11.0	15.3	-10.0	7.2
		[Std]	[37.8]	[6.4]	[31.3]	[53.3]	[17.8]	[8.1]
Brazil	1995-2009	Mean	19.1	9.5	3.6	6.3	-11.0	11.0
		[Std]	[47.8]	[7.3]	[24.7]	[27.2]	[21.6]	[15.6]
Chile	1988-2009	Mean	18.0	3.4	4.0	5.0	-9.7	8.4
		[Std]	[29.5]	[3.4]	[17.2]	[14.0]	[13.8]	[6.9]
China	1993-2009	Mean	4.7	-0.2	6.0	5.1	-4.6	4.9
		[Std]	[45.9]	[3.8]	[21.1]	[8.2]	[11.4]	[7.2]
Columbia	1993-2009	Mean	18.7	4.4	3.7	4.3	-13.9	11.6
		[Std]	[41.3]	[3.4]	[20.2]	[17.1]	[14.0]	[7.2]
Czech Rep.	1995-2009	Mean	11.7	-1.0	2.0	1.6	-0.6	4.5
		[Std]	[30.4]	[1.6]	[24.2]	[10.8]	[14.0]	[3.4]
Egypt	1995-2009	Mean	30.0	1.3	5.7	5.5	-9.3	7.3
		[Std]	[62.6]	[5.2]	[26.2]	[15.1]	[7.9]	[5.0]
Hungary	1995-2009	Mean	18.4	0.8	3.0	2.7	-10.9	10.4
		[Std]	[47.6]	[2.6]	[23.2]	[11.2]	[16.6]	[7.6]
India	1993-2009	Mean	13.9	1.2	5.7	6.1	-9.1	6.8
		[Std]	[39.8]	[2.6]	[19.0]	[14.6]	[8.4]	[3.0]
Indonesia	1988-2009	Mean	23.9	4.6	8.1	8.7	-14.6	11.2
		[Std]	[67.2]	[5.9]	[29.9]	[25.2]	[16.1]	[11.1]
Israel	1993-2009	Mean	8.9	2.8	6.3	6.1	-6.0	5.0
		[Std]	[30.1]	[2.8]	[20.1]	[11.9]	[9.0]	[4.3]
Jordan	1988-2009	Mean	6.7	1.0	8.2	7.5	-7.6	5.5
		[Std]	[29.6]	[5.2]	[24.4]	[11.9]	[10.7]	[6.1]
Korea	1988-2009	Mean	10.7	2.8	7.4	8.2	-4.5	4.6
		[Std]	[37.4]	[1.9]	[30.4]	[26.3]	[15.9]	[2.2]
Malaysia	1988-2009	Mean	12.0	1.8	8.3	8.1	-3.8	2.9
		[Std]	[35.1]	[1.5]	[24.2]	[14.9]	[8.1]	[1.3]
Mexico	1988-2009	Mean	18.6	-1.2	3.1	4.2	-18.8	17.7
		[Std]	[34.6]	[7.1]	[25.8]	[23.1]	[15.8]	[23.7]
Morocco	1998-2009	Mean	7.9	2.6	2.9	4.2	0.3	1.9
		[Std]	[22.8]	[1.6]	[22.6]	[7.3]	[8.9]	[1.1]
Pakistan	1993-2009	Mean	16.5	0.3	8.1	7.9	-13.6	8.6
		[Std]	[53.6]	[3.3]	[20.1]	[11.3]	[8.8]	[4.6]
Peru	1993-2009	Mean	21.0	-0.4	5.2	4.9	-9.1	8.2
		[Std]	[38.0]	[7.0]	[20.8]	[11.9]	[13.7]	[11.9]
Philippines	1988-2009	Mean	10.8	1.7	5.9	6.5	-9.4	7.4
		[Std]	[44.1]	[2.4]	[22.8]	[18.1]	[11.3]	[3.6]
Poland	1994-2009	Mean	2.0	2.1	1.5	1.5	-8.5	9.4
		[Std]	[34.3]	[2.2]	[21.2]	[12.6]	[16.8]	[9.9]
Russia	1995-2009	Mean	14.4	-9.9	5.9	6.1	-26.7	34.2
		[Std]	[60.0]	[11.5]	[67.0]	[60.7]	[25.3]	[49.4]
S. Africa	1993-2009	Mean	10.4	3.7	8.5	9.2	-9.2	6.9
		[Std]	[22.8]	[2.4]	[22.6]	[21.9]	[19.9]	[2.5]
Sri Lanka	1993-2009	Mean	12.7	-0.1	5.3	4.6	-13.8	10.3
		[Std]	[55.8]	[4.1]	[21.4]	[11.5]	[5.1]	[4.7]
Thailand	1988-2009	Mean	15.1	2.5	7.6	7.6	-3.9	3.8
		[Std]	[51.0]	[2.9]	[27.6]	[20.3]	[12.4]	[2.2]
Turkey	1988-2009	Mean	39.1	2.0	2.8	3.1	-45.4	52.1
		[Std]	[120.6]	[8.4]	[22.2]	[17.1]	[28.1]	[31.2]

Source: Own calculations based on the historical economic data described in the "data" section.

Table 2: Correlations among Real Asset Returns in Emerging Market Countries

Country	Local Stocks and Local Bank Deposits	Local Stocks and World Stocks	Local Stocks and World Bonds	Local Bank Deposits and World Stocks	Local Bank Deposits and World Bonds
Argentina	-0.15	0.52	0.10	0.29	0.35
Brazil	0.30	0.59	-0.21	0.73	0.39
Chile	-0.09	0.34	-0.42	0.23	0.15
China	0.31	0.44	-0.37	0.12	-0.09
Columbia	-0.59	0.03	-0.23	0.36	0.12
Czech Rep.	0.56	0.35	-0.31	0.62	0.00
Egypt	0.09	0.60	0.02	0.34	0.42
Hungary	-0.23	0.52	-0.24	-0.11	-0.23
India	0.04	0.50	-0.56	0.18	0.18
Indonesia	0.09	0.01	-0.38	0.21	0.22
Israel	0.34	0.62	-0.17	0.23	0.05
Jordan	0.20	0.30	0.13	0.19	-0.04
Korea	0.04	-0.12	-0.61	0.35	0.22
Malaysia	0.06	0.23	-0.29	0.50	0.45
Mexico	0.26	0.16	-0.24	0.50	0.64
Morocco	-0.30	0.40	-0.53	0.55	0.10
Pakistan	0.16	0.15	-0.17	0.25	0.04
Peru	0.04	0.32	-0.34	0.10	0.18
Philippines	-0.08	0.30	-0.27	0.30	0.29
Poland	-0.14	0.64	-0.12	0.03	0.16
Russia	0.19	-0.25	-0.48	0.18	0.20
South Africa	-0.06	0.41	-0.18	0.62	0.16
Sri Lanka	0.45	0.40	-0.10	0.64	0.26
Thailand	0.08	0.13	-0.29	0.31	0.20
Turkey	0.04	0.26	-0.21	-0.11	-0.04
Summary Statistics					
Mean	0.07	0.31	-0.26	0.30	0.17
Std	0.25	0.23	0.19	0.22	0.19
Minimum	-0.59	-0.25	-0.61	-0.11	-0.23
Maximum	0.56	0.64	0.13	0.73	0.64

Source: Same as Table 1.

Table 3: Unconstrained and Constrained Optimal Asset Allocation for Conservative Pension Fund Participants in Emerging Market Countries (Risk Aversion = 5)

Country	Optimal Portfolio Weights (Unconstrained)						Optimal Portfolio Weights (Constrained)	
	Local Stocks	Local Bank Deposits	World Stocks	World Bonds	% Stocks	% International	Local Stocks	Local Bank Deposits
Argentina	20	40	0	40	20	40	20	80
Brazil	10	90	0	0	10	0	10	90
Chile	60	0	0	40	60	40	60	40
China	10	0	0	90	10	90	10	90
Columbia	30	70	0	0	30	0	30	70
Czech Rep.	40	0	0	60	40	60	40	60
Egypt	30	0	0	70	30	70	30	70
Hungary	40	0	0	60	40	60	30	70
India	30	0	0	70	30	70	30	70
Indonesia	30	10	0	60	30	60	20	80
Israel	20	0	0	80	20	80	20	80
Jordan	0	0	10	90	10	100	20	80
Korea	40	0	0	60	40	60	20	80
Malaysia	30	0	0	70	30	70	30	70
Mexico	70	0	0	30	70	30	70	30
Morocco	40	0	0	60	40	60	40	60
Pakistan	20	0	10	70	30	80	20	80
Peru	40	0	0	60	40	60	50	50
Philippines	30	0	0	70	30	70	20	80
Poland	0	100	0	0	0	0	0	100
Russia	30	10	0	60	30	60	30	70
South Africa	50	10	0	40	50	40	40	60
Sri Lanka	20	0	0	80	20	80	20	80
Thailand	20	10	0	70	20	70	20	80
Turkey	10	50	0	40	10	40	10	90
Summary Statistics								
Mean	28.8	15.6	0.8	54.8	29.6	55.6	27.6	72.4
Std	16.9	29.9	2.8	25.7	16.2	26.6	15.9	15.9
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
Maximum	70.0	100.0	10.0	90.0	70.0	100.0	70.0	100.0

Source: Own calculations as explained in text.

Table 4: Optimal Allocation to International Assets for Varying Risk Aversion (%)

Country	Risk Aversion Coefficient (γ)					
	1	2	3	4	5	10
Argentina	70	70	70	50	40	20
Brazil	0	0	0	0	0	0
Chile	0	10	30	40	40	50
China	100	100	100	100	90	90
Columbia	0	20	10	10	0	0
Czech Rep.	0	20	40	50	60	70
Egypt	0	40	60	70	70	80
Hungary	0	40	50	60	60	40
India	30	50	60	70	70	70
Indonesia	30	50	60	60	60	40
Israel	50	70	70	80	80	40
Jordan	100	100	100	100	100	100
Korea	50	60	60	60	60	70
Malaysia	40	60	60	70	70	80
Mexico	0	10	20	30	30	40
Morocco	0	40	50	60	60	70
Pakistan	50	70	80	80	80	90
Peru	0	20	40	50	60	70
Philippines	50	60	70	70	70	40
Poland	0	0	0	0	0	0
Russia	40	50	60	60	60	20
South Africa	30	40	40	40	40	20
Sri Lanka	50	70	80	80	80	80
Thailand	50	60	70	70	70	40
Turkey	40	60	50	50	40	30
Summary Statistics						
Mean	31.2	46.8	53.2	56.4	55.6	50.0
Std	31.0	27.5	26.6	26.1	26.6	30.0
Minimum	0.0	0.0	0.0	0.0	0.0	0.0
Maximum	100.0	100.0	100.0	100.0	100.0	100.0

Source: Same as Table 3.

Table 5: Distribution of Retirement Nest-eggs for Optimal Unconstrained (UC) and Constrained (C) Portfolio Strategies (Risk Aversion = 5)

Country		Distribution of Retirement Nest-egg						
		1prct	5prct	10prct	25prct	50prct	75prct	95prct
Argentina	Nest-egg: UC	4.29	5.96	7.39	10.74	17.67	31.42	85.62
	C	3.95	4.96	5.66	7.00	8.81	11.09	15.11
	%Change	**-7.98**	**-16.71**	**-23.49**	**-34.81**	**-50.11**	**-64.7**	**-82.35**
Brazil	Nest-egg: UC	12.65	16.54	19.23	24.34	31.74	41.65	60.83
	C	12.65	16.54	19.23	24.34	31.74	41.65	60.83
	%Change	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Chile	Nest-egg: UC	11.15	16.68	21.36	31.12	48.85	78.77	161.66
	C	7.53	11.89	15.59	24.26	40.48	68.27	147.95
	%Change	**-32.47**	**-28.71**	**-26.98**	**-22.05**	**-17.13**	**-13.33**	**-8.48**
China	Nest-egg: UC	4.69	5.50	6.00	6.97	8.31	10.02	13.40
	C	1.99	2.31	2.51	2.85	3.30	3.83	4.73
	%Change	**-57.51**	**-58.06**	**-58.26**	**-59.13**	**-60.24**	**-61.75**	**-64.72**
Columbia	Nest-egg: UC	7.08	9.28	10.92	14.23	19.44	26.72	42.67
	C	7.08	9.28	10.92	14.23	19.44	26.72	42.67
	%Change	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Czech Rep.	Nest-egg: UC	3.22	4.34	5.09	6.60	9.02	12.38	20.03
	C	2.24	2.99	3.52	4.65	6.41	8.98	14.48
	%Change	**-30.23**	**-31.07**	**-30.89**	**-29.61**	**-28.96**	**-27.49**	**-27.68**
Egypt	Nest-egg: UC	7.31	11.74	15.09	23.98	41.92	74.24	192.23
	C	3.85	6.15	7.90	12.44	21.39	36.57	82.05
	%Change	**-47.37**	**-47.66**	**-47.63**	**-48.12**	**-48.96**	**-50.75**	**-57.32**
Hungary	Nest-egg: UC	3.72	5.57	6.96	10.43	16.49	27.10	59.64
	C	3.10	4.23	5.03	6.79	9.61	13.85	24.67
	%Change	**-16.81**	**-24.04**	**-27.84**	**-34.93**	**-41.74**	**-48.90**	**-58.62**
India	Nest-egg: UC	6.99	9.04	10.49	13.51	17.84	24.01	37.56
	C	2.80	3.74	4.35	5.74	7.84	10.82	17.48
	%Change	**-59.93**	**-58.58**	**-58.47**	**-57.49**	**-56.05**	**-54.96**	**-53.47**
Indonesia	Nest-egg: UC	8.31	12.82	16.22	25.43	43.14	76.68	175.14
	C	5.18	6.93	8.37	11.58	16.84	25.28	46.49
	%Change	**-37.69**	**-45.93**	**-48.39**	**-54.47**	**-60.96**	**-67.04**	**-73.45**
Israel	Nest-egg: UC	4.41	5.83	6.75	8.71	11.61	15.42	23.68
	C	3.71	4.42	4.84	5.69	6.86	8.25	10.71
	%Change	**-15.72**	**-24.30**	**-28.24**	**-34.65**	**-40.93**	**-46.50**	**-54.78**
Jordan	Nest-egg: UC	5.28	6.77	7.82	9.90	13.46	18.65	30.67
	C	2.40	2.87	3.20	3.83	4.64	5.63	7.44
	%Change	**-54.45**	**-57.50**	**-59.01**	**-61.33**	**-65.51**	**-69.83**	**-75.76**

(Continued)

Table 5: *(Continued)*

Country		Distribution of Retirement Nest-egg						
		1prct	5prct	10prct	25prct	50prct	75prct	95prct
Korea	Nest-egg: UC	6.01	8.47	10.17	13.83	19.92	29.14	51.74
	C	3.89	4.61	5.11	5.99	7.23	8.87	12.12
	%Change	**-35.35**	**-45.59**	**-49.73**	**-56.68**	**-63.73**	**-69.57**	**-76.57**
Malaysia	Nest-egg: UC	7.09	9.62	11.26	15.08	21.06	29.73	50.54
	C	3.40	4.22	4.80	5.99	7.72	10.24	15.85
	%Change	**-52.11**	**-56.18**	**-57.35**	**-60.28**	**-63.35**	**-65.56**	**-68.64**
Mexico	Nest-egg: UC	5.84	10.91	15.28	27.40	54.11	110.43	305.48
	C	3.83	6.83	9.38	16.99	33.58	70.67	203.91
	%Change	**-34.36**	**-37.43**	**-38.61**	**-38.02**	**-37.94**	**-36.01**	**-33.25**
Morocco	Nest-egg: UC	4.96	5.95	6.58	7.88	9.59	11.71	15.88
	C	3.76	4.63	5.15	6.25	7.79	9.89	13.82
	%Change	**-24.30**	**-22.13**	**-21.78**	**-20.59**	**-18.76**	**-15.53**	**-12.94**
Pakistan	Nest-egg: UC	7.83	10.41	12.19	16.30	22.77	32.46	55.53
	C	2.34	3.03	3.49	4.39	5.81	7.78	12.18
	%Change	**-70.04**	**-70.90**	**-71.38**	**-73.05**	**-74.48**	**-76.04**	**-78.07**
Peru	Nest-egg: UC	9.12	13.66	16.48	23.32	34.79	52.85	98.89
	C	4.06	6.56	8.57	13.61	23.25	41.06	92.84
	%Change	**-55.45**	**-51.93**	**-47.98**	**-41.65**	**-33.18**	**-22.31**	**-6.12**
Philippines	Nest-egg: UC	3.92	5.34	6.54	9.07	13.45	20.63	39.74
	C	3.05	3.65	4.05	4.83	5.97	7.45	10.61
	%Change	**-21.97**	**-31.65**	**-38.03**	**-46.73**	**-55.59**	**-63.89**	**-73.29**
Poland	Nest-egg: UC	4.00	4.18	4.29	4.48	4.71	4.97	5.39
	C	4.00	4.18	4.29	4.48	4.71	4.97	5.39
	%Change	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Russia	Nest-egg: UC	0.81	1.34	1.86	3.19	6.38	13.91	46.13
	C	0.51	0.70	0.85	1.14	1.68	2.51	4.90
	%Change	**-36.89**	**-48.02**	**-54.41**	**-64.22**	**-73.64**	**-81.97**	**-89.37**
South Africa	Nest-egg: UC	6.35	8.82	10.65	14.52	20.92	30.59	53.69
	C	5.23	6.49	7.26	8.93	11.40	14.69	21.25
	%Change	**-17.72**	**-26.43**	**-31.81**	**-38.50**	**-45.50**	**-51.97**	**-60.42**
Sri Lanka	Nest-egg: UC	3.21	4.29	5.06	6.85	9.73	14.11	24.13
	C	1.97	2.41	2.74	3.42	4.49	6.05	9.67
	%Change	**-38.66**	**-43.89**	**-45.85**	**-50.11**	**-53.90**	**-57.12**	**-59.93**
Thailand	Nest-egg: UC	4.97	6.65	8.07	11.25	16.56	25.59	46.85
	C	3.40	4.30	4.94	6.23	8.17	10.82	16.48
	%Change	**-31.49**	**-35.32**	**-38.75**	**-44.63**	**-50.64**	**-57.71**	**-64.83**
Turkey	Nest-egg: UC	3.25	4.40	5.19	6.88	9.57	13.77	23.15
	C	2.68	3.67	4.38	6.04	8.66	12.59	22.77
	%Change	**-17.40**	**-16.78**	**-15.44**	**-12.25**	**-9.58**	**-8.62**	**-1.65**

Source: Same as Table 3. **Note**: UC=Unconstrained, C=Constrained.