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Pfau, Wade Donald

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"Emerging Market Pension Funds and International Diversification"

by

Wade D. Pfau
Associate Professor of Economics
National Graduate Institute for Policy Studies (GRIPS)
7-22-1 Roppongi, Minato-ku
Tokyo, Japan 106-8677

wpfau@grips.ac.jp

Tel.: 81-3-6439-6225

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“Emerging Market Pension Funds and International Diversification”

Abstract

Many countries are currently increasing the advanced funding of their public pension systems to improve their sustainability in the face of rapidly aging populations. When pensions are funded, the issue of asset allocation becomes of paramount importance. Standard portfolio selection theory provides a fundamental justification for international diversification: by widening the pool of potential assets, investors can potentially increase returns while possibly even reducing risks through the selection of complementary assets with low correlations. Nonetheless, many emerging market countries have regulations that strictly limit the choice of investments for pension funds, in some cases excluding international assets entirely. This paper uses modern portfolio theory to determine the optimal asset allocation for public pension systems in emerging market countries. We find that on average, about half of the portfolios of emerging market countries should be in world assets. The paper then quantifies the costs of prohibiting international diversification.

Journal of Economic Literature Classification Numbers: H55, G11, G23

Changing demographic conditions are playing havoc on the public pension systems of countries both rich and poor. Traditionally, countries tended to rely on pay-as-you-go pension systems which allowed them to provide pensions to their current elderly using the contributions of the current workforce. These systems tend to work so long as the growth rates of contributors and their productivity exceeds the growth of pensioners. Worldwide, though, reduced fertility rates and increasing longevity are making such systems unsustainable in the sense that promised pension payments to the increasing elderly populations will exceed worker contributions. In response, a number of countries are increasingly shifting their public pension systems from pay-as-you-go toward the inclusion of more advanced funding. For many emerging market countries, these reforms are accompanying efforts to expand pension coverage to a larger portion of the population, many of whom are still not protected by any formal pension schemes. Advanced funding can help to preserve intergenerational equity, potentially provide additional savings for economic development, and allow the pension fund or pensioners to enjoy the benefits of compound interest.

But with the expansion of advanced funding, the issue of asset allocation becomes of paramount importance. Countries must decide how to regulate the choice of potential investments for pension participants (in the case of individual pension accounts) or the centralized pension fund (in the case that pension contributions are accumulated in one central account). To be clear from the outset, the analysis of this paper can be applied to any pension system reform that is not purely pay-as-you-go. There are some different aspects that must be considered for different kinds of pension funding, such as the time schedule of pension payments and the sensitivity of pension payments to inflation and

wage growth, but generally the same asset allocation issues apply regardless of whether the system is defined-benefit or defined-contribution, centrally or individually managed, publicly or privately managed, contributory or noncontributory, and mandatory or voluntary. Asset choices potentially include domestic fixed income instruments such as bank deposits or government bills and bonds, domestic equities, or domestic real estate and other alternative assets. International assets are also part of the investment universe, such as foreign government or corporate bonds, equities, or other alternative assets from abroad.

Two basic frameworks exist for regulating the asset allocation of pension funds: quantitative restrictions and prudent person rules. Quantitative restrictions set limits on the amounts of different types of assets than can be held in the pension fund portfolio, while prudent person rules provide more flexibility for the pension fund manager to choose investments in a prudent way as would be done for their own affairs (Davis, 2002a). In practice, quantitative restrictions are used to limit the amounts of equity investments and international investments allowed in the portfolio, with the idea that less risky assets will better protect the pensions of their participants. There can be some justification for this, for example if the pension fund managers are not knowledgeable about the investment process and may make the bad decisions, or if the liabilities of the pension fund are very short-term and thus need to be matched with short-term assets. Keeping funds at home can also be a way to promote domestic investment projects and financial sector development. At the same time though, pension fund regulations that are designed in theory to protect the contributor may actually create more harm by preventing the fund from enjoying the diversification benefits of a broader asset allocation and by allowing for corruption in the allocation of pension assets. As pension funds grow in size, they must also be concerned

about whether domestic markets can provide sufficient quantities of assets. Also, pension funds that invest mainly in domestic government bonds may only lead that greater fiscal irresponsibility of the government in question.

This paper builds on several studies which have used a variety of techniques to estimate the potential benefits of international diversification. For example, Hu, Stewart, and Yermo (2007) look at the case of China using data from 1993 to 2004. They compare the returns to a basic portfolio split between domestic bonds and domestic bank deposits, which matches the current regulations for Chinese pension funds, to a variety of liberalized portfolios that include varying combinations of domestic stocks and foreign stocks and bonds. They find that the liberalized portfolios provide higher returns and higher risks, but that such risks will be necessary because the returns on the basic portfolio are too low to provide sustainability for the pension funds. Pfau (2009) estimates the optimal asset allocation for the pension funds in Pakistan and finds that the inclusion of foreign assets provides the potential to increase returns while also lowering risks, and this result is robust to a wide variety of assumptions about asset returns, risks, and correlations. Similarly, Srinivas and Yermo (1999) estimate that including foreign equities in the portfolios of Latin American pension funds could also increase returns while lowering risks, which could result in larger benefits for pensioners. Finally, Burtless (2007) looks at the role of international diversification for eight industrialized countries and finds that generally they could obtain higher pension payments and less shortfall risk if they invest part of their assets outside of their home countries. Similar findings for industrial countries are also provided in Davis (2002b).

What we seek to do in this paper is to provide a thorough analysis of the potential role for international assets in the pension systems of 26 emerging market countries. Though acknowledging the potential benefits of international diversification is not a new idea, this paper's contribution is to provide a real world analysis for emerging market countries that quantifies the potential extent of these benefits. We find that on average, about half of emerging market pension fund assets should be devoted to world assets, and that the costs of prohibiting such diversification will be, on average, a 21 percent reduction in returns. Such findings can potentially be used to help convince the skeptics of international diversification.

Advantages and Disadvantages of International Diversification for Pension Funds

The Case Against International Diversification

A number of arguments have been made against international diversification for pension fund assets. First, there is a perception that international assets are more risky than domestic assets, perhaps because of limited knowledge held about foreign assets by domestic fund managers, or because of currency risk. Also, because pensioners will mainly consume domestic goods in their retirement, their pension savings should be linked closely to domestic inflation. Moreover, the large capital outflows that can result from international investment could have negative macroeconomic consequences, such as a depreciation of the exchange rate or problems with the balance of payments.

Finally, keeping funds at home may be important, because these funds may provide one of the few sources of investment funds available for an emerging market country. Pension funds can provide a source of funding for social investments, including housing loans and the construction of hospitals and schools (Iglesias and Palacios, 2000;

International Labour Office, 1997). Government officials may also see the pension fund as a source of capital to help promote the development of domestic financial markets, or to even support prices in the stock market. Roldos (2004) highlights many advantages that pension funds can provide to local financial markets, which include developing risk management techniques, providing a source of demand for long-term liabilities which can help to produce a liquid benchmark yield curve that lets the corporate bond market develop, improving transparency and governance of financial markets, and leading the innovation of new financial products. Reisen (1997) also describes how pension funds can increase the efficiency of fund allocation and stimulate the financial infrastructure.

Potential Benefits from International Diversification

First of all, the portfolio selection theory extending back to Markowitz (1952) and Roy (1952) provides the basic justification for international diversification: by widening the pool of potential assets, investors can potentially increase returns while even reducing risks through the selection of complementary assets with low correlations among one another. Diversification works by considering not how assets behave in isolation, but by how they contribute to the overall risk and return of the portfolio. Because international assets are not exposed to the same country-specific shocks as domestic assets, they tend to provide valuable diversification benefits through their typically lower correlations with domestic assets, even after accounting for currency risk (the standard deviation of exchange rate movements) (Solnik and McLeavey, 2004, p. 451-493). However, economists have found that most countries do not hold the amount of international assets predicted by optimal portfolio theory, and this evidence is reviewed in Lewis (1999). The lack of a suitable explanation leads this to be called the home-bias puzzle.

A second important advantage of international diversification relates to the common situation that the domestic financial sector in an emerging market economy is too small to satisfy the demands of a large institutional investor. Local markets often cannot provide the amount of financial assets required by a rapidly growing pension fund (Chan-Lau, 2005; Roldos, 2004; International Labour Organization, 1997). Roldos (2004) expresses concern that the lack of supply and diversity among local security markets will distort prices and magnify volatility for pension funds, concentrate risk exposures, and potentially contribute to asset price bubbles. Pension funds may even reduce trading volume because they are too large to trade actively on the markets (Chan-Lau, 2005). Solnik and McLeavey (2004) also identify some potential barriers to international diversification, though these are more from the perspective of investors in developed markets deciding whether to invest in emerging markets, and so can be interpreted as potential advantages for those in emerging markets to invest in developed markets. They argue that, “Large institutional investors may wish to be careful and invest only a small part of their portfolios in these small-capitalization, less-liquid shares” (p.477).

// Table 1 About Here //

Table 1 makes an initial attempt to quantify this situation in 2005 for emerging market countries by comparing the size of pension fund assets to the size of domestic financial markets. Total pension fund assets as a percentage of GDP were not available for all countries, but among those with data, Chile has the highest relative holdings of 59.35 percent of GDP. Indeed, this is the direction that other countries can be expected to approach, as Chile was a pioneer in creating comprehensive defined-contribution pensions in 1980. From the table, other Latin American countries also have large relative holdings,

with Columbia at 13.69 percent, Peru at 12.44 percent, Argentina at 12.32 percent, and Mexico at 10.04 percent. Meanwhile, pension assets in Israel total 34.06 percent of GDP, and the emerging European nations of Hungary and Poland hold close to 9 percent of GDP.

These numbers can be compared to the size of the stock market and other public and private debt in order to give an idea about the potential liquidity issues. For the Latin American countries mentioned, though the stock market capitalization is larger, in all cases the total volume of stocks traded in 2005 is less than the respective pension fund assets. Though pension funds would not necessarily be turning over their entire portfolios in a given year, it is clear that with too much invested in the domestic stock markets, these countries would be major players, and their transactions could have a big impact on asset prices, potentially facing price decreases when trying to sell assets or a run-up in prices when attempting to purchase assets. For the other countries mentioned, the stock volume traded is larger than the pension assets, but the problem still remains, and can only be expected to grow further in the coming years as pension assets are accumulated.

Public and private debts are more broad categories than just tradable bonds. Generally, though the sample of countries with data availability is limited, public debt is larger than pension fund assets. This is not the case in Chile or Peru, where the pension fund could potentially hold all public debt. Also for those countries with available data, only the Czech Republic, Korea, Mexico, and Thailand have larger private debt holdings than pension fund assets.

A third issue is that if pension funds mainly invest in domestic government securities, then there is concern that pension funds may only depress interest rates and lead to increased government debt, as it is important that the government be able to mobilize

the funds effectively (International Labour Office, 1997). Even more problematic, misuse of pension funds can occur if pension fund managers divert funds to the politically well connected, rather than to those providing the most potential for successful investment. International evidence about the tendency for low returns among public pension systems is reviewed in Iglesias and Palacios (2000), who find that many pension funds produce returns below bank deposit rates and even below inflation on account of the lack of accountability in their investment approaches. International diversification would help to avoid this problem as well. Taken to the extreme, Kotlikoff (1999) argues that for many emerging market countries, there is no comparative advantage for developing local financial markets, and it would make sense to diversify completely in a market-weighted indexed world portfolio of assets to altogether avoid these types of problems.

Finally, a number of replies have been made about the potential disadvantages of international diversification. First is the idea that international assets are thought to be more risky, perhaps because of limited knowledge held about foreign assets by domestic managers or because of currency risk. While this may have been an issue in the past, the rapid growth of index funds means that pension managers can obtain the benefits of diversification at low cost and without the need to select assets in unfamiliar markets. Additionally, as will be shown in the results section of this paper, local stock markets are almost always more volatile in emerging markets than are the returns from the world stock market, even after accounting for currency risk. In fact, currency risk may actually provide a valuable hedge for emerging market countries, as poor local conditions or high inflation will tend to result in a depreciation of the local currency, which will in turn boost the returns from international assets. As for the macroeconomic consequences, this no longer

needs to be of much concern, as Bodie and Merton (2002) explain how pension funds can use “international pension swaps” to obtain the diversification benefits without the need for large capital flows. With a pension swap, the capital flows amount only to the difference in returns for two financial assets (such as the local stock market index and the world stock market index) for a predetermined principal amount of investment. This swap allows most of the pension fund assets to remain invested in the domestic market. As for using pension funds to promote domestic development and financial sector growth, this is certainly an advantage of keeping funds at home if investment projects are available, but Reisen (1997) argues that to obtain the benefits for the domestic economy does not mean that the optimal solution is to prohibit all foreign investment. A proper balance must be found. Additionally, foreign investment by a pension fund could potentially serve as a type of collateral that would help encourage foreign direct investment, such that the local economy may still receive investment funds while also enjoying the benefits of diversification.

Methodology and Data

This section describes our approach for considering whether the pension funds in emerging market countries may benefit from international diversification. We rely on the standard mean-variance portfolio selection framework, in which the investor is interested in choosing the portfolio that maximizes their utility, given the expected returns and expected volatility of each asset class, as well as the expected correlations among the asset classes. Investors are assumed to be interested in the tradeoff between risk and return. Portfolios that provide higher expected returns with lower volatility (measured as the standard deviation of asset returns) are preferred by the typical investor, who will seek a

portfolio on the efficient frontier. This is the set of portfolios whose asset allocations maximize the expected returns for different levels of risk, or alternatively minimize risks for different levels of returns. Expanding the set of available asset classes by including international assets can only benefit the investor by allowing for more return per unit of risk, or by providing less risk per unit of return. Because movements in asset prices are not perfectly correlated, the total volatility of a portfolio will be less than the volatility of the individual components. The potential benefits of portfolio diversification grow as the correlation among the available assets becomes smaller.

The acceptable tradeoff between risk and return depends on the risk aversion of the investor. Using the standard framework, investors want to choose the asset allocation that will lead to a portfolio which maximizes their utility (U_P), defined as:

$$U_P = r_P - .005A\sigma_P^2$$

where A is the investor's risk aversion coefficient, r_P is the expected return of the portfolio, and σ_P is the expected standard deviation. For A , a value of zero would imply risk neutrality, and an increasing value for A means greater risk aversion. Typically, an aggressive investor is thought to have a value of one or two, a moderate investor has about three, and a conservative investor could range from five to ten, or even more. We will calculate optimal asset allocations using a variety of risk aversion coefficients, as it is not clear what degree of risk aversion is appropriate for pension fund managers. But because of space limitations and to the extent that pension funds tend to be risk averse, we will provide a detailed focus on results using a risk aversion coefficient of five. We also include a table summarizing the results for other various coefficient values.

While the mean-variance portfolio selection framework is commonly used, we should note the potential disadvantages of the approach as well as the existence of several alternative methods. Disadvantages of the mean-variance approach include, first, that it is quite sensitive to input data, meaning that small changes in the assumptions can have large implications for the optimal asset allocation. An alternative modeling framework is the Black-Litterman model, which uses a well-diversified world portfolio as a starting point, and then modifies asset allocation in response to the investor's belief. Such an approach is less sensitive to inputs, but it would imply a very small allocation of domestic assets for the small-capitalization emerging market countries (Sharpe, Chen, Pinto, and McLeavey, 2007). We do not use this approach because we wish to convince policymakers of the need to diversify, and such need is an assumption already built into the model.

Second, our mean-variance approach will look only at assets, whereas pension funds need to model assets in relation to their future liabilities and the risk characteristics of those liabilities (Blake, 2000). Compared to our approach of using only assets, the asset-liability approach considers asset allocation with respect to the time horizons and risks of the liabilities which will be funded. We do not use this approach, because it requires a full actuarial model for future pension obligations, and because the pension systems in many emerging market countries are still immature with mostly long-term liabilities. In this case, the differences between the two approaches should be minimal. Indeed, it is for pension systems with short-run funding needs where the two approaches may produce dramatically different results.

Third, the mean-variance approach treats gains and losses to the portfolio as symmetric, whereas the pension fund may be more concerned about the potential for loss

than for gain, or more specifically the pension fund may put greater weight on requiring that enough assets are available to fund the liabilities. For this concern, the mean-variance approach can be modified, for instance, by using Roy's safety-first criterion, which finds the portfolio that maximizes the probability that returns will exceed some necessary minimal level, rather than directly maximizing the return for a given level of risk (Roy, 1952). When the minimum level is the risk-free rate of return, this would be equivalent to maximizing the Sharpe ratio (Sharpe, Chen, Pinto, and McLeavey, 2007). We hope to consider these approaches in subsequent research.

Finally, the mean-variance approach is static, focusing only on a given point of time without considering how current asset allocation decisions may affect the future situation. Though with a long-lived pension fund, this particular point is less important, beyond the need to consider the asset-liability approach as liabilities move closer. Nonetheless, a common response to this problem, as well as to consider shortfall risk, is to use Monte Carlo simulations to create probability distributions for future outcomes that incorporate the flow of pension payments and benefits over time. We hope to consider this approach in subsequent research as well.

Moving forward with the mean-variance approach, we must first choose the range of assets to consider for the portfolio. The investment universe is quite wide and many possibilities exist. We will limit ourselves to four asset classes: domestic stocks, domestic fixed income assets, world stocks, and world bonds. This will be sufficient to consider the potential role of international assets in the investment portfolio, though in reality the pension fund may have a chance to invest more broadly in assets such as real estate, infrastructure projects, corporate bonds, private equity, inflation-protected bonds, hedge

funds, options, derivatives, and more narrowly defined international investments involving particular sectors or regions.

Data is available through the end of 2006 for all 26 countries, though the starting dates differ for countries, ranging from 1988 to 1998. For each country, we use the longest time period in which all the necessary data could be collected. The local stock returns are calculated as the annual percent changes at year end in local currency for the MSCI Standard Core Gross Indices of each country (www.msci.com). Unless otherwise noted, the local fixed income returns are represented by domestic bank deposit rates as classified by the International Monetary Fund's International Financial Statistics (IMF IFS). The exceptions are: for India and Jordan (in 1988-89) we use the central bank discount rate, and for Pakistan we use the call money rate. Though we would also like to consider short-term and long-term government debt, we do not do it in this paper because such data is not available for many of the emerging market countries.

The World Stock Market is represented by the MSCI All-Country World Index. The World Bond Market data is from Bodie, Kane, and Marcus (2008), and actually represents the annual returns on government bonds for 16 developed countries using GDP weights. Our data represents the total returns available after dividend payments, and no administrative costs have been deducted from any of the financial assets. As for other relevant data, the exchange rate is defined as the amount of US dollars (USD) that can be purchased with a unit of local currency. Data is calculated from the IMF IFS database using the monthly data to obtain annual percent changes at the year end. This exchange rate data is then used to convert the returns on the world assets into the domestic currency, so that our results are from the perspective of a local investor who does not hedge currency

risk. Finally, inflation is calculated from the annual consumer price index data provided in the IMF IFS database. The inflation data allows us to also consider the real returns after removing the impacts of domestic inflation. Nonetheless, our results will be provided in nominal terms, because calculating the optimal asset allocation involves the use of a risk-free asset, but emerging market countries generally do not have any risk free asset that can be expected to provide a return equal to the inflation rate. With the nominal data, the risk free asset will literally provide no risk and no return.

Results

In this section, we describe the input data, provide the results of the optimal asset allocation calculations, and estimate the potential gains provided by international diversification over the case where international assets are prohibited.

Means, Standard Deviations, and Correlations

// Table 2 About Here //

Table 2 provides information about the time period for each country, as well as the means and standard deviations of the relevant variables. First, regarding stock returns, these emerging market countries generally witnessed domestic stock markets with higher returns and higher risks than were available from the unhedged world stock market. This indicates that even with currency risk, diversified world stocks are less risky than individual emerging market country stock markets. The only exceptions to this trend are that domestic stock market returns were less in China and Israel, and only in South Africa was the domestic stock market less volatile than the world stock market. The standard deviation of stock market returns was less than 30 percentage points for only five of the 26 countries, with the minimum standard deviation of 23.65 occurring for South Africa.

For fixed income assets, we use bank deposit yields, and the return and volatility of these yields tend to be less than the longer duration world bond returns, especially after accounting for currency risk. Exceptions for this include that Argentina, Brazil, Chile, Columbia, Indonesia, Mexico, Poland, and Turkey experienced higher returns on their domestic assets, and the volatility of returns was higher in Argentina, Brazil, and Russia. A tendency among these countries is high inflation rates, which suggests that much of the bank deposit yield was driven by inflation.

For the world assets, including world stocks and world bonds, the returns and risks vary from country to country because different time periods are used, and because the returns are calculated in terms of the local currency for each country. As indicated in the above discussion, world stocks tend to have lower returns and lower risks than the domestic stocks even after accounting for currency risk, while the longer duration world bonds tend to have higher returns and higher risks than the local bank deposit yields. These world asset returns do vary in a large degree from country to country because of the important impact of exchange rate movements.

As for exchange rates, most of these countries experienced depreciation against the US dollar during their respective time periods, with the exceptions of the Czech Republic, Korea, and Morocco. The most extreme average depreciations occurred in Argentina, Brazil, Turkey, and Venezuela, countries which all experienced high inflation rates. A depreciating local currency will boost the returns from the world assets. Regarding inflation, some countries experienced rather high inflation, which was undoubtedly a major factor leading to the depreciation of their currencies. Because of hyperinflation experienced in the 1980s, Argentina and Brazil present rather extreme cases, with average

inflation of 322 and 555 percent, respectively. Also, countries with average inflation above 15 percent, and thus more significant depreciations, include Mexico, Russia, Turkey, and Venezuela.

// Table 3 About Here //

Table 3 presents the correlations among these various assets for each of the 26 emerging market countries. From the table, we can see that there is generally low correlation among all the assets, and so there is potential for diversification to provide benefits. Correlations can range from -1 to 1, and the smaller the correlations are, the larger are the benefits of diversification for those assets. For local stocks and local bank deposits, the mean correlation is -0.08, and except for Chile and Hungary, the countries with noticeably positive correlations tend to be those that experienced higher inflation. In comparing local stocks to the world assets, the mean correlation with world stocks is 0.28 and that with world bonds is -0.11. Local bank deposits, meanwhile, have an average correlation of 0.30 with world stocks and 0.39 with world bonds. The table also shows that the distance from zero for most of the correlation coefficients is not statistically significant.

Optimal Asset Allocation

The means, standard deviations, and correlations are used as inputs to calculate the optimal asset allocation for investors in each country. Table 4 shows the results for the case of a relatively risk averse investor with a risk aversion coefficient of 5. The results are shown in nominal terms, and the risk-free asset is assumed to have a return and risk of zero. There is a great deal of diversity in the table, but on average, half of the portfolio investments should be held in international assets. At the extremes, China's international allocation is 99.78 percent, while Columbia, Hungary, Poland, and Turkey are not found to

require international assets. The distribution of results is not symmetric, as these four countries with an allocation of zero bring down the average and there are only two other countries with international allocations below 40 percent. Other countries with particularly high international allocations include Pakistan (86.66 percent), Sri Lanka (86.31 percent), Jordan (83.51 percent), and Malaysia (81.29 percent).

// Table 4 About Here //

For the various assets, on average 18.26 percent is allocated to local stocks, 27.8 percent to local bank deposits, 11.44 percent to world stocks, 38.79 to world bonds, and hyperinflation in Argentina and Brazil lead to an average 3.72 percent for the riskless asset with no return. It is interesting that for these two countries, domestic assets are so volatile because of hyperinflation, that the optimal portfolio includes only international assets and the risk reducing cash. Overall, we find that international assets can potentially play an important role in the investment portfolios of emerging market pension funds.

// Table 5 About Here //

Table 5 shows the average asset allocations across the countries for various risk aversion coefficients, which summarizes how the overall asset allocation trends vary depending on attitude toward risk. The most aggressive investors with risk aversion of one hold the most stock (73.1 percent) with just over half of their portfolios in the risky local stock markets. The allocation to stocks gradually decreases as risk aversion coefficients become larger, such that for extremely conservative investors with a coefficient of 50, only 5.4 percent of the portfolio is held in stocks. As the local stock allocation decreases, it is replaced by local bank deposits and cash. Meanwhile, the percentage allocated to international assets follows an inverse U-shape curve, as the most aggressive investors

favor the risky local stock market, but then the allocation for international assets is higher than 50 percent for investors with risk aversion coefficients between 2 and 5. For more conservative investors, the allocation to international assets decreases, though even a conservative investor with a coefficient of 10 still finds holding 34 percent of their portfolio in international assets to be optimal. What we can observe in Table 5 is that international assets play an important role in the optimal portfolios of investors with widely ranging attitudes toward risk.

Impacts of Restricting International Assets

Table 6 shows the optimal asset allocation choices for investors with risk aversion coefficients of five in each country when the pension funds are prohibited from holding international assets. Only in the case of Chile, Mexico, and Russia would international assets provide the opportunity to both increase returns and reduce risks. Nonetheless, if international assets were available, the risk averse investors would generally be willing to accept greater risks for a chance to obtain higher returns. On average, without international investments, investors must accept a 21.3 percent reduction in their portfolio returns, though this would be accompanied by an average 20.7 percent reduction in risk. The biggest impacts occur in Argentina and Brazil, where because of the impacts of hyperinflation on the volatility of domestic returns, investors would tend to rather hold cash. Also, returns in China would decrease by almost 60 percent without the inclusion of international assets.

// Table 6 About Here //

Conclusion

As we have seen, international assets can potentially play an important role of the investment portfolios of emerging market pension funds. However, the results of this paper should not be treated as finalized advice for asset allocation. Some caveats for these results include, first, that the estimates are based on historical data, and to the extent that relationships among the variables change in the future, the implied results will be different. Fund managers must consider whether the historical record provides useful assumptions moving forward. Also, managers must consider whether it will be possible to match the stock returns of their country's stock index, given the liquidity and size constraints they face. Fund managers may also have a variety of other assets to choose from as well, including property, or alternative assets such as private equity, commodities, currencies, and hedge funds. Also, pension fund managers may have different goals than maximizing risk-adjusted returns, such as promoting domestic financial markets or funding social investments like hospitals and housing. Additionally, these results have assumed a one-period optimization model, but pension funds may be long-term investors and may also need to match their liabilities with assets of similar duration and characteristics. Pension funds may also focus more on shortfall risk and put more weight on avoiding losses. All of these considerations could justify a modification of the results found in this paper. But what this paper has set out to demonstrate is that countries can expect to benefit from international diversification in real and meaningful ways.

References

- Bank for International Settlements (2007) *BIS Quarterly Review*, September 2007.
- Blake, David (2000), Does It Matter What Type of Pension Scheme You Have?, *The Economic Journal*, Vol. 110 (February 2000): pp. F46-F81.
- Bodie, Zvi, Alex Kane, and Alan J. Marcus (2008) *Essentials of Investment*. Seventh Edition. Boston: McGraw-Hill.
- Bodie, Zvi, and Robert C. Merton (2002), International Pension Swaps, *Journal of Pension Economics and Finance*, Vol. 1, No. 1, pp. 77-83.
- Burtless, Gary, (2007), International Investment for Retirement Savers: Historical Evidence on Risk and Returns. Center for Retirement Research Working Paper 2007-5. Boston: Center for Retirement Research at Boston College.
- Chan-Lau, Jorge (2005), Pension Funds and Emerging Markets, *Financial Markets, Institutions, and Instruments*, Vol. 14, No. 3, pp. 107-134.
- Davis, E. Phillip (2002a), Prudent Person Rules or Quantitative Restrictions? The Regulation of Long-Term Institutional Investors' Portfolios, *Journal of Pension Economics and Finance*, Vol. 1, No. 2, pp. 157-191.
- Davis, E. Phillip, (2002b), Pension Fund Management and International Investment – A Global Perspective, Pensions Institute Discussion Paper 0206.
- Hu, Yu-Wei, Fiona Stewart, and Juan Yermo, (2007), Pension Fund Investment and Regulation: An International Perspective and Implications for China's Pension System, OECD Working Paper, <http://www.oecd.org/dataoecd/9/30/39604854.pdf>
- Iglesias, Augusto, and Robert J. Palacios, (2000), Managing Public Pension Reserves, Part I: Evidence from the International Experience, *Social Protection Discussion Paper Series*, No. 3. Washington, DC: World Bank.
- International Labour Office (1997) *Social Security Financing*, Geneva: International Labour Office.
- International Monetary Fund (2008) *International Financial Statistics CD-ROM* (February 2008), Washington, DC: International Monetary Fund.
- Kotlikoff, Laurence J., (1999) The World Bank's Approach and the Right Approach to Pension Reform, Mimeo. Boston University.
- Lewis, Karen K. (1999), Trying to Explain Home Bias in Equities and Consumption, *Journal of Economic Literature*, Vol. 37, No. 2, pp. 571-608.
- Markowitz, Harry (1952), Portfolio Selection, *Journal of Finance*, Vol. 7, No. 1, pp. 77-91.

- MSCI Barra (2008) *Global Investable Market Indices*. Available at:
<http://www.msclubarra.com/>
- Organisation for Economic Co-operation and Development (2008) *Global Pension Statistics*. Paris: OECD. Available at: www.oecd.org/daf/pensions/gps
- Pfau, Wade D. (2009), The Role of International Diversification in Public Pension Systems: The Case of Pakistan, *Economic Issues*, Vol. 14, No. 2, forthcoming.
- Reisen, Helmut (1997), Liberalizing Foreign Investments by Pension Funds: Positive and Normative Aspects, *World Development*, Vol. 25, No. 7, pp. 1173-1182.
- Roldos, Jorge E. (2004), Pension Reform, Investment Restrictions, and Capital Markets. IMF Policy Discussion Paper PDP/04/4. Washington, DC: International Monetary Fund.
- Roy, A.D. (1952), Safety First and the Holding of Assets, *Econometrica*, Vol. 20, No. 3, pp. 431-449.
- Sharpe, William F., Peng Chen, Jerald E. Pinto, and Dennis W. McLeavey, (2007) "Asset Allocation" in John L. Maginn, Donald L. Tuttle, Dennis W. McLeavey, and Jerald E. Pinto (eds.) *Managing Investment Portfolios: A Dynamic Process*. Third Edition. Hoboken, NJ: John Wiley and Sons, pp. 230-327.
- Solnik, Bruno, and Dennis McLeavey (2004) *International Investments*, Fifth Edition, Boston: Pearson Addison Wesley.
- Srivinas, P. S., and Juan Yermo, (1999), Do Investment Regulations Compromise Pension Fund Performance? Evidence from Latin America. World Bank Latin American and Caribbean Studies Paper. Washington, DC: World Bank.
- World Bank (2007) *World Development Indicators 2007 CD-ROM*. Washington, DC: World Bank.

TABLE 1
Pension Funds and Domestic Investment Opportunities: Size and Liquidity in 2005

Country	GDP (Billions USD)	Total Pension Fund Assets as % of GDP	Stock Market Capitalization as % of GDP	Stock Traded, Total Volume as % of GDP	Stock Traded, Total Turnover Ratio	Public Debt as % of GDP	Private Debt as % of GDP
Argentina	\$183.19	12.32	33.56	8.97	30.44	27.69	8.31
Brazil	\$796.05	NaN	59.62	19.37	38.32	48.75	14.08
Chile	\$115.25	59.35	118.39	16.37	14.89	17.08	18.9
China	\$2,234.30	NaN	34.94	26.24	82.55	24.33	10.71
Columbia	\$122.31	13.69	37.62	5.2	17.86	29.8	0.5
Czech Rep.	\$124.36	4.14	30.83	33	118.6	43.47	5.61
Egypt	\$89.37	NaN	89.15	28.41	42.97	NaN	NaN
Hungary	\$109.24	8.55	29.82	21.89	78.03	40.55	4.9
India	\$805.71	NaN	68.64	55	94.2	32.76	1.12
Indonesia	\$287.22	NaN	28.35	14.59	54.18	16.54	2.29
Israel	\$123.43	34.06	97.31	48.52	55.55	NaN	NaN
Jordan	\$12.71	NaN	296.1	187.28	84.99	NaN	NaN
Korea	\$787.62	7.36	91.18	152.74	209.79	45.7	56.12
Malaysia	\$130.33	NaN	139.06	38.27	26.87	38.82	52.75
Mexico	\$768.44	10.04	31.12	6.86	25.66	17.12	15.39
Morocco	\$51.62	NaN	52.73	8.03	15.86	NaN	NaN
Pakistan	\$110.73	NaN	41.48	127.33	376.3	29.71	0
Peru	\$79.38	12.44	45.35	2.54	7.19	5.82	3.78
Philippines	\$99.03	NaN	40.55	7.02	20.12	38.07	0.76
Poland	\$303.23	8.79	30.96	9.88	36.34	33.76	0
Russia	\$763.72	1.59	71.83	20.86	39.03	3.08	0
South Africa	\$239.54	NaN	236.04	83.79	39.32	29.96	12.34
Sri Lanka	\$23.48	NaN	24.36	4.85	24.27	NaN	NaN
Thailand	\$176.63	4.87	69.94	50.55	74.74	28.3	13.27
Turkey	\$362.50	0.9	44.56	55.52	154.91	49.79	0
Venezuela	\$140.19	NaN	3.58	0.18	4.48	39.93	0.32

Source: Pension Fund Assets are from OECD Global Pension Statistics. GDP and Stock Market Data is from the World Bank World Development Indicators 2007. Public and private debt is from the Bank of International Settlements.

TABLE 2
Summary Statistics for MSCI Emerging Market Economies (Nominal Data)

	Time Period		Local Stocks (%)	Local Bank Deposits (%)	World Stocks (local currency) (%)	World Bonds (local currency) (%)	Exchange Rate (USD/local) (%)	Inflation Rate (%)
Argentina	1988-2006	MEAN (SD)	1208.27 (4822.71)	1018.52 (3942.72)	28.7 (34.28)	27.43 (36.3)	-18.07 (33.72)	322.39 (899.53)
Brazil	1988-2006	MEAN (SD)	698.27 (1177.25)	1437.96 (2632.85)	47.76 (44.92)	46.5 (45.29)	-37.12 (44.19)	555.12 (894.47)
Chile	1988-2006	MEAN (SD)	30.73 (38.11)	13.31 (9.6)	14.41 (16.14)	13.14 (12.89)	-3.8 (8.84)	8.92 (7.21)
China	1993-2006	MEAN (SD)	5.12 (42.87)	4.83 (3.69)	13.22 (17.79)	11.05 (11.01)	-1.73 (8.6)	5.21 (7.89)
Columbia	1993-2006	MEAN (SD)	34.08 (43.35)	18.51 (10.53)	17.72 (19.22)	15.56 (17.69)	-6.23 (12.18)	12.97 (7.34)
Czech Republic	1995-2006	MEAN (SD)	18.54 (28)	3.94 (2.75)	7.46 (22.97)	5.88 (11.54)	3.45 (14.33)	4.75 (3.57)
Egypt	1995-2006	MEAN (SD)	45.46 (68.71)	8.95 (1.4)	14.68 (19.78)	13.11 (13.04)	-3.77 (9.43)	5.87 (4.05)
Hungary	1995-2006	MEAN (SD)	37.19 (56.07)	12.02 (5.59)	14.35 (25.69)	12.77 (15.56)	-3.44 (15.05)	11.46 (8.1)
India	1993-2006	MEAN (SD)	19.45 (34.72)	8.48 (2.54)	14.98 (17.97)	12.82 (13.21)	-3.49 (6.07)	6.47 (3.06)
Indonesia	1988-2006	MEAN (SD)	36.43 (73.17)	16.98 (7.22)	17.51 (23.05)	16.23 (19.1)	-6.89 (16.33)	11.76 (11.84)
Israel	1993-2006	MEAN (SD)	13.06 (29.02)	8.95 (3.93)	14.26 (16.46)	12.1 (13.03)	-2.77 (6.69)	5.42 (4.54)
Jordan	1988-2006	MEAN (SD)	14.62 (29.22)	6.52 (2.05)	14.11 (20.36)	12.83 (11.9)	-3.49 (8.96)	5.37 (6.07)
Korea	1988-2006	MEAN (SD)	15.27 (37.92)	7.92 (2.72)	9.83 (21.63)	8.56 (17.62)	0.78 (16.92)	4.81 (2.28)
Malaysia	1988-2006	MEAN (SD)	14.97 (35.31)	5.06 (1.98)	11.98 (19.56)	10.7 (12.47)	-1.36 (8.74)	2.94 (1.17)
Mexico	1988-2006	MEAN (SD)	42.51 (42.32)	17.1 (14.32)	17.8 (20.56)	16.52 (16.67)	-7.18 (12.01)	19.79 (24.94)
Morocco	1998-2006	MEAN (SD)	10.79 (24.43)	4.77 (1.33)	7.23 (20.43)	6.29 (6.77)	2.02 (10.32)	1.74 (0.99)
Pakistan	1993-2006	MEAN (SD)	25.83 (53.15)	8.38 (3.14)	17.3 (18.73)	15.13 (11.24)	-5.8 (5.97)	7.5 (3.5)
Peru	1993-2006	MEAN (SD)	28.02 (33.5)	7.89 (4.16)	15.83 (20.89)	13.66 (14.35)	-4.33 (8.41)	9.27 (12.88)
Philippines	1988-2006	MEAN (SD)	20 (48.36)	10.03 (4.28)	14.35 (18.18)	13.08 (15.45)	-3.74 (11.16)	7.71 (3.52)
Poland	1994-2006	MEAN (SD)	12.6 (35.64)	13.35 (9.86)	12.14 (21.68)	10.17 (11.61)	-1.68 (12.17)	10.79 (10.58)
Russia	1995-2006	MEAN (SD)	54.49 (89.26)	19.76 (29.63)	22.39 (30.13)	20.81 (25.53)	-11.46 (21.73)	39.87 (54.16)
South Africa	1993-2006	MEAN (SD)	19.74 (23.65)	11 (3.28)	15.26 (25.03)	13.09 (18.59)	-3.77 (20.69)	6.49 (2.43)
Sri Lanka	1993-2006	MEAN (SD)	19.2 (35.04)	9.92 (2.61)	17.3 (15.94)	15.14 (11.65)	-5.81 (4.3)	9.75 (3.3)
Thailand	1988-2006	MEAN (SD)	18.78 (52.21)	7.11 (4.19)	11.39 (19.61)	10.12 (14.75)	-0.78 (13.78)	4.03 (2.1)
Turkey	1988-2006	MEAN (SD)	126.01 (214.4)	58.15 (21.38)	39.3 (25.69)	38.02 (21.39)	-28.66 (21.65)	58.57 (27.63)
Venezuela	1993-2006	MEAN (SD)	57.49 (76.38)	23.46 (12.42)	31.01 (20.36)	28.86 (21.21)	-19.51 (15.23)	35.85 (24.62)

Source: Local and world stock market data is from MSCI. Local fixed income, exchange rates, and inflation data is from the IMF International Financial Statistics. World bond data is from Bodie, Kane, and Marcus (2008).

TABLE 3
Correlations Among Assets for MSCI Emerging Market Economies
(Nominal Data)

	Local Stock & Local Bank Deposits	Local Stock & World Stock	Local Stock & World Bonds	Local Bank Deposits & World Stock	Local Bank Deposits & World Bonds
Mean	-0.08	0.28	-0.11	0.30	0.39
SD	0.38	0.27	0.31	0.23	0.22
Minimum	-0.64	-0.26	-0.70	-0.17	-0.01
Maximum	1.00	0.83	0.76	0.71	0.84
Argentina	1 ***	0.65***	0.54**	0.65***	0.56**
Brazil	0.41 *	0.83***	0.76***	0.6***	0.68***
Chile	0.5 **	0.43*	0.1	0.13	0.45*
China	-0.21	0.32	-0.36	0.44	0.61**
Columbia	-0.51 *	-0.26	-0.32	0.44	0.31
Czech Rep.	-0.64 **	0.12	-0.28	0.37	0.62**
Egypt	-0.4	0.53*	-0.14	-0.17	0.23
Hungary	0.33	0.36	0.13	0.59**	0.81***
India	-0.32	0.44	-0.43	0.38	0.4
Indonesia	-0.11	0.06	-0.34	0.39*	0.38
Israel	0.12	0.55**	-0.1	0.33	0.2
Jordan	-0.6 ***	0.19	0.03	0.04	0.06
Korea	-0.05	-0.17	-0.7***	0.09	0.11
Malaysia	-0.06	0.25	-0.15	0.22	0.37
Mexico	0.35	0.16	-0.19	0.31	0.28
Morocco	-0.41	0.57	-0.56	0.14	0.34
Pakistan	-0.32	-0.18	0.01	0.27	0.36
Peru	-0.19	0.31	-0.04	0.42	0.46*
Philippines	0.1	0.35	-0.09	-0.06	0.12
Poland	-0.43	0.42	-0.04	0.26	0.58**
Russia	-0.08	-0.02	-0.5	0.35	0.43
S. Africa	-0.46	0.38	-0.02	0.28	0.31
Sri Lanka	-0.09	-0.02	-0.07	-0.15	-0.01
Thailand	-0.16	0.2	-0.22	0.18	0.21
Turkey	0.21	0.36	0.06	0.71***	0.84***
Venezuela	-0.03	0.45	0.18	0.5*	0.55**

Source: Same as Table 2

Note: Results for a two-sided t-test of statistical significance for the correlation coefficients are provided in the table as * (10 percent significance), ** (5 percent significance), and *** (1 percent significance).

TABLE 4
MSCI Emerging Market Countries (Nominal Data)
Optimal Asset Allocation for the Conservative Investor (Risk Aversion = 5)

	Portfolio Return	Portfolio Risk	Return / Risk Ratio	Optimal Portfolio Weights					% Stocks	% Intl.
				Local Stock	Local Bank Deposits	Unhedged World Stock	Unhedged World Bond	Cash		
Mean	18.23	12.00	1.52	18.26	27.80	11.44	38.79	3.72	29.69	50.22
SD	10.28	4.55	0.42	13.18	33.65	15.41	26.53	13.14	12.41	30.73
Minimum	7.60	5.60	0.86	0.00	0.00	0.00	0.00	0.00	2.06	0.00
Maximum	59.55	21.97	2.75	45.46	97.94	41.29	74.84	48.88	54.98	99.78
Argentina	14.78	17.19	0.86	0	0	37.04	15.12	47.84	37.04	52.16
Brazil	24.12	21.97	1.1	0	0	28.04	23.08	48.88	28.04	51.12
Chile	17.7	13.28	1.33	24.79	29.97	11.43	33.81	0	36.22	45.24
China	11.82	10.02	1.18	0.22	0	35.83	63.95	0	36.05	99.78
Columbia	22.82	10.03	2.28	27.67	72.33	0	0	0	27.67	0
Czech Rep.	11.61	11.93	0.97	45.46	1.08	0	53.46	0	45.46	53.46
Egypt	18.43	13.63	1.35	18.64	17.09	0	64.27	0	18.64	64.27
Hungary	16.07	10.96	1.47	16.08	83.92	0	0	0	16.08	0
India	14.74	10.05	1.47	28.93	0	0	71.07	0	28.93	71.07
Indonesia	18.88	8.75	2.16	10.05	81.92	0	8.03	0	10.05	8.03
Israel	12.32	9.06	1.36	1.55	20.33	39.07	39.05	0	40.61	78.12
Jordan	13.23	10.9	1.21	15.98	0.52	11.72	71.78	0	27.7	83.51
Korea	10.04	6.75	1.49	25.13	32.03	0	42.85	0	25.13	42.85
Malaysia	11.58	11.01	1.05	18.51	0.2	7.98	73.31	0	26.5	81.29
Mexico	27.21	17.79	1.53	41.11	0	0	58.89	0	41.11	58.89
Morocco	7.6	5.6	1.36	28.94	0	0	71.06	0	28.94	71.06
Pakistan	17.34	11.12	1.56	13.34	0	35.92	50.74	0	49.26	86.66
Peru	19.3	14.89	1.3	39.26	0.03	0	60.71	0	39.26	60.71
Philippines	12.25	7.47	1.64	7.66	51.53	16.1	24.71	0	23.76	40.81
Poland	13.25	7.49	1.77	13.81	86.19	0	0	0	13.81	0
Russia	28.5	19.26	1.48	22.91	2.25	0	74.84	0	22.91	74.84
South Africa	14.37	7.91	1.82	36.27	54.29	0	9.44	0	36.27	9.44
Sri Lanka	16.58	9.4	1.77	13.69	0	41.29	45.02	0	54.98	86.31
Thailand	9.82	7.95	1.24	11.81	46.18	5.45	36.56	0	17.26	42.01
Turkey	59.55	21.69	2.75	2.06	97.94	0	0	0	2.06	0
Venezuela	30.1	15.79	1.91	10.78	45.11	27.45	16.66	0	38.23	44.11

Source: Own Calculations using Tables 2 and 3.

TABLE 5
MSCI Emerging Market Countries (Nominal Data)
Average Optimal Allocations (% of Portfolio)
for Various Risk Aversion Coefficients

Risk Aversion	1	2	3	4	5	10	25	50
Local Stock	50.2	33.8	25.6	21.1	18.3	11.2	6.0	3.9
Local Bank Deposits	8.6	13.1	17.9	23.0	27.8	48.4	64.3	62.3
Unhedged World Stock	22.9	18.7	15.8	13.2	11.4	7.0	3.0	1.5
Unhedged World Bond	17.3	34.4	39.7	39.9	38.8	27.0	11.5	5.8
Cash	1.1	0.1	1.1	2.7	3.7	6.4	15.2	26.4
% Stocks	73.1	52.4	41.3	34.3	29.7	18.3	9.0	5.4
% International	40.1	53.0	55.4	53.2	50.2	34.0	14.5	7.4

Source: Own Calculations using Tables 2 and 3.

TABLE 6
MSCI Emerging Market Countries (Nominal Data)
Constrained Asset Allocation for the Conservative Investor (Risk Aversion = 5)
THE COST OF PROHIBITING INTERNATIONAL ASSETS

	Portfolio Return	Portfolio Risk	Return / Risk Ratio	Optimal Portfolio Weights			% Change in Return	% Change in Risk
				Local Stock	Local Bank Deposits	Cash		
Mean	14.82	9.59	1.53	17.58	73.60	8.82	-21.3	-20.7
SD	11.13	5.03	0.52	11.48	24.54	27.32	22.5	22.1
Minimum	1.41	3.41	0.27	0.00	0.14	0.00	-90.5	-69.1
Maximum	59.57	21.71	2.74	42.18	97.92	99.86	0.0	7.9
Argentina	1.41	5.31	0.27	0	0.14	99.86	-90.5	-69.1
Brazil	9.78	13.98	0.7	0.8	0.29	98.91	-59.5	-36.4
Chile	17.42	13.76	1.27	23.57	76.43	0	-1.6	3.6
China	4.84	3.41	1.42	2.79	97.21	0	-59.1	-66.0
Columbia	22.82	10.03	2.28	27.67	72.33	0	0.0	0.0
Czech Rep.	10.1	10.39	0.97	42.18	57.82	0	-13.0	-12.9
Egypt	15.32	11.08	1.38	17.45	82.55	0	-16.9	-18.7
Hungary	16.07	10.96	1.47	16.08	83.92	0	0.0	0.0
India	10.82	6.78	1.6	21.34	78.66	0	-26.6	-32.5
Indonesia	18.82	8.72	2.16	9.45	90.55	0	-0.3	-0.3
Israel	9.39	4.81	1.95	10.86	89.14	0	-23.8	-46.9
Jordan	8.36	5.67	1.47	22.71	77.29	0	-36.8	-48.0
Korea	8.77	4.75	1.85	11.52	88.48	0	-12.6	-29.6
Malaysia	6.77	6.05	1.12	17.27	82.73	0	-41.5	-45.0
Mexico	25.65	19.19	1.34	33.64	66.36	0	-5.7	7.9
Morocco	6.22	5.23	1.19	24.07	75.93	0	-18.2	-6.6
Pakistan	10.99	7.24	1.52	14.93	85.07	0	-36.6	-34.9
Peru	15.95	12.69	1.26	40.01	59.99	0	-17.4	-14.8
Philippines	10.93	5.95	1.84	9.02	90.98	0	-10.8	-20.3
Poland	13.25	7.49	1.77	13.84	86.16	0	0.0	0.0
Russia	19.43	19.71	0.99	16.37	53.16	30.47	-31.8	2.3
South Africa	14.2	7.63	1.86	36.56	63.44	0	-1.2	-3.5
Sri Lanka	11.51	5.98	1.92	17.14	82.86	0	-30.6	-36.4
Thailand	8.35	6.01	1.39	10.61	89.39	0	-15.0	-24.4
Turkey	59.57	21.71	2.74	2.08	97.92	0	0.0	0.1
Venezuela	28.61	14.86	1.93	15.14	84.86	0	-5.0	-5.9

Source: Own Calculations using Tables 2 and 3.