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by

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Abstract

Pakistan's pension system is in the process of increasing funding in anticipation of providing for a growing elderly population. The pension assets are mainly invested domestically, as it was just in January 2007 that regulations changed to allow the purchase of international assets. In this paper, we quantify how diversification of the pension funds to include world financial assets could help a great deal in improving the sustainability of Pakistan pensions by simultaneously increasing expected returns and decreasing volatility. These arguments are made using historical data, and the robustness of our findings is demonstrated using a large variety of alternative assumptions about future asset returns, risks, and correlations. We find that international diversification could dramatically help to create sustainability for Pakistan's main public pension system available to private workers.

Introduction

As with many countries both rich and poor, the Pakistan government is searching for appropriate reforms to make a more sustainable pension system. This search is leading the country to increasingly shift its public pension systems from pay-as-you-go toward the inclusion of more funding. Regarding public pensions for private workers in Pakistan, the defined-benefit Employees Old-Age Benefit Institution (EOBI) is presently building up large funding in anticipation of future benefit payments, and the Voluntary Pension System (VPS) was created in 2005 as a fully-funded defined-contribution pension for registered taxpayers. In July 2006, a funded pension for government servants began as well. These changes are needed because demographic trends will lead to an increasing fraction of the population that is elderly, which will make it increasingly difficult for the working population to provide pay-as-you-go pension benefits. In light of these demographic trends, funding helps to preserve intergenerational equity, to potentially provide additional savings for economic development, and to allow pensioners to enjoy the benefits of compound interest. More reforms of this nature can be expected in the future, as changes are required to ensure the sustainability of the existing pensions, as well as to expand coverage to the high percentage of the population not currently protected by a formal pension scheme.

When pensions are funded, the issue of asset allocation becomes of paramount importance. Pakistan policymakers understand this and realize that the existing approach needs an overhaul. Indeed, the EOBI Chairman, Brig. Ahktar Zamin, said in a 2006 speech that the EOBI's investment strategy is "passive and archaic" (Zamin, 2006, p. 11). Nonetheless, while also recognizing many problems with domestic investment choices, policymakers do not typically broaden their discussion to issues of international diversification. International investments were prohibited until recent revisions to the EOBI investment policies that were approved in January 2007. What we seek to do in this paper is to provide a thorough analysis of the potential role for international assets in the Pakistan pension system, and also show how the inclusion of international assets is robust to an extensive set of assumptions about future asset risks, returns, and correlations. 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 an emerging market country that quantifies how remarkable these benefits can be using not just an *ex post* analysis, but also under a variety of situations that can allow the reader to incorporate their own ideas about future asset behaviors and see how these ideas affect the optimal portfolio choice.

To be sure, there has been an extensive debate about whether pension funds should invest internationally. The basic 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 (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, evidence which is reviewed in Lewis (1999). For instance, Levy and Sarnat (1970) show that for a US based investor, depending on the assumption used for the risk-free rate, between 49 and 73 percent of the portfolio should be held in international assets. Similarly, Srinivas and Yermo (1999) estimate that including foreign equities in the portfolios of Latin American pension funds could increase returns while lowering risks, which could result in larger benefits for pensioners. 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 (2002). The lack of a suitable explanation for this missing diversification leads this to be called the home-bias puzzle.

Aside from theory, we also consider a number of practical issues in the debate. First, an important advantage of international diversification relates to the common fact 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).

We can observe these problems especially with regard to the availability of long-term government bonds in Pakistan. The State Bank of Pakistan (2005) identifies a lack of supply in long-term government bonds in the domestic market as a critical issue for the financial sector resulting in underdeveloped long-term and corporate bond markets (p. 143). Bukhari (2006) adds that most bond owners in Pakistan hold them until maturity, leaving few bond transactions in either the primary or the secondary markets. In fact, State Bank of Pakistan (2004) indicates that more than 90 percent of the government securities held by the EOBI are kept until maturity, rather than being actively traded. Pension funds have been further constrained since 2000 when the government prohibited institutional investors from using the National Savings Schemes, though this restriction was removed in

November 2006. Increasing demand from pension funds will only exacerbate these problems in the future.

Meanwhile, while dramatic growth in the Pakistan stock market since 2000 (market capitalization as a percentage of Gross Domestic Product grew from 10.3 percent in 2000 to 36.3 percent in 2006) has reduced supply constraints, many problems remain. First, further examination of the State Bank of Pakistan (2005) data suggests that the rise in market capitalization is the result of capital gains on existing stocks, as the value of total listed capital has grown at about the same rate as GDP, and the trade volume of shares has not shown a discernable pattern (p.136). Bukhari (2006) expresses concern about the low free float to market capitalization ratios for many large companies, as well as a lack of initial public offerings of new stocks. Also, other concerns include that Pakistan pension funds are limited to the equities of a small number of companies that meet their necessary accounting and liquidity regulations, and that the Pakistan stock market has shown extreme volatility in recent years.

Misuse of pension funds can also remain a problem, and international evidence about the tendency for low returns among public pension systems is reviewed in Iglesias and Palacios (2000). Irfan (2003) describes these issues in Pakistan, including a scam resulting in the loss of one billion rupiah from the EOBI fund (p. 13). Also, if pension funds mainly invest in domestic government securities, then there is concern that pension funds may only depress interest rates and lead to greater government debt, as it is important that the government be able to mobilize the funds effectively (International Labour Office, 1997). 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.

On the other hand, there are potential advantages from keeping pension fund assets at home. For instance, 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). Roldos (2004) highlights many advantages that pension funds can provide to local financial markets, including the development of 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.

Another important issue when considering international diversification is the macroeconomic impact of the financial outflows as the pension fund sells the domestic currency to invest abroad. Related to the impossible trinity of international finance, if international diversification implies an increased liberalization of capital flows, then the

country will no longer be able to both influence its exchange rate and have a monetary policy that responds to domestic economic fluctuations. For several reasons, concern for this issue will not be strong for the case of Pakistan. First, while Pakistan does use its monetary policy to respond to domestic issues, the current concerns in Pakistan are related to the inflationary effects of large capital inflows, in which outflows from the pension fund may help to balance (Akhtar, 2007). Second, Reisen and Williamson (1994) argue that international diversification by pension funds should not reduce the abilities of central banks to conduct monetary policy, because such investment will tend to integrate the world's stock markets more than interest rates. Finally, macroeconomic consequences no longer need to be of much concern, as Reisen and Williamson (1994) and Bodie and Merton (2002) both explain how pension funds can use "international pension swaps" to obtain the diversification benefits without the need for large capital flows, if this is a concern. 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, and large capital flows will be of little concern.

Also, there are other potential disadvantages of international investment that mostly do not apply to the case of Pakistan. First, 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. Also, currency fluctuations can actually work to hedge fluctuations in the domestic economy or can at least be hedged with derivatives. Another concern, at least for defined benefit pensions, is that there is a need to match the durations of assets and liabilities, especially when the liabilities are of short duration (Blake, 2000). But in Pakistan the pension system and population are still young and the pension liabilities have a long duration. Such conditions mean that the funds can tolerate currency risks and potential capital losses (Reisen, 1997). Finally, Reisen (1997) argues that to obtain the benefits for domestic financial markets, it does not mean that the optimal solution is to prohibit all foreign investment, only that a proper balance must be found.

To develop our analysis, we first provide an overview of Pakistan's pension system and demography, before moving to our methodology and data. We then provide our results, which include an analysis of optimal asset allocations for different degrees of risk aversion using the historical data, an assessment of the costs of restrictions for international assets, and a check of robustness for optimal asset allocations using a variety of alternative assumptions for returns, risks, and correlations. We find substantial evidence to support the inclusion of international assets, as such diversification can lead the pension funds to enjoy both larger returns and less volatility in the fluctuations of these returns.

The diversification benefits of international assets are clear, as we find low correlations between international and domestic assets, and we find that the currency risk associated with international investment provides a hedge for domestic economic conditions.

Demographic Trends and the Pension System in Pakistan

Demographic trends in Pakistan are such that pension pre-funding can help provide a buffer to deal with the large-scale increases in the elderly population that can be expected in the coming years. Pakistan is still a young country with fertility rates well above the population replacement rate. The Population Division of the United Nations (2006) reports that while the total fertility rate was above six babies per women in the 1950s, 1960s, 1970s, and 1980s, it is now declining. By the late 1990s it was below five, and it is falling to about 3.5 during this decade, and the UN expects it to settle at about the replacement rate level of slightly above two by 2050. At the same time, people are living longer on account of improvements in health, sanitation, and nutrition. The UN reports that males and females born in the 1960s could expect to live to their mid-40s, but that by 2005 life spans had increased to about 64 for both genders, and by 2050 these life expectancies are projected to increase to the mid-70s.

// Figure 1 About Here //

Figure 1 combines this information to show the population in three different age groups. In 2005, there were 9.3 million people aged 60 and over in Pakistan, which represents 5.9 percent of the population. The elderly will more than double to 19.2 million by 2025. By 2050, the best guess is that there will be 48.1 million people aged 60 and over, which will be 16.5 percent of the population. In terms of the ratio of elderly people (age 60 +) to working-age people (age 15-59), there were 9.7 working-age people per elderly person in 2005, which will decline to 3.7 working-age people per elderly person in 2050 (United Nations, 2006). Some relief will be provided for the working-age people during the coming years as there will be a decline in the percentage of young people needing support. However, Figure 1 shows that the working-age population will peak at 64.1 percent of the total population in 2040 and then begin to decline. If the figure could be extended beyond 2050, we would see the number of elderly people continuing to rise while the number of working-age people will begin a process of decline as there will be fewer young people to transition into the working ages. In anticipation of these changes, pension systems in Pakistan are now increasing their funding levels. We will briefly describe the key parts of Pakistan's public pension system.

Though coverage remains low, the publicly regulated pension system in Pakistan is moving toward a multipillar model recommended by the World Bank in Holzmann and Hinz (2005). First, created in 1976, the Employees Old Age Benefit Institution (EOBI) is a defined-benefit first pillar pension for formal sector workers employed by firms with at least 10 workers (or at least 20 workers for firms created after July 2006). Social Security Administration (2007) and Irfan (2003) provide excellent background details about how the system operates, and the EOBI website (www.eobi.gov.pk) is our source for the most

updated information. Briefly, benefits are provided to eligible members for old-age, disability, and survivorship. Old-age benefits are provided as two percent of the last drawn monthly salary before retirement times the number of years of covered employment. The minimum pension amount is now 1,500 rupees. Full pensions are available to participants with at least 15 years of contributions for men aged 60 or women aged 55. Reduced pensions are available at younger ages (55 for men, 50 for women) for those with sufficient contributions. As of 2006, these benefits are funded through employer contributions of six percent of payroll and employee contributions of one percent of payroll. The government contributed as well between 1986 and 1995, and it will provide further contributions if needed. On June 30, 2006, there were 58,210 employers registered with the fund. The number of private employees covered was more than 2.5 million. In this paper, we are mostly interested in funding issues for the EOBI.

An actuarial valuation in June 2003 found that the existing scheme is not financially viable (EOBI website). Inflows are expected to exceed outflows until 2023, after which the actuaries project that the fund will pay more in benefits and administrative expenses than it receives in contributions and income from assets. By 2035, the EOBI fund is expected to be exhausted. The actuaries project that the fund's assets will need to earn at least seven percent per year in real terms to remain viable. Nonetheless, benefit payments are still low and the EOBI is currently in the process of accumulating assets.

// Table 1 About Here //

Table 1 provides information about the EOBI fund assets between 1999 and 2004. We can see that the fund grew rapidly from 30.3 billion rupiah (PKR) at the start of the fiscal year in 1999 to PKR 81.6 billion at the end of fiscal year 2004. Though not listed in the table, the size of the fund was PKR 133.9 billion on August 31, 2007. Most of this growth has resulted from the income provided by fund assets, as the contributions from employers and employees have been relatively small. During this time, as well, pension payments have been smaller than contributions, though payments are growing more quickly as the number of qualifying elderly grows.

Regarding asset allocation, the EOBI does not hold any international assets, and more than 90 percent of its assets were held in domestic fixed income instruments during this time. Since we do not have details about the time flow of contributions and payments during the year, we estimate the return on assets as income from assets divided by the amount of assets at the fund at the start of the year. For government securities, returns have been high, ranging from between 14.6 and 18.36 percent. These high returns are a result of the large yields provided by Pakistan government bonds. The EOBI ignores capital gains / losses resulting from changing bond prices, since its government securities tend to be held to maturity. But yields have fallen for newly issued bonds in recent years and we must doubt whether such high returns could be maintained in the future. As for equities, the returns have been more volatile as the stock market has fluctuated. Returns from other assets tended to be more similar to government securities in the early part of the

period, but have fallen in recent years as old securities with high yields have matured without any new high-yielding assets to replace them. The EOBI website also provides more recent data regarding the asset allocation on August 31, 2007. Though international investments are now technically allowed, the asset allocation does not refer specifically to them. We can, however, find an increasingly reliance on stocks. At this time, government securities made up 73.8 percent of the portfolio, followed by stocks with 18.3 percent, "strategic holdings" with 3.6 percent, real estate with 2.9 percent, and other securities with 1.4 percent.

While there is not yet a second pillar pension for private workers, the Voluntary Pension Fund (VPS) began operation in 2005 as a voluntary third pillar pension. It allows registered taxpayers (about 1.5 million people) or people with National Identity Cards to voluntarily contribute funds to a defined-contribution account that offers investment choice among several funds, which are licensed by private fund managers. Initially, choice is available among three sub-funds: equities, fixed-income securities, and money market securities. Participants can tailor their investments among these three funds to match their tolerance for risk by choosing from aggressive, balanced, conservative, or very conservative funds. International investment is not possible with these funds, though additional asset classes may be offered to investors at a later date (Beg, 2005).

Pakistan also has separate pension schemes for government servants that includes both defined-benefit and defined-contribution aspects, but these schemes operate mostly on an unfunded pay-as-you-go basis, and so we will not describe them in further detail. However, a new system in July 2006 has introduced funded pensions for new government workers as well. Pension funding is becoming increasingly important in Pakistan, which means that asset allocation issues must be carefully considered.

Methodology and Data

This section describes our approach for considering whether the pension funds in Pakistan 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

lower the correlation among the available assets, the higher are the potential benefits of portfolio diversification.

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 10, or even more. We will provide our results for optimal asset allocations using a variety of risk aversion coefficients, as it is not clear what degree of risk aversion is appropriate for the Pakistan pension system. Nonetheless, pension funds do tend to be risk averse, and so when we check the robustness of our results, we will use a risk aversion coefficient of five.

While the mean-variance portfolio selection framework is the most 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. However, we attempt to cope with this potential problem by checking for the robustness of the results with many alternate assumptions. An alternative modeling framework for this purpose 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 an emerging market country like Pakistan. 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 (Sharpe, Chen, Pinto, and McLeavey, 2007).

Second, our mean-variance approach will look only at assets, whereas defined-benefit pension funds need to model assets in relation to their future liabilities and the risk characteristics of those liabilities. 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 Pakistan pension system is still immature with mostly long-term liabilities, 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 is 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 five broad asset classes: Pakistan stocks, Pakistan government bonds, Pakistan government bills, 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.

We use annual data for the returns at year end, from 1993 to 2006. Regarding, our data sources, the Pakistan Stock Market is represented by the annual percent changes at year end in local currency for the MSCI Pakistan Standard Core Index (www.msci.com). These values are similar to the returns of the Karachi Stock Exchange (KSE) 100 Index. Pakistan Government Bonds are represented by 10-year Federal Investment Bonds, with data coming from the State Bank of Pakistan. To be consistent with our world bond data, we will calculate the total return (*RET*) on these bonds, which consists of their yield and capital gains / losses resulting from interest rate movements, with the formula:

$$RET_t = \frac{yield_{t-1}}{yield_t} + \frac{\left(1 - yield_{t-1}/yield_t\right)}{\left(1 + yield_t/100\right)^{10}} - 1 + \frac{yield_{t-1}}{100}$$

For Pakistan bills, we use six-month Treasury bill data from the International Monetary Fund's International Financial Statistics (IMF IFS) database. We fill in a few missing data points with the average values for the time period. The World Stock Market is represented by the MSCI All-Country World Index. The World Bond Market is represented by a weighted average of two actual mutual funds: the Vanguard Total Bond Market Index fund for the US market, and the T Rowe Price International Bond fund to represent investment

opportunities in non-US bonds. For each fund, we add the administrative costs back to the fund returns to make them comparable with the other assets that have not had administrative costs deducted, and we weigh each fund by the fraction of domestic debt securities from the US in the world total using statistics from the Bank of International Settlements (2007). Our data represents the total returns available after dividend payments. During this time period, the weight for US bonds fluctuated between 43 and 50 percent.

As for other relevant data, the exchange rate is defined as the amount of US dollars (USD) that can be purchased with a Pakistan rupiah (PKR). 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 the Pakistan investor who does not hedge currency risk. Finally, inflation data is also from the IMF IFS database, using the monthly data to obtain annual percent changes at the year end. The inflation data allows us to also consider the real returns for the Pakistani investor after removing the impacts of domestic inflation.

Results

Our objective is to consider the role of international assets for Pakistan pension funds. Our analysis will proceed as follows. First, we discuss the characteristics of our historical data. Then, we use the historical data to calculate optimal asset allocations for varying degrees of risk aversion. This is followed by a quantification of the costs of regulations prohibiting international assets. Finally, we provide extensive robustness checks for the asset assumptions to find out whether there remains a role for international assets in a variety of alternate circumstances.

Historical Relationships: Means, Standard Deviations, and Correlations

// Table 2 About Here //

Table 2 shows the calculations for nominal and real returns, risks, and correlations for the relevant variables during the historical time period. All values are annual percent changes at year end. During this time period, the Pakistan stock market showed significant volatility, as the mean return was 18.3 percent with a standard deviation of 46.4 percent. Ten year government bond yields stayed close to 15 percent until 2000, and then began to decline to as low as 5.52 percent in 2002 before rising to 10.51 percent in 2006. Calculating the returns available from such bond yields requires considering both the yield and the change in the bond price. With our bond portfolio assumptions, the 10-year bonds enjoyed an average return of 14.9 percent with a standard deviation of 15.7 percent. As for the Pakistan six-month Treasury bills, these lower risk investments enjoyed an average return of 9.3 percent with a standard deviation of 3.9 percent.

We also consider the potential returns from international investments during this period. Exchange rate data is needed to calculate unhedged returns. On average, the PKR depreciated at a rate of 5.8 percent per year, as one USD could buy 25.7 PKR at the end of 1992, and 60.92 PKR at the end of 2006. The standard deviation of these changes was 5.8

percent. Because of the PKR depreciation, unhedged returns for the Pakistan investor were larger than the returns denominated in USD. Of course, the direction of future currency movements is hard to predict, but as we will discuss further below, we believe it will generally be advantageous not to hedge currency risk. In terms of PKR, the world stock market earned an average return of 16.7 percent with a standard deviation of 19.1. These exceed the values in USD, which were 9.3 percent with a standard deviation of 15.7. In terms of PKR, the world bond market returned 14 percent on average with a 10.1 percent standard deviation, while the returns in USD were 7 percent with a 6.7 percent standard deviation. For both world stocks and world bonds, currency risk added about 3.5 percentage points to the standard deviations.

Table 2 also provides information about the real returns for the various assets after removing the effects of domestic inflation, which averaged 7.5 percent with a standard deviation of 3.5 percent. For Pakistan assets, the real returns were lower, though the standard deviations for bonds and bills actually increased. Of special consideration here is the impact of domestic inflation on the returns of the world assets, which matters for what Pakistan consumers could purchase with the proceeds of their foreign investments. The real return on unhedged world stocks was 7.7 percent with a 17 percent standard deviation, while world bonds earned 5.4 percent with a 9 percent standard deviation. If USD currency risk had been hedged, the high inflation in Pakistan would have led to real returns from world stocks of only one percent with a 14.2 percent standard deviation, while world bonds would have experienced a -1 percent return with a 7.1 percent standard deviation. We can see that international assets that are hedged for currency risk do not provide protection from high inflation for domestic investors. Currency depreciation should accompany inflation (as expected, we do find a negative correlation between exchange rates and inflation), and in the long-run, currency risk may be less important to the extent that exchange rates will tend to slowly revert to the underlying economic fundamentals (Rogoff, 1996). This serves as a justification for not hedging currency risk, and our analysis proceeds assuming that no hedging for currency risk takes place.

The preceding paragraph began the discussion of correlation between various assets, and these correlations are shown in Table 2 as well. The upper triangle of the correlation matrix shows correlations for the nominal returns, while the lower triangle shows the correlations for real returns. A correlation of one implies that two assets move in tandem and so there is no diversification benefit, while decreasing correlations mean increasing benefits from diversification. Negative correlations are particularly attractive for optimal portfolio selection as they provide more risk reduction while still maintaining the same returns. We see that correlations among Pakistan financial assets tend to be fairly low. World assets are negatively correlated with Pakistan stocks and bonds, but positively correlated with Pakistan bills, at least in nominal terms. In particular, the correlation between Pakistan bonds and unhedged world stocks is quite low (-0.658), which implies large diversification benefits from holding these two assets. Pakistan stocks and bonds are

also positively correlated with the exchange rate, which means that when Pakistan stocks and bonds are performing poorly, the currency also tends to depreciate, which will boost the returns from the world assets. The results of Table 2 will now be used to calculate the optimal asset allocations.

Optimal Asset Allocation and the Cost of Constraints on Asset Allocation Decisions

// Table 3 About Here //

Table 3 provides the details for the optimal asset allocations using the historical data, given a variety of risk aversion coefficients. We show the results using both nominal and real data, and the asset allocations are quite similar with either approach, so our discussion focuses on the nominal data. More aggressive investors are willing to accept more risk to obtain a higher return. The most aggressive investor we consider, whose coefficient of risk aversion is one, could expect to earn a return of 16.4 percent with volatility of 11.4 percent. The optimal portfolio for this investor included 72.9 percent stocks and 59.6 percent international assets. The biggest allocation in the portfolio is for world stocks (59.6 percent), followed by Pakistan bonds (27.1 percent) and Pakistan stocks (13.3 percent). Pakistan bills and world bonds do not play a role. The result for world bonds may be surprising since their returns were only slightly below Pakistan bonds, while their volatility was almost 6 percentage points less. But the result can be understood because of the correlations of world bonds and Pakistan bonds with world stocks. World stocks played a key role in the portfolio, and their correlation with world bonds was relatively high at 0.447, while their correlation with Pakistan bonds was quite low at -0.658. Pakistan bonds and world stocks complement one another very well, and this helps them to dominate the optimal portfolio.

We began the analysis for the most aggressive investor, but pension funds are thought to be relatively conservative. For the risk aversion coefficients ranging from two to 10, there are clear trends for the changing asset allocations: the percentages allocated to both the Pakistan and world stock markets slowly decline, while the percentage for Pakistan bonds increases and eventually world bonds also play a small role. Thus, for a risk coefficient of 10, Pakistan bonds make up 51.7 percent of the portfolio, followed by world stocks (45.3 percent), world bonds (2.6 percent) and Pakistan stocks (0.4 percent). There is still not yet a role for Pakistan bills, and this conservative portfolio still has 45.7 percent of its assets in stocks and 47.9 percent invested abroad, for an overall return of 15.7 percent and a volatility of 7.1 percent.

// Table 4 About Here //

Table 4 provides evidence of how regulations constraining available investment choices can actually reduce returns while simultaneously increasing risks. Table 4 includes the results from using both nominal and real returns. The top part of each subsection repeats the results for risks and returns from Table 3, which represent the optimal decisions of investors with varying degrees of risk aversion for the five types of assets we have considered. This is the unconstrained portfolio in the sense that we did not

include any limits on the assets held. Then we show how the potential risks and returns of the optimal asset allocation decisions change when the pension fund is prohibited from holding any world stocks or world bonds.

We find that investors with risk aversion coefficients less than or equal to five are forced to accept both lower expected returns and higher volatility. For example, a cautious investor with risk aversion of five would have to sacrifice 23 percent of their potential returns while also adding an additional 12 percent to the standard deviations of these returns if they are prohibited from including international assets in their portfolio. Meanwhile, highly conservative investors do find portfolios with lower volatility, but this is at the cost of having smaller returns than they would have otherwise found acceptable in the unconstrained portfolio.

The results are particularly striking when we consider the case of real returns. As described before, the actuarial projections suggest that the EOBI will be unsustainable unless the fund assets can earn a real return of at least 7 percent each year. Our findings show that a portfolio which includes international assets is much more likely to at least come close to reaching this goal. For example, with a risk aversion coefficient of five, the unconstrained portfolio that includes international assets enjoys a 7.1 percent return with a standard deviation of 7.4 percent. The geometric mean return that can be earned over a long duration after accounting for the volatility is 6.8 percent, which is close to what is needed for sustainability (we must also include the *caveat* that we have not deducted the administrative costs, which would reduce all of the returns in the tables accordingly). However, when we exclude international assets from the portfolio, the possible returns fall by more than half to 3.4 percent, while the standard deviation increases to 8.3 percent. This implies a geometric return of 3.1 percent in real terms, which is much lower than the alternative of 6.8 percent.

Indeed, allowing world assets has the potential to provide a workable solution toward making the EOBI sustainability with perhaps only minor changes to contribution rates or benefit levels. It will also allow VPS participants to enjoy larger pensions (for example, over 30 years, a PKR which grows in real terms at 6.8 percent will provide 7.2 PKR, which is 2.9 times more than the 2.5 PKR that would results from a 3.1 percent growth rate) for a given contribution rate.

The Robustness of the Assumptions for Optimal Asset Allocation Decisions

Almost surely, the future will be different from the past, while the previous analysis implicitly assumes that future market returns, volatilities, and correlations will behave with the same patterns. *Ex post* analysis alone is insufficient, as pension fund managers must forecast future asset patterns when making their asset allocation decisions. For example, managers may expect less volatility from the Pakistan stock market, or lower average returns from Pakistan bonds, or that the Pakistan currency could appreciate against the USD and lower the unhedged returns from international assets, or that the correlations between domestic and world assets could increase, among many other possibilities.

In this section, we vary our assumptions to study whether world assets continue to play an important role in optimal asset allocation decisions. We look specifically at the case of a conservative investor with a risk aversion coefficient of five, using nominal data. Table 5 shows the impacts for varying the returns and risks of stocks and bonds. Then, Table 6 examines variations in the correlation coefficients between these assets. In each case, three values are chosen to represent a broad range of possibilities surrounding the historical values. We will see that international assets always play an important part of the optimal portfolios, even in rather extreme cases of particularly high returns or low volatilities for Pakistan assets. We do not find a case where international assets are eliminated because as assumptions vary in ways that diminish either world stocks or bonds, we usually find that the other asset grows in important as a replacement in the portfolio.

// Table 5 About Here //

Table 5 provides many interesting insights about the asset allocation process. First, varying the returns on Pakistan stocks does not make much difference, as the allocation for them would only be 10.7 percent even if annual returns were as high as 28 percent. If Pakistan stock returns are below 16 percent, they do not play any role in the portfolio. Meanwhile, the optimal portfolio is more sensitive to the returns on world stocks. For instance, if world stock returns were only 8 percent, they would not have a role in the portfolio. However, it is interesting to note that a reduction in world stock returns leads them to be replaced by world bonds, thus preserving a role for world assets. We also see this if world stock returns fell to 12 percent; they would provide 15.3 percent of the portfolio while world bonds provide 42.4 percent of the portfolio. In the other direction, increasing returns on world stocks to as high as 24 percent causes them to play a larger role in the portfolio, overtaking Pakistan bonds in importance. As for the volatility of Pakistan stocks and world stocks, we find for Pakistan stocks that that if the volatility is much lower, then they do play a larger role in the portfolio, gaining ground from Pakistan bonds and world stocks. But even if the future standard deviation of Pakistan stocks were only 17.5 percent, they would still provide only 25.2 percent of the portfolio, which is less than Pakistan bonds and world stocks. Meanwhile, an increase in the volatility of world stocks causes them to play a smaller role in the portfolio, ceding ground to mostly to Pakistan bonds, but also to world bonds.

Table 5 also shows the results for Pakistan and world bonds. First, varying the returns on Pakistan bonds does have important implications. As the returns on these bonds decreases, their position in the portfolio is taken by world bonds. For example, world bonds would consist of 55 percent of the portfolio if Pakistan bond returns are 9 percent. Indeed, a reduction in returns from Pakistan bonds causes world assets to dominate a large portion of the portfolio. We also find that increasing returns on world bonds will lead them to quickly play a very important role in the portfolio, as the optimal portfolio allocations are particularly sensitive to small changes in the returns on world bonds. If the returns on world bonds increase from 14 percent to 18 percent, then their weight in the

portfolio explodes from 0.8 percent to 77.7 percent. A return of 21 percent for world bonds leads them to dominate 96.7 percent of the optimal portfolio.

Meanwhile, changing volatility for Pakistan bonds mostly leads to a tradeoff between these bonds and world stocks in the portfolio, as less volatility increases the weight for Pakistan bonds. Finally, the optimal portfolio is not particularly sensitive to the volatility of world bonds. Even if the standard deviation for world bonds falls to 3 percent, they would still only represent 17.4 percent of the total, as this volatility reduction is not enough to counteract the effects of the extreme negative correlation between Pakistan bonds and world stocks.

// Table 6 About Here //

In Table 6, we vary correlation coefficients to see how this impacts the optimal portfolios. First, the baseline correlations between domestic stocks and bonds, and between world stocks and bonds, tend to be relatively large and positive compared to most of the other correlation coefficients. We see that if the correlation between Pakistan stocks and Pakistan bonds is smaller, then Pakistan stocks do gain some ground from world stocks. But even if the correlation were -0.5, Pakistan stocks would still provide only 12.4 percent of the portfolio, compared to 38.4 percent for world stocks. Meanwhile, if the correlation between world stocks and world bonds decreases, we find that the total portion of the portfolio dedicated to international assets will increase as world bonds play a more important role through a steady tradeoff with both world stocks and Pakistan bonds.

Next, we consider the correlation between Pakistan stocks and world stocks, which is close to zero in the baseline case. If this correlation is more negative, then the allocation to Pakistan stocks does slowly increase, but this occurs only through a tradeoff with Pakistan bonds. An increase in this correlation removes Pakistan stocks from the portfolio. As for the correlation between Pakistan stocks and world bonds, we find little impact from varying the correlation in either direction, as these two assets continue to play a very minor role in the portfolio.

The next result, concerning the correlation between Pakistan bonds and world stocks, provides the most striking and important detail in the table. As we have seen, these two assets play a key role in the optimal portfolio, and we find that a very important reason for this is that the correlation between them is -0.658. If the correlation increases, these two assets rapidly lose ground to world bonds. For instance, with a correlation of zero, world bonds will provide 44.9 percent of the portfolio, followed by Pakistan bonds (28.7 percent), world stocks (21.6 percent), and Pakistan stocks (4.9 percent). Also worth noting is that an increasing correlation leads to an increase in the total allocation for world assets, as world bonds grow in importance more rapidly than world stocks decline. Finally, we vary the correlation between Pakistan bonds and world bonds, but it does not have much impact on the portfolio, except that extremely negative correlations will lead to world bonds replacing some of the role of world stocks.

Conclusion

We have found evidence to support the inclusion of international assets in Pakistan pension funds. These results hold for a variety of circumstances and attitudes toward risk. Indeed, we find that it is rather hard to remove international assets from the optimal portfolio, even when using rather extreme assumptions for risks and returns that put Pakistan assets in a more favorable light. For instance, if the percentage of the portfolio dedicated to world stocks falls, it is typically replaced by world bonds. We even found that international assets could help make possible the returns needed to maintain sustainability for the defined-benefit Employees Old-Age Benefit Institution fund.

These results should not be interpreted as finalized recommendations for asset allocation. First, Pakistan fund managers must decide which assumptions are most appropriate for future asset behaviors. Beyond this, there are practical factors that would work both to increase and to decrease the percentage of world assets in the portfolio. Factors that support additional increases in world assets include, first, that the investments in world assets we consider in this paper will be easy to obtain for pension fund managers. They merely need to purchase passively managed index funds with low administrative costs. But it may be harder for Pakistan fund managers to match the returns we assume for Pakistan assets because of their role as a large market player and the lack of available supply for domestic assets. Another factor to boost world assets in the portfolio would be to further differentiate between world regions and sectors, rather than just considering a combined world portfolio. Also, to the extent that covered labor income in Pakistan is more correlated with domestic asset returns, this would suggest a higher weight for world assets.

Other factors favor a larger weight for Pakistan assets. First, the inclusion of real estate, corporate bonds, and other domestic assets could potentially reduce the amount of world assets in the optimal portfolio. Also, pension fund managers may be justified to sacrifice some returns in favor of domestic investment projects, if such projects could otherwise benefit pensioners or provide other positive externalities for the country. An example of this sort would be to use the pension funds to create suitable housing or hospitals and clinics for pensioners. Furthermore, fund managers must be mindful of any macroeconomic implications from the potentially large capital outflows of pension funds, and they must decide how much importance to place on the role of domestic investments in developing the local capital markets.

Nevertheless, no matter what the final asset allocation decisions are, our findings present strong evidence to at least support the incorporation of some international assets into the pension portfolios. Globalization may lead to increasing correlations among world financial markets in the coming years, but it can also lead to a sense of shared destiny for the people of the world. International diversification of pension assets, especially in an individually managed defined-contribution pension where people can directly observe the process, would provide a way for people to feel more connected to the world community.

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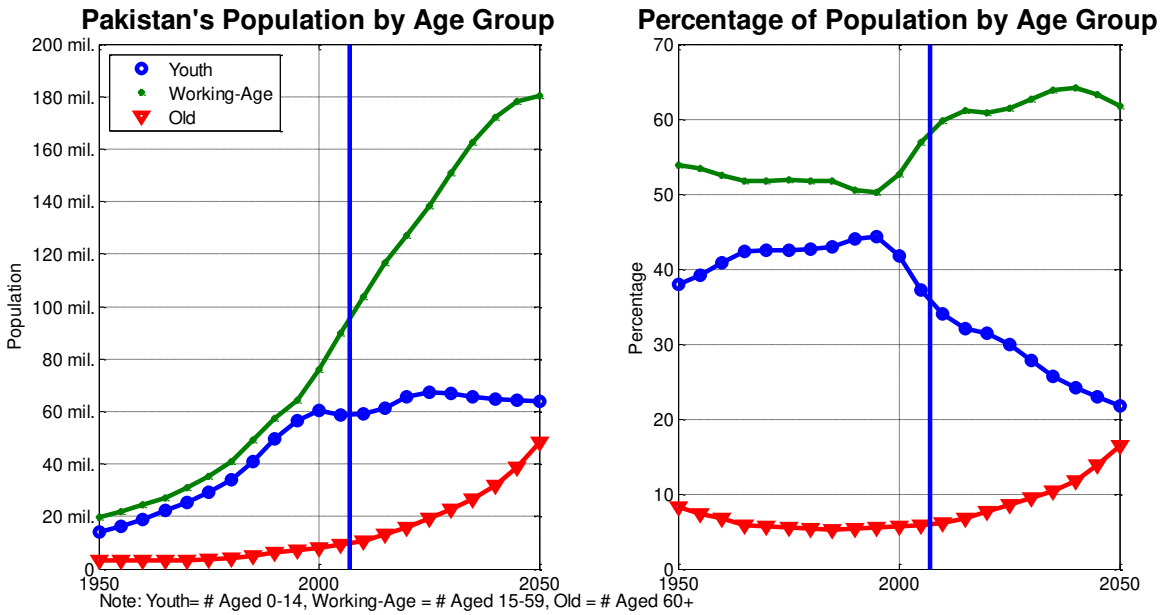
Figure 1



Note: Youth= # Aged 0-14, Working-Age = # Aged 15-59, Old = # Aged 60+
Source: United Nation's World Population Prospects, The 2006 Revision (Medium Projections)

TABLE 1
Details of the EOBI Fund

	FY99	FY00	FY01	FY02	FY03	FY04
	Balance Sheet (Billions of PKR)					
Fund Assets at Year Start	30.3	35.9	41.5	47.9	58.9	69.3
(+) Employer & Employee Contributions	1.4	1.5	1.7	1.9	2.3	2.7
(+) Income from Assets	5.0	5.4	6.3	8.4	10.3	12.0
(-) Benefit payments	0.7	0.9	1.3	1.4	1.6	1.7
(-) Administrative Costs	0.2	0.3	0.3	0.5	0.5	0.6
Fund Assets at Year End	35.9	41.5	47.9	58.9	69.3	81.6
Year End Fund Assets as a % of GDP	1.2%	1.1%	1.2%	1.3%	1.4%	1.4%
Stock Market Capitalization as a % of GDP		10.3%	8.2%	9.4%	15.7%	25.2%
	Asset Allocation (%)					
Government Securities	90.39	91.10	93.09	96.14	93.85	91.73
Equities	0.10	0.08	0.08	0.23	1.82	4.57
Other	9.51	8.82	6.82	3.63	4.33	3.70
	Approximate Returns on Assets (%)					
Government Securities	18.36	16.50	19.36	14.60	15.35	14.71
Equities	1.48	2.59	2.96	79.47	29.50	28.58
Other	18.61	16.19	18.31	12.70	6.69	3.82

Note: Returns on assets are calculated as income from assets divided by asset value at year start.
Sources: Fund information: State Bank of Pakistan (2003) and State Bank of Pakistan (2004); Stock Market information: State Bank of Pakistan (2005); GDP information: IMF IFS; Own calculations.

TABLE 2
Historical Values for Time Series Economic Data
(Annual Returns, 1993 - 2006)

		Nominal Returns & Risks			Real Returns & Risks		
		Arithmetic Mean	Standard Deviation	Geometric Mean	Arithmetic Mean	Standard Deviation	Geometric Mean
Pakistan Stock Market		18.3	46.4	9.0	9.6	44.2	0.8
Pakistan 10 Year Treasury Bonds		14.9	15.7	13.9	6.5	16.5	5.3
Pakistan 6 Month Treasury Bills		9.3	3.9	9.2	1.1	4.1	1.0
Exchange Rate (USD / PKR)		-5.8	5.8	-6.0	-12.8	6.9	-13.1
World Stock Market	(in USD) (hedged)	9.3	15.7	8.1	1.0	14.2	-0.1
	(in PKR) (unhedged)	16.7	19.1	15.0	7.7	17.0	6.3
World Bond Market	(in USD) (hedged)	7.0	6.7	6.8	-1.0	7.1	-1.2
	(in PKR) (unhedged)	14.0	10.1	13.6	5.4	9.0	5.0
Inflation		7.5	3.5	7.4	---	---	---

Correlations

	Pakistan Stock	Pakistan Bond	Pakistan Bills	World Stock (PKR)	World Bond (PKR)	FX (USD / PKR)	World Stock (USD)	World Bond (USD)	CPI
Pakistan Stock	1	0.300	-0.166	-0.058	-0.053	0.143	-0.059	0.042	-0.120
Pakistan Bond	0.363	1	0.159	-0.658	-0.035	0.181	-0.729	0.136	-0.276
Pakistan Bills	0.007	0.502	1	0.249	0.448	-0.691	-0.027	-0.062	0.402
World Stock (PKR)	-0.060	-0.618	-0.006	1	0.447	-0.541	0.925	0.083	0.365
World Bond (PKR)	0.002	0.135	0.433	0.328	1	-0.686	0.200	0.705	0.215
FX (USD / PKR)	0.241	0.422	-0.003	-0.461	-0.335	1	-0.188	0.030	-0.256
World Stock (USD)	-0.043	-0.642	-0.184	0.919	0.105	-0.133	1	0.086	0.311
World Bond (USD)	0.147	0.381	0.225	-0.049	0.695	0.392	0.013	1	0.010

Note: Upper triangle of correlation coefficient matrix represents nominal data, while lower triangle represents real data.
Source: A full description of sources and calculation methods is provided in the "Methodology and Data" section.

TABLE 3
Pakistan Asset Allocation for Varying Degrees of Risk Aversion,
Based on Annual Data, 1993-2006

With Nominal Data

		Risk Aversion Coefficient					
		1	2	3	4	5	10
Return (%)		16.4	16.0	15.9	15.8	15.8	15.7
Risk (%)		11.4	8.3	7.6	7.4	7.3	7.1
Portfolio Weights (%)	Pakistan Stocks	13.3	5.4	2.7	1.5	0.8	0.4
	Pakistan Bonds	27.1	42.5	47.7	50.0	51.3	51.7
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.0
	World Stocks	59.6	52.1	49.6	48.5	47.8	45.3
	World Bonds	0.0	0.0	0.0	0.0	0.0	2.6
Percent Stocks		72.9	57.5	52.3	50.0	48.7	45.7
Percent International		59.6	52.1	49.6	48.5	47.8	47.9

With Real Data

		Risk Aversion Coefficient					
		1	2	3	4	5	10
Return (%)		7.7	7.3	7.2	7.2	7.1	7.1
Risk (%)		11.0	8.3	7.7	7.5	7.4	7.3
Portfolio Weights (%)	Pakistan Stocks	14.2	5.3	2.4	1.2	0.9	0.3
	Pakistan Bonds	25.0	39.6	44.2	46.2	46.5	46.6
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.0
	World Stocks	60.7	55.1	53.4	52.6	51.8	48.8
	World Bonds	0.0	0.0	0.0	0.0	0.8	4.3
Percent Stocks		75.0	60.4	55.8	53.8	52.7	49.1
Percent International		60.7	55.1	53.4	52.6	52.6	53.0

Source: Own calculations using data in Table 2.

TABLE 4
The Impact of Constraints on Pakistan Asset Allocation for Varying Degrees of Risk Aversion, Based on Annual Data, 1993-2006

With Nominal Data

		Risk Aversion Coefficient					
		1	2	3	4	5	10
Unconstrained Portfolio							
	Return (%)	16.4	16.0	15.9	15.8	15.8	15.7
	Risk (%)	11.4	8.3	7.6	7.4	7.3	7.1
Optimal Portfolio When World Assets Are Prohibited							
	Return (%)	15.5	15.2	14.0	12.8	12.2	10.8
	(percent change in return)	-5%	-5%	-12%	-19%	-23%	-31%
	Risk (%)	17.4	16.2	12.7	9.9	8.2	5.2
	(percent change in risk)	53%	95%	67%	34%	12%	-26%
Port. Wts.	Pakistan Stocks	18.6	9.8	7.3	6.0	5.2	3.6
	Pakistan Bonds	81.4	90.2	71.3	53.5	42.8	21.5
	Pakistan Bills	0.0	0.1	21.4	40.5	52.0	75.0

With Real Data

		Risk Aversion Coefficient					
		1	2	3	4	5	10
Unconstrained Portfolio							
	Return (%)	7.7	7.3	7.2	7.2	7.1	7.1
	Risk (%)	11.0	8.3	7.7	7.5	7.4	7.3
Optimal Portfolio When World Assets Are Prohibited							
	Return (%)	7.1	6.8	5.2	4.1	3.4	2.3
	(percent change in return)	-8%	-7%	-28%	-43%	-52%	-68%
	Risk (%)	18.2	17.0	12.8	9.9	8.3	4.9
	(percent change in risk)	66%	105%	66%	32%	11%	-32%
Port. Wts.	Pakistan Stocks	19.1	10.6	7.1	5.8	5.1	2.6
	Pakistan Bonds	80.9	88.9	65.1	46.4	35.1	17.4
	Pakistan Bills	0.0	0.5	27.8	47.8	59.9	80.0

Source: Own calculations using data from Table 2.

TABLE 5
Robustness of Optimal Asset Allocation
for Varying Assumptions About Pakistan Assets (Risk Aversion = 5)
Based on Annual Nominal Data, 1993-2006

Varying Returns for Stocks							
		Pakistan Stocks (18.3%)			**World Stocks (16.7%)**		
		16.0%	**24.0%**	**28.0%**	**8.0%**	**12.0%**	**24.0%**
Return (%)		15.7	16.3	17.1	14.5	14.2	20.6
Risk (%)		7.2	8.2	9.2	8.5	7.5	9.1
Portfolio Weights (%)	Pakistan Stocks	0.0	6.6	10.7	4.3	3.3	0.0
	Pakistan Bonds	52.1	46.8	43.4	30.2	39.0	37.7
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.0
	World Stocks	47.3	46.6	45.9	0.0	15.3	62.3
	World Bonds	0.5	0.0	0.0	65.4	42.4	0.0
Varying Volatility for Stocks							
		Pakistan Stocks (46.4%)			**World Stocks (19.1%)**		
		17.5%	**25.0%**	**55.0%**	**10.0%**	**25.0%**	**47.5%**
Return (%)		16.4	16.0	15.8	16.2	15.6	15.0
Risk (%)		7.9	7.6	7.3	5.4	8.0	8.6
Portfolio Weights (%)	Pakistan Stocks	25.2	10.0	0.6	1.3	0.2	1.7
	Pakistan Bonds	35.6	45.2	50.4	29.0	61.3	58.4
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.0
	World Stocks	39.2	44.8	48.0	69.7	38.4	15.2
	World Bonds	0.0	0.0	0.9	0.0	0.2	24.7
Varying Returns for Bonds							
		Pakistan Bonds (14.9%)			**World Bonds (14.0%)**		
		6.0%	**9.0%**	**21.0%**	**12.0%**	**18.0%**	**21.0%**
Return (%)		15.1	14.7	19.5	15.8	17.5	20.9
Risk (%)		10.4	9.6	7.6	7.3	8.5	9.8
Portfolio Weights (%)	Pakistan Stocks	9.4	8.1	0.0	1.3	3.7	1.7
	Pakistan Bonds	0.0	8.2	64.5	50.6	13.3	1.6
	Pakistan Bills	0.1	0.0	0.0	0.1	0.0	0.0
	World Stocks	24.4	28.8	35.5	48.0	5.3	0.0
	World Bonds	66.1	55.0	0.0	0.0	77.7	96.7
Varying Volatility for Bonds							
		Pakistan Bonds (15.7%)			**World Bonds (10.1%)**		
		6.0%	**12.0%**	**24.0%**	**3.0%**	**6.0%**	**12.0%**
Return (%)		15.4	15.7	16.0	15.5	15.8	15.8
Risk (%)		4.1	6.3	8.8	6.3	7.2	7.3
Portfolio Weights (%)	Pakistan Stocks	1.3	1.0	1.6	1.2	0.9	1.3
	Pakistan Bonds	72.3	57.8	38.6	42.1	50.6	50.6
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.1
	World Stocks	26.4	41.2	57.9	39.4	47.0	48.0
	World Bonds	0.0	0.0	2.0	17.4	1.6	0.0

Note: #'s in parentheses next to asset names are the baseline historical values from Table 2.
Source: Own calculations using data from Table 2.

TABLE 6
Robustness of Optimal Asset Allocation
for Varying Assumptions About Correlation Coefficients (Risk Aversion = 5)
Based on Annual Nominal Data, 1993-2006

		Pak. Stocks & Pak. Bonds (0.300)			**World Stock & World Bonds (0.447)**		
		-0.500	**0.000**	**0.600**	**-0.333**	**0.000**	**0.333**
Return (%)		16.0	15.9	15.8	15.4	15.6	15.8
Risk (%)		4.8	7.1	7.2	5.1	6.4	7.2
Portfolio Weights (%)	Pakistan Stocks	12.4	5.5	0.0	1.4	1.1	1.1
	Pakistan Bonds	49.3	49.1	49.8	36.2	44.0	50.4
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.0
	World Stocks	38.4	45.4	48.6	38.2	41.5	47.2
	World Bonds	0.0	0.0	1.6	24.2	13.4	1.3
		Pak. Stocks & World Stocks (-0.058)			**Pak. Stocks & World Bonds (-0.053)**		
		-0.500	**-0.167**	**0.250**	**-0.500**	**0.000**	**0.667**
Return (%)		16.2	15.8	15.7	15.8	15.8	15.8
Risk (%)		6.9	7.3	7.2	7.3	7.3	7.3
Portfolio Weights (%)	Pakistan Stocks	10.6	2.9	0.0	1.6	1.2	1.2
	Pakistan Bonds	39.2	49.6	49.8	49.8	50.5	50.5
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.0
	World Stocks	50.2	47.5	48.4	47.5	47.7	47.7
	World Bonds	0.0	0.0	1.8	1.1	0.6	0.6
		Pak. Bonds & World Stocks (-0.658)			**Pak. Bonds & World Bonds (-0.035)**		
		-0.333	**0.000**	**0.667**	**-0.500**	**-0.167**	**0.300**
Return (%)		15.4	15.1	14.5	15.5	15.8	15.8
Risk (%)		8.9	9.1	8.7	6.4	7.2	7.3
Portfolio Weights (%)	Pakistan Stocks	3.4	4.9	4.6	0.8	1.1	1.3
	Pakistan Bonds	38.9	28.7	28.3	46.6	50.4	50.6
	Pakistan Bills	0.0	0.0	0.0	0.0	0.0	0.1
	World Stocks	34.2	21.6	2.7	39.9	47.2	48.0
	World Bonds	23.5	44.9	64.4	12.8	1.3	0.0

Note: #'s in parentheses below asset names are the baseline historical values from Table 2.

Source: Own calculations using data from Table 2.