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Pension Fund Investment and Regulation

- a Macro Study

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Abstract:

Pension fund assets have been accumulated rapidly during the past decades, and it is evident that this trend will continue. An immediate problem arising from the rapid accumulation of such a large volume of assets across countries is how to invest them. Pension funds differ from other institutional investors, e.g. mutual funds, in that their investment horizons are relatively long, typically 30-40 years. In addition, they are pooled assets to support people's retirement lives. The authorities have a policy concern about their investment performance, because otherwise, the shortfalls will have to be met by the nation state (Clark and Hu 2005a). In this paper, we seek to address this issue from the macro perspective. By using a unique dataset covering 39 countries (17 EMEs and 22 OECD) and based on the classic mean-variance optimisation approach, first we find a negative impact of international portfolio investment restrictions on pension fund returns and risk, and this issue is particularly serious for EMEs. Following a shift from the QAR to the PPR, the average risk is expected to fall by 27% for EMEs pension funds, while the figure is 10% for OECD pension funds. Second, there is evidence that if higher portfolio returns are wanted, higher proportion should be invested in equities and foreign assets. Third, our results show that pension funds should value the diversification benefit arising from property investment (Booth 2002).

Key words: Pension fund regulation, pension fund portfolio, mean-variance framework, prudent person rule

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1. Introduction

People are living longer, and how to tackle the problem of ageing population is at the top of governments' agendas. The key current trend regarding social security systems is the shift from unfunded schemes, e.g. pay-as-you-go (PAYG) to funded schemes. The Aaron (1966) conditions state that if the market return is greater than the population growth rate, funded pension systems are more appropriate. However, funded plans have been also argued to be related with some drawbacks, e.g. high transition costs. Despite the topical debate about the merits and demerits of funded systems, many governments across the world have shown strong interest in funded pension schemes, not least due to the efforts from the World Bank (Holzmann and Hinz 2005).

Consequently, pension funds, defined as accumulated assets contributed by sponsors and beneficiaries to provide for the deferred future pension entitlements of beneficiaries (Davis 1995, Bodie and Davis 2000), have increased markedly across the world during recent decades (Davis and Hu 2005a; OECD 2005).

As highlighted in Davis and Hu (2005a), pension fund markets in OECD countries have witnessed a noticeable increase in pension assets. For example, UK pension assets were equivalent to 115.6 billion US dollars in 1980, (21.5% of GDP), but in 2000 these two figures rose to 1226.3 billion US dollars (85% of GDP). Many other OECD countries also saw the same trend. Meanwhile, as of 2000, total pension fund assets across 18 selected advanced OECD countries reached the level of US$12 trillion. The US was the biggest pension market, accounting for just above half of the whole assets. Two other major countries were Japan and the UK. In terms of pension assets relative to GDP, the Netherlands had the largest figure at 149% of GDP, while this figure for New Zealand was 0.69%, the smallest across OECD countries.

As for emerging market economies (EMEs), Chile witnessed its pension funds, growing from zero in 1980 to 60 per cent of GDP as of 2002 (latest figure was 65% as of 2003, see OECD 2005). The biggest EME pension markets, however, were Singapore and Malaysia, two countries which adopted provident pension systems in the 1950s. Total pension assets across 29 selected EME countries were US$ 280 billion, while the average pension asset to GDP ratio was 12%, much less than OECD countries' 42%.

It is virtually certain that pension funds will continue their rapid expansion during the coming decades. An immediate problem arising from such a large volume of assets across many countries is how to invest them. Pension funds are different from other institutional investors, e.g. mutual funds, in that their investment horizons are relatively long, up to 40 years. In addition, other institutions, e.g. mutual funds, tend to only undertake security selection by specifying the assets invested, while pension funds usually consider both security selection and asset allocation (Davis and Steil 2001).

Meanwhile, since pension funds are pooled assets to support people's retirement lives, national governments have a particular concern about their investment performance and associated risk. If pension funds are managed poorly, and unable to pay incomes to retirees in due time, governments may have no political choice, but to incur fiscal costs to meet up these losses (Clark and Hu 2005a). Hence, how to ensure pension funds are managed in an appropriate way is becoming an increasingly important issue for national governments. In this paper, we seek to address this issue, from the macro perspective. Our ambition in this paper is not to provide commercial advice at a micro level about how to allocate pension fund assets, but rather, from the perspective of regulators, to give a formal assessment of the presence of beneficial effects when investment is liberalised. Specially, we seek to make four contributions. First, we quantitatively investigate whether international diversification benefits exist, and if so, what is the extent. Second, are such effects different across OECD countries and EMEs? Third, we construct and use our own series of global equity/bond returns which are expected to be immune to country specific shocks. Fourth, we use a dataset of asset returns which is the largest in the current pension literature to assess optimum portfolios.

The remainder of the paper is organised in the following manner. Section 2 addresses the issue of investment strategies employed for different pension plans. In Sections 3 and 4, we consider arguments for and against portfolio restrictions, particularly on foreign investment. In section 5 using the mean-variance framework, we seek to empirically analyse whether pension fund investment restrictions on foreign assets by the national regulators are justified. In this section, we use a dataset covering 39 countries, including both OECD countries and EMEs. Section 6 concludes the paper.

2. Pension fund investment

The general trend of current company pension fund sector development is away from defined benefit (DB) to defined contribution (DC) pension plans by many businesses. One of the key differences between these two types of pension plan is who bears the investment risk (Baker et al 2005; Clark and Hu 2005b). For the former, pension benefits are defined in that they are always a certain percentage of the employee's final salary, regardless of the fund management's performance. In this context, plan sponsors bear the investment risk. If pension fund investment is run badly, plan sponsors have the obligation to make good such losses by using their own assets. In contrast, for the DC plans, the investment risk is transferred to the individual employees. Plan sponsors make payments to DC plan participants' accounts by matching employees' contributions. Meanwhile, besides company funds, pension assets could be managed in a more individualised way, in that plan participants are always left to decide how to invest their assets from a range of different fund managers, like in the US 401(K) plans and in the Australian Superannuation Funds (Clare 2005). For DC plans, however, any investment risk falls on individuals, although the risk is ultimately borne by the government. The underlying rationale is that, as a result of bad investment returns, any shortfall might have to be met by the state if either DC or DB schemes cannot deliver sufficient supplementary income to avoid pensioner poverty and income inequality (Clark and Hu 2005a).

2.1 Investment strategies for defined contribution plans

In recognition of the difference between these two types of pension plan, it is argued that different investment strategies are applicable to DC and DB pension plans (Bodie 1998; Davis 2001). Specifically, in the context of defined contribution plans, as noted earlier, risks are transferred to plan participants, and the sponsors do not need to worry too much about the performance of the pension funds. Therefore, the investment process should focus on the asset side only, with liabilities being an insignificant issue. In other words, fund managers should closely follow the portfolio investment theory, i.e. the mean-variance approach. As regards the mean-variance approach, the mean is referred to as the expected return from the various investment assets in the portfolio, e.g. bonds, equities, etc., while variance is the corresponding risk. This approach holds that a DC pension fund should in principal maximise expected return for a given risk, so as to attain as high as possible a replacement ratio[2] at retirement. In addition, Blake (1997) argues that, in order to find the optimal asset combination along the optimal frontier, it is always sensible first to determine the risk preference of investors, then, based on the risk level, to find out expected returns. According to this rationale, Blake suggests that pension assets be directed to risky but high return assets, e.g. equities, when the fund is immature or the duration is relatively long, while bonds investment should be given more weighting when the fund becomes mature.

Specifically, the optimal portfolio of pension funds is contingent upon an investor's investment horizon. Normally, young people should invest more in risky assets, e.g. stocks, while the older person is relatively conservative and more willing to buy safe assets, e.g. government bonds. This is in line with the assertion that risk aversion rises with age. This argument, as a rule of thumb by financial planners, however, is not consistent with financial theories (Cahill and Campbell 2004). For example, Markowitz (1991) argues that for any rational investor, young or old, the optimal investment portfolio should combine risk-free assets, e.g. treasury bills, and risky assets, e.g. bonds and stocks, which also refers to the classic two-fund separation theory (Copeland and Weston 1992). According to this theory, when it is needed to consider a less risky investment, it simply means a fund shift from risky portfolio to risk-free assets, i.e. treasury bills. Through this movement, it is not necessary to change the risky portfolio's asset mix. In addition, Bodie (2004a) highlights that there is no necessary connection between investment horizon and risk aversion. Investors with long time horizons might be risk averse, while those with short time horizons might be risk lovers. For example, a wealthy businessman in his 50s might not be as risk averse as a young worker who does not have a permanent job. Therefore, the classic financial theory implies that the optimal asset allocation has nothing to do with time horizons and ages.

When analysing pension fund investment, conventional financial theory, however, might be flawed or inappropriate, if not allowing for other factors. The point relates to labour income. Campbell and Viceira (2002) consider future labour income to be a risky asset, which in their view should be matched by some type of risky assets, e.g. stocks, in terms of funds investment. Therefore, the more future labour income, the more investment in risky assets. Consequently, young people, compared with old/retiring people should invest more in risky assets, e.g. stocks, in that they have a relatively long time to retire, and labour income comprises a large portion of their life-long wealth/portfolio. When approaching retirement, which implies that a smaller proportion of life wealth portfolio is made up of future labour income, and also given that labour income should be always matched by a corresponding amount of high risk assets, then the investment portfolio should tilt towards less risky assets, e.g.

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[2] Replacement ratio is defined as the ratio of pension income to the final salary.

government bonds. This argument is the extension of an earlier work by Bodie, Merton and Samuelson (1992), where they show that if future labour income is certain, optimally employed investors should hold proportionally more stocks in their portfolios than retired investors. This result applies whether labour supply is flexible or not. When there is greater labour supply flexibility, employed investors are advised to take more risk by investing in stocks.

The arguments above are also consistent with the theoretical model designed by Viceira (2001). The author assumes that labour income is perfectly correlated with the value of human capital, and the return on human capital is given by the percent change in labour income. By deriving an approximate analytical solution of the model it is proved that the fraction of savings invested in risky assets increases/falls with age in the early/late part of the life-cycle. The finding is in line with the standard life-cycle model (Ando and Modigliani 1963), as depicted by the hump-shaped form of saving pattern, which might induce a similar pattern in the percentage of assets invested in risky assets, e.g. equities. Using numerical simulations on models with risky labour income, Heaton and Lucas (1997) and Koo (1998) find that investors should hold most of assets in equities, indicating the importance of high-return assets in common investors' asset portfolio. Meanwhile, if it is assumed that short selling is allowed, they find that investors are even willing to sell short bonds and use the proceeds to buy equities.

2.2 Investment strategies for defined benefit plans

As mentioned above, in DB plans, the sponsors are not only responsible for making contributions to the plan, but they are also obliged to guarantee a pre-determined retirement benefit. Therefore, a strategy considering both assets and liabilities is more sensible, which means matching pension assets and pension liabilities, in terms of maturity and value.

Regarding the pension liabilities, there are three commonly used definitions (Holzmann et al 2004). The first one is known as the accumulated benefit obligation (ABO), which is equal to the accumulated pension obligations if the pension plan were closed down completely at the time of calculation. The second definition is the projected benefit obligation (PBO), which, unlike the ABO, is based on the assumption that the plan would not be terminated completely at the time of calculation, and allowed to continue until all plan participants died, i.e. they carry on working, contributing and getting salary rises. The last one is the indexed benefit obligation (IBO), in which, liabilities are calculated by indexing retirement pension to wage increases or prices. In comparison to the first two definitions, the IBO is less popular in current practice, as indicated in Davis (1995) and Holzmann et al (2004).

Regarding the ABO and PBO, there is no definite answer about which one is better, and it depends on specific conditions. If the analysis is at the macro level, for example, involving a calculation about the level of national implicit pension debts, the PBO is preferred, since pension payment is kind of debt underwritten by the government or sponsor, and it has to be paid periodically until all participants die. In contrast, if the analysis is at the micro level, i.e. for a particular company, Bodie (2004b) argues that the ABO, as the actual economic cost associated with the DB scheme sponsors, is an appropriate definition to use. In other words, from the economic and shareholders' perspective, the pension obligations guaranteed by the company is the accumulated obligations, rather than the projected ones. The intuition is that if a firm goes into bankruptcy, the shareholders are obliged to pay off the losses according to the ABO calculation, but subject to the constraint of the residual funds, while the difference between these two estimates based on the ABO and PBO is met by the government through the Pension Benefit Guarantee Group (PBGP) in the US, the Pension Protection Fund (PPF) in the UK, or via general fiscal assistance.

Davis (2005a) argues that if the plan sponsor seeks to fund the accumulated benefit obligation, and the obligation is nominal, i.e. without price-indexation, then the strategy of portfolio immunisation is most appropriate. Immunisation is the process of constructing a portfolio that has no interest rate risk (Luenberger 1998), with the present value and duration[3] of the future obligation of pension funds matching those of the portfolio, mainly fixed-income assets, e.g. bonds. Another related case is whereby the sponsor agrees to make price or inflation indexed pension payment at retirement. Immunisation in principal is still the best choice, but in this context, long-term inflation protected bonds should be used. Bodie (2001, 2004b) is a strong proponent of the only-bonds investment strategy. He does not believe equities offer higher returns and inflation protection in the long run. In contrast, he suggests default-free and inflation protected government bonds are the most sensible investment instrument for retirement provision. Any other investment policy, he argues that, unnecessarily increases the risk borne by the employees or the shareholders of the corporation. Consistent with such argument, the UK's Boots pension funds switched all assets into bonds in 2001 (Blake 2003a).

Bodie's arguments are to some extent in line with the analysis by Campbell and Viceira (2001), who note that long-term bonds are appropriate financial instruments to provide a stable income stream to long-lived risk-averse investors. In the paper, they attribute the investor's demand for long-term bonds to two reasons, i.e. speculative purpose and hedging purpose. The former arises from the fact that holding long-term bonds has a term premium, in comparison to short-term bonds and treasury bills, while the latter relates to long-term bonds' desirable property of providing a stable income stream in a long term. Their findings are stronger if index-linked, rather than nominal, long-term bonds are used. As noted by Davis (2002) and Hu (2005a), however, such long-term bonds with price protection are not available in many countries. Even in those countries, like the UK and the US where financial markets are deepest, total outstanding inflation-indexed government bonds were much less than the aggregated pension fund assets (GFSR 2004). For example, in the UK, as of 2003, inflation-indexed government bonds were at the order of \$139bn, while pension assets were \$954bn. Unless the inflation-protected bond market undergoes a significant growth, and reaches a high level in the near future, the all-bond investment strategy for pension plans is not feasible at the national aggregate level.

Partly due to the scarcity of long term, particularly index-lined bonds (de Martel 2004), a mismatch between pension funds' cash flows and liabilities always emerges (Ryan 2004). It basically means that in some years, cash flows from bond investments are greater than the corresponding liabilities, while in other years, the opposite

[3] The duration of a fixed-income instrument is the weighted average of the times that payments (cash flow) are made, and it always lies between the first and last cash flows. For the zero-coupon bond, however, the duration equals its maturity date, as the only and final payment is made at maturity.

happens. Such a cash mismatch can lead to inefficient asset distribution over the life of pension plans, as well as sub-optimal portfolio risk budgeting (Sharpe 2002). Another similar concept is "gap risk" (Siegel 2003), which gives rise to the same consequence, i.e. a cash mismatch. The underlying reason, however, is different. As for pension funds in many countries, fund managers' performance is often evaluated against a strategic benchmark. Those benchmarks, by definition artificial, reflect the issuance pattern in the market. For example, for a bond benchmark, the duration and cash flow profile is simply a weighted average based on the market weightings of major bonds with different maturities. Given low weights of long dated bonds, the strategic bond benchmark reflects more information on short or medium bonds, typically 10 or 15 years bonds. In this context, the traditional bond benchmark is not appropriate, since the duration of pension liabilities is normally quite long, e.g. 20 years or longer. Therefore there is a gap, arising from the popular investment practice where fund managers mange pension funds with long durations against relatively short benchmarks.

To minimise the cash flow gap between assets and liabilities over the life of DB plans, particularly those plans linked to inflation and wage increases, major fund mangers have introduced new financial products into the market. For example, in early 2005, SSgA (State Street Global Advisors) marketed its new product, i.e. PALMs (Pooled Asset Liability Matching Solution) (Dootingh 2005). The product involves the exploitation of inflation-linked swap market, aiming to match pension assets and liabilities at a greater certainty. In addition, the period could range from few years to 40 years, long enough to cover most pension funds. In addition, given the significant impacts of changes in inflation and interest rates on DB plans' liabilities (Clark and Hu 2005b), CSFB (Credit Suisse First Boston, 2005) argues that hedging techniques need to be employed. For example, their simulation results show that by conducting a 40-year hedging programme, the level of both interest rate and inflation risks in a representative DB pension fund could be reduced by up to 75%, thus leading to a better match between assets and liabilities. CSFB's argument is consistent with recent findings by Engle et al (2005), where they find the beneficial impacts of interest rate swaps on the risk-return profile of a typical DB plan, by using a scenario-based ALM model.

Recent developments in new financial products, as discussed above, reveal the importance of matching assets and liabilities in DB plans. Similarly, actuaries use returns on the assets to discount liabilities; in this context, the asset-liability mismatch is minimised. The actuarial practice sounds reasonable, however, it is groundless, at least economically, since if assuming it is correct, the natural implication is that pension liabilities could be reduced by investing in risky and high-return assets. Largely due to this concern, pension accounting has undergone major changes, i.e. a gradual move to the fair value or mark to market approach (Skerratt 2002; Fore 2004), for example the IAS (International Accounting Standards) 19. Although from the economist's perspective, the traditional practice of discounting liabilities in the actuarial industry is wrong, it addresses an important aspect of pension fund investment, i.e. understanding liability evaluation and asset allocation at the same time. Inkmann and Blake (2004) argue that in the current literature and practice, the valuation of liabilities and the optimal allocation of pension assets are considered to be two separate processes. They further argue that it is dangerous in that it ignores the inter-linkage between these two issues. To counter this shortcoming, they design a theoretical model by combining these two parts together. With numerical examples, it is found that the default spread (the likelihood that the promised pension payment cannot be delivered) has a negative relationship with equity investment, i.e. the more investment in risky assets, i.e. equities, the less likely that a company cannot cover the value of the pension liabilities.

If the obligations are based on the PBO methodology, Davis (2005a) considers risk diversification to be the most appropriate investment approach. The underlying reasoning is that the projected benefit obligation is associated with more risk, which is implied by the ongoing nature of the liabilities calculation. Labour earnings growth is relevant in this case, in that the workers accrue benefits as salaries rise. Consequently, in order to reduce the risk as much as possible, a risk diversification strategy should be utilised. A variety of assets are available in the markets, and all serve as potential investment instruments, e.g. bonds, equities, and property (Booth 2002) and even hedge funds (IPE 2004; Kat 2005). Given the different risk and return characteristics of various assets (Davis 2001; Watson Wyatt 2004) and based on finance theory, in general the risk of pension portfolio is smaller, if more different classes of assets are included. Even within the same asset class, it is likely to achieve diversification. Siegel and Waring (2004) argue that for diversification purpose, a combination of index-linked bonds with equities is less desirable than that with nominal bonds. The reason is that returns on index-linked bonds and equities are much more closely correlated than those between index-linked bond and nominal bonds, which in turn arises from the common inflation protection feature associated with equities and index-linked bonds.

Among all the available assets, one class of assets, which have been a close focus of interest in the arena of pension fund regulation, is foreign assets. Given the importance of this issue, we will discuss it in the next section.

3 International investment

3.1 Arguments in favour of international investment

Modern finance theory (Levy and Sarnat 1970; Solnik 1998) believes that international investment in a portfolio offers better diversification, which implies a lower risk for a given return, or a higher return for a given risk. Figure 1 graphically illustrates the benefits of global diversification. For example, when the risk is fixed at the level of 21% (proxied by standard deviation), a purely domestic investment for a US investor can achieve a return at the level of 16%. When foreign opportunity is utilised, however, the potential return can rise to 20% with no short sales, and 23% with short sales. Similar benefits, also available for other countries as shown in Figure 1, mainly result from the elimination of unsystematic risk. The volatility or risk could be decomposed into two kinds of risks, i.e. unsystematic risk and systematic risk for international portfolios. The former is always referred to as the risk specific to a particular country, while the latter is the risk relevant to the whole global economy. Given that the former is only associated with some particular countries, therefore, the strategy of international investment could be employed to remove them, whereas as regards the latter, whatever the portfolio construction, it is not possible to eliminate them.

In the context of international investment, therefore, an appropriately constructed global portfolio should in principle be able to eliminate any unsystematic risk. Although both OECD countries and EMEs can benefit from global diversification, it is argued that the beneficial impacts on EMEs are larger (Reisen, 1997; Section 5 in this paper). This is largely due to high volatilities suffered by the financial markets in EMEs, as well as the lesser correlation between domestic and international markets. Based on a large dataset covering equity markets in more than 80 countries and with the observation period back to 1850 in many cases, Goetzmann et al (2005) find that emerging markets serve as an important and useful component to expand the opportunity set of a fully diversified portfolio, thus justifying across-border investments between advanced and emerging markets. In addition, the financial underdevelopment in EMEs (Davis 1998; Vittas 2000; Hu 2005c), i.e. lack of experience of financial regulators, weak accounting practice, is suggestive of investing abroad.

As noted at the outset, the underlying reasoning for the global portfolio is that the markets of the world do not move in the same direction, so a downturn in one country can be offset by a rise in another country, which reflects the typical phenomenon of varying business cycles across countries in the medium term (Backus et al 1992). Therefore, international investments allow pension funds to be less vulnerable to domestic growth, which is not feasible for PAYG systems. In a long run, the different aging process and demographic structure of different countries, notably developed and developing countries, can also justify the cross-country investment (Davis 2005a). In emerging markets, the capital-output ratio normally is quite low, which is associated with the high rate of return to capital. Therefore, the higher returns in emerging markets stimulate capital outflows from ageing regions, e.g. Europe and Japan. Such capital movement between countries has been argued to be mutually beneficial. For the outflow countries, like the UK, investment diversification is achieved by seeking higher returns, while for the inflow countries, like China, economic growth is boosted as the capital inflow spurs the productivity. It is worth noting, however, that if such capital flows cease abruptly, it can cause macro disruption to recipient countries.

The classic mean-variance approach traditionally relies on the assumption of symmetric risk, i.e. equity markets move proportionally or in same magnitude following good and bad news. The reality, however, is that in many cases, the risk is asymmetric, i.e. equity markets become more volatile after negative return shocks, than positive news (Davis 2003). To answer the question whether global diversification benefits exist when they are most needed, i.e. in bear markets, Thorp and Milunovich (2005) incorporate asymmetric risk into their model. Their numerical examples show that the international investment benefit is still available, and the asymmetric risk model they used can even lead to more benefits than traditional/symmetric risk model. The finding, however, is only available for long-horizon investors.

Concerning the beneficial effects arising from investment from developed countries to emerging markets, Holzmann (2000), however, argues that such investment can only mitigate, rather than solve the aging problem. By drawing on simulation results by MacKellar et al (1999), he notes that in contrast with the scenario without foreign capital flow, the scenario with free foreign capital flow only causes global GDP to increase slightly, e.g. 0.53% in 2020, and 1.04% in 2050. In this context, the fast aging countries (FAC) face a decreasing GDP due to more capital outflows and the slow ageing countries (SAC) face an increasing GDP due to more capital inflows.

The reverse capital flows from the FAC (developing countries) to the SAC (developed countries), mentioned here, have been doubted by some commentators. In fact, recent experience has SAC's lending to FAC via foreign exchange reserves. For example, Wolf (FT 2005) notes that if emerging markets are to lend on a vast scale to any government, it should be to their own governments which need capital, rather than accumulating foreign-exchange reserves. Along with the debate on the issue of global saving glut (IMF 2005; SFRC 2005), Bernanke (2005) and Sanyal (2005) argue that foreign reserve accumulation in many emerging markets is justified, if not an optimal strategy, in that it reduces the risk of inefficient asset allocation in the domestic markets, and also serves as a buffer against potential capital outflows in the near future, a lesson learned from the string of painful financial crisis worldwide, e.g. in Mexico in1994, in South Asia in 1997-98, in Russia 1998, and in Argentina in 2002.

3.2 Augments against international investment (home bias puzzle)

As discussed above, modern portfolio investment theory suggests a globally diversified portfolio construction, and any other under-diversified portfolios are subject to unnecessary unsystematic risk which could have been removed. The reality, however, is that on average investors, both institutions and individuals, hold most of their assets in home markets. As regard pension funds, it is revealed that in most countries, pension fund portfolios have much greater allocation to domestic bonds and equities than to foreign assets (French and Poterba 1991; Davis 2005a). For example, as of 2004, the UK's top 100 pension funds allocated 5 per cent of total assets to bank deposits, 23 per cent to domestic bonds, 45 per cent to domestic equities and only 27 per cent to foreign assets (Clark and Hu 2005a). How to explain this phenomenon - known as home bias puzzle?

A variety of arguments have been identified to explain the home bias puzzle. The first is the transaction cost associated with international investment, which includes information cost, bid-ask spread, and trading commission, among others. The transaction costs are not trivial in many cases, and particularly high for those investment in emerging markets, since in order to realise the potential higher returns in the unfamiliar markets, investors have to incur extra costs on information collection, marketing, etc. For example, one recent empirical study by Faruqee et al (2004) finds a negative linkage between transaction/information costs and foreign investment. In that paper, they use an IMF survey dataset covering 23 countries, 3 of which are emerging markets – Malaysia, Singapore, and Hong Kong. One dependant variable is eq_i^j, defined as equities of country j held by the residents of country I (in millions of US dollars) in 1997; this is designed to proxy capital flows between countries. In order to capture the relation between transaction/information costs with eq_i^j, a number of explanatory variables are used, which are $dist_i^j$ (the physical distance between the capital cities of country I and j, lin_i^j (a dummy variable to look at whether the capital inflow and outflow countries use the same language), *phoneline* (the number of main phone lines in use per 1,000 inhabitants in country i), and $phone\cos t_i$ (the per-minute international phone costs from country i to country j during business hours. Their empirical results show that a higher transaction cost does lead to less equity flows between countries. For example, one of their estimations reveals that a one per increase in $dist_i^j$, i.e. distance between countries i and j, results in a 0.559 per cent decrease in eq_i^j , i.e. capital flows from country i to country j. Similar results are also found when expanding the equation by adding more potential explanatory variables, e.g. $phone\cos t_i$.

Meanwhile, Kang and Stulz (1997) find that in the Japanese stock market, foreign investors are more interested in those Japanese firms which have better information access and more open to the investors, even though the returns are not expected to be higher than those from other firms. The explanation for the findings of this observation is that information costs related to such firms are lower, thus they are more attractive to foreign investors. A more recent study by Aggarwal et al (2005) stresses the importance of information transparency to investors. By using data at both country and firm levels, it is found that US institutional investors invest more in emerging markets and firms which have greater accounting transparency as well better legal framework. In addition, by employing Bayesian approaches, Herold and Maurer (2003) find some evidence, supporting the home bias in the US. In line with Muermann et al (2005), they include regret into the analysis, and conclude that the optimal allocation of a typical US investor's pension funds to foreign assets is 12%, when it assumes that regret aversion[4] equals risk aversion. In addition, De Roon et al (2001) investigate the home bias puzzle, and find that if market efficiency is assumed, i.e. no transaction costs and no short sales, there are strong global investment benefits. If transaction costs are taken into account, however, such diversification gains disappear, though the authors admit the possibility of small-sample bias.

Another explanation for the presence of the home bias is that home investment can hedge against the part of wealth that is not tradable or traded in capital markets. This explanation highlights that the capital asset pricing model (CAPM), which is central to calculate the optimal risk and return mix, implicitly assumes that all wealth of investors are liquid and tradable. But this assumption obviously ignores the non-tradable assets, e.g. human capital. Therefore, does this omission explain the home bias? (Lewis 1999). Empirical work by Baxter and Jermann (1997), however, rejects this hypothesis. In that paper, human capital is found to be positively related to both domestic equity and foreign equity, but the correlation with the former is larger. Therefore, they suggest a short-position for domestic equities, and the optimal portfolio should comprise a larger share of foreign equity than the actual portfolio, i.e. to diversify risk. For example, allowing for human capital, whereas foreign equity is found to be 20% in the actual portfolio of the investors, it is in the range of 49% and 69% in the optimal portfolio.

In addition, it is argued that the diversification benefit can be achieved in the same way by holding shares of multinationals, e.g. Ford, British Petroleum, which are all global organisations having presence across many countries. Therefore, economic or

[4] Regret aversion refers to the common people's dislike of the disutility of not choosing the ex-post optimal alternative. For example, if the return on Stock A turns out very high, the investor might regret not having allocated more assets to it.

political conditions in overseas countries would affect the multinationals' profits, and further share prices. For example, good sales of Ford vans in one country, e.g. China would offset weak sales in another, e.g. Russia, which is exactly the underlying rationale behind the diversification theory as noted earlier. This explanation seems to be plausible, but it does not hold empirically (Lewis 1999). Studies have shown that the share prices of multinationals move very closely with the stock market indexes in their home countries, and in some cases, it is near to a one-to-one movement. Therefore, holding shares of multinationals cannot guarantee the diversification benefits arising from a fully diversified portfolio. Meanwhile, even if we assume the argument above is valid, it might only apply to large and advanced economies (Davis 1998), like the US, UK and Germany, etc. where multinationals are headquartered and listed. For most other countries, the home bias is not justified, and hence international investing is still desirable, on the ground that those countries have very few, if any, truly global companies which can readily diversify their operating and business risks. In other words, it is very difficult for a mainly domestic portfolio in such countries to be constructed in a way to achieve a reasonable degree of global diversification as in the US and the UK.

Another relevant argument, doubting the beneficial impacts of global diversification, relates to the shift from country to industry factors (Ferreira and Gama 2004). Traditional wisdom and evidence show that the benefits of diversification mainly arise from investments across countries, rather than industries (Beckers et al 1996; Rouwenhorst 1999). Recent empirical work, however, reveals the reverse, i.e. the increasing importance of industry factors in explaining firms' returns, relative to country factors. Based on a dataset covering 36 industries and 39 countries, Campa and Fernandes (2005) construct two series of mean absolute deviation for both country and industry factors. By using these constructed data, it is found that in the 1990s, country factors dominated industry factors, while in 2000s and onwards, industry effects become dominant. It gives evidence that investing across countries has been less desirable than investing across industries in terms of global risk diversification since 2000. On the other hand, by separating country/industry effects between mature and emerging markets, Phylaktis and Xia (2005) find the different effects across countries. In other words, in mature countries, firms' returns were more explained by industry factors, while in emerging markets, country factors still dominated. It is noted that even in those cases where industry factors dominate, diversification across countries is still needed in that the same industry might face very different operational conditions, e.g. varying level of political risk between developing and developed countries.

The last but not least explanation for home bias preference is concerned with foreign asset restrictions on pension funds from the national authorities. We talk about this issue in more detail in the next section.

4 Pension fund regulation

Pension funds, as one form of large financial institutions, are subject to various regulations, although the structures of such regulations differ across countries (Srinivas et al 2000; OECD 2001, 2004). Davis (2001) details the principal portfolio regulations for pension funds as well as life insurance companies across 9 advanced countries. In that paper, he identifies two forms of government policies on pension fund investment; one is the strict quantitative asset restrictions (QAR), where the government makes specific regulations, typically on the limits of holding a particular class of assets. For example, the latest statistics (Yermo 2003) show that, in Germany, a maximum of 25% of pension fund assets could be invested in equities and maximum 50% in bank deposits; as for foreign assets, there was a 70% currency matching requirement. The other form has the minimum specific regulations, known as the prudent person rule (PPR). The definition of PPR is not definitive and difficult to pin down (Vittas 1998); one definition from the OECD (Galer 2002) states that under the principle of the prudent person rule:

A fiduciary must discharge his or her duties with the care, skill, prudence and diligence that a prudent person acting in a like capacity would use in the conduct of an enterprise of like character and aims.

In the context of pension fund investment, it is referred to as the investment strategy whereby pension funds are invested prudently as someone would do in the conduct of his or her own affairs (Davis 2001). In that paper, Davis identifies 7 advanced countries implementing the PPR for pension fund investment, i.e. Canada, Finland, Italy, Japan, the Netherlands, the UK and the US, with the remaining two, Germany and Sweden following the strategy of quantitative asset restrictions. Regarding emerging market economies, most countries adopted the QAR approach (Yermo 2003), particularly at the earlier stage. For example, Chilean pension funds were not allowed to invest in the international capital markets in the early 1980s when its pension system just started privatisation (Fontaine 1997), but this restriction was eased gradually over time, in that they become less relevant when the capital markets become more mature and developed (Vittas 1998; Acuna and Iglesias 2001); now it is permitted to invest up to 12% abroad (Srinivas et al 2000). This gradual policy relaxation happened in China as well (Hu 2005c). Initially, all pension funds in China were allowed to invest in bank deposits only. Since the late 1990s, however, pension funds have been permitted and encouraged to invest in equities, although through investment mandates to local mutual fund managers. As of end 2004, pension funds' foreign investment was still not allowed, although the validity of this restriction is under discussion. Despite recent trends of removing restrictions, many countries still restrict pension fund investment. Why do governments regulate pension fund investment, particularly in terms of foreign investment?

4.1 Arguments favouring pension fund regulations

Pension funds are a distinct form of asset, in that they are collected and managed with the purpose of proving retirement provisions for millions of retirees in each country. Meanwhile, explicitly or implicitly, governments always stand behind social security systems. If retirees cannot receive enough income to live, the government has to incur fiscal costs to meet it (Clark and Hu 2005a), although pensioners might not receive the same amount of income as expected from their funds. In consequence, to mitigate the adverse impacts of excessive risk taken by fund managers, governments seek to restrict the investment assets available to pension funds.

Market failure is another argument explaining why the authorities seek to regulate the pension fund industry (Davis 2001). Market failure is an economic phenomenon where the free market mechanism cannot solve economic problems in an efficient matter, thereby justifying the intervention of the government. There are three aspects of market failure, i.e. information asymmetry, externality and monopoly. Information asymmetry always induces well-informed parties with private information to selectively contract with less-informed parties, thus exploiting the latter. Examples include the pension mis-selling and Maxwell scandals in the UK (Blake 2003b). Given the concerns about pension funds' performance, partly following such information asymmetry, it was recommended in the Myners Review of Institutional Investment (2001) to enhance pension fund trustees' competence. A recent survey also emphasises the growing responsibility, and thus the importance of competence and expertise of pension fund trustees (Clark et al 2005; NAPF 2005).

Externalities arise when the behaviour of a particular group of people or firms have implications on others. Bank runs following the failure of a major financial institution in the market is one example here; nevertheless, whether such contagion could occur for pension funds is less clear. In response to this risk, the Pension Benefit Guarantee Group (PBGP) was set up in the US, while the Pension Protection Fund (PPF) was recently created in the UK; such a guarantee mechanism is conceptually similar to deposit insurance from banking regulations (Hinz et al 1999).

A third form of market failure relates to the degree of market power. In the context of pension funds, it means if the market is controlled by a small number of plan sponsors, these sponsors might intend to optimise the interests of the management, but at the expense of plan members. Also, if all employees are forced to join pension schemes, it might entail poor conditions for pensions, e.g. long periods investing.

Pension fund investment regulations have many forms. But typically they specify holding limits by five dimensions, i.e. asset class, concentration of ownership, issuer, security, and level of risk (Srinivas et al 2000; Yermo 2005). Holding limits by the issuer and/or security means that pension fund's investment in a particular issuer/share, e.g. Microsoft, cannot exceed a specified percentage of the pension fund portfolio, e.g. 10%. The underlying logic is that an excessive investment exposure to a single firm entails high risk. Based on modern portfolio theory, holding a single firm has far higher risk than holding the whole market. This argument was proved by numerous real-world examples, e.g. the collapse of big names, e.g. Enron, Worldcom. Even the seemingly most healthy firms might go into bankruptcy overnight, implying the risk of investing in one firm. Limits to concentration of ownership mean how much of a firm could be held by pension funds.

All five types of investment restrictions, i.e. by asset class, concentration of ownership, issuer, security, and level of risk, are similar to the prudential regulation techniques used in other financial institutions, e.g. banks (Hinz et al 1999). For example, the first one, i.e. restriction by asset class, is closely linked to diversification and capital adequacy when regulating banks. By the same token, it also plays an important role in the pension fund investment industry, which is the focus of this paper. As noted above, two approaches apply to the restriction by asset class, one is the strict quantitative asset restrictions (QAR), the other one is the well known prudent person rule (PPR). Reasons why the QAR approach is popular in many countries include the high risk associated with some assets and people's dislike of risk and failure to understand portfolio diversification. I

Davis (2005a) presents results showing that different assets have different return-risk characteristics. Across OECD countries, the average return of domestic bonds over 1967-1995 was 1.7% with standard deviation at 16.8%, while those two figures of domestic shares were 8% and 22.5% respectively. However, given that most trustees and regulators are more concerned about the security of pension funds, upper limits are always imposed on the holdings of risky assets, e.g. equities in many countries, even they offer corresponding higher returns. A recent survey from OECD (OECD 2001 and Yermo 2003) shows that 14 out of 27 OECD countries placed specific restrictions on equities' maximum holdings. Concerning bond investment, however, only 8 of 27 countries had any restrictions.

4.2 Arguments favouring restrictions on foreign investment

The first concern is the possibility of domestic savings to flow offshore. Therefore in order to keep such scarce resources at home, especially for developing countries, strict investment regulations are imposed. This argument is strengthened by the positive linkage between domestic savings, and particularly pension assets, and economic growth and financial development, as reviewed by Davis and Hu (2005b). For example, Davis (2004) outlines how pension reforms which introduce elements of funding can have a positive impact on financial market development, e.g. following such pension reforms, the functions of financial markets are improved. In addition, empirical work has found not only the strong positive linkage between pension reform/pension assets, growth and finance, but also the causality relationship between them (Holzmann 1997, Walker and Letfort 2002, Davis and Hu 2005a, Hu 2005a and 2005b). If pension fund assets have such positive implications, there is a natural incentive for the reforming governments to restrict pension funds to be invested domestically, although foreign pension funds might flow in if there is no constraint on capital inflows. The theoretical analysis (Fischer and Reisen 1993) suggests that liberalisation of capital outflow controls would entail capital outflow at the early stage, and capital inflow at the later stage. So the total effect is a net capital inflow in the long run. The long term positive impact is due to the ease of the repatriation of domestic assets, thus reducing foreign investors' worry about inward investment in the first instance.

The second concern is the reforming government's consideration of using pension assets to finance implicit pension debts (Holzmann et al 2004). It is well known that under traditional pay-as-you-go (PAYG) systems, huge amounts of pension debt are accumulated due to the unfunded nature. If the pension reform is towards the direction of fully or partially funding, such IPDs will become explicit. In general, there are two methods to finance such debts, taxes and debts (Reisen 1997). For tax financing, it has the problem of a double burden on the current working population. In addition, high taxes are always an obstacle to investment at least in the short run, thus further limiting economic growth. Therefore, debt financing is more appropriate from the government point of view, if it is assumed that private sector follows the Ricardian hypothesis[5]. In this context, pension assets are viewed as captive funds. In other words, the government seeks to keep pension assets at home, e.g. by strict investment regulations to pay off the IPD. Typically, a minimum holding imposed on government

[5] Ricardian theory refers to the hypothesis that rational consumers will automatically adjust their personal saving and consumption inter-temporarily so as to smooth their current and future consumption (Seater J J 1993).

bonds is specified. There is, however, a concern that if pension funds only hold government bonds, there is only a distributional difference of funding and PAYG, in that under both scenarios, pension debts or pension promises are underwritten and paid by the government.

The last argument in favour of restriction on international investment of pension funds is closely linked with capital controls. As highlighted in Davis and Hu (2005a), pension fund assets are very large relative to the economy in many countries. For example, Hu (2005a) shows that the average ratio of pension assets to GDP was 42% for 18 advanced OECD countries as of 2002, while this ratio was 12% for emerging market economies (EMEs) in the same year. The latest statistics give the pension assets-GDP ratio at 61% across 26 OECD countries as of 2003 (OECD 2005)[6]. In recognition of the size of aggregate pension assets in each country, it is argued that capital mobility might lead to significant capital outflows, therefore inducing exchange rate volatility and macroeconomic instability. National experience from the UK indicates the driving force of pension funds in capital outflows (Reisen and Williamson 1997). For example, foreign assets accounted for 15% of the UK pension fund portfolio in 1985, up from 7% in 1979, showing the effect of financial deregulation, as capital controls were abolished[7].

All three arguments above are related to government's fear on excessive capital outflow. In order to eliminate or at least reduce this fear, Merton (1990), Bodie and Merton (2002) design one innovation, called the international pension swap. In this context, pension funds in one country enter a swap contract with a financial institution in another country. Then at the end of each period, only the difference of required payments to both parties, rather than the principal plus the difference is involved. For example, the notional principal is $100million, and the return in world stock market is 5 per cent, while that in domestic market is 3 per cent, then the amount flowing out of the country is only (5%-3%)*100=2million, much less than the principal of $100 million. By investing in this way, the unintended and potential undesirable side effects of pension capital flight are significantly reduced, while the benefits of international diversification are still achieved.

However, against this idea of international pension swaps, Menil (2005) argues it does not come without costs, i.e. there is always a wedge between costs of capital raised domestically and those raised overseas. The author considers it as the economic cost of the pension swaps. But it is the existence of the return wedge across borders which justifies the benefits of international diversification in general, and the international pension swap in particular. In other words, if the world market becomes highly integrated and such swaps become feasible on a large scale, there is no need to diversify unsystematic risks by investing abroad.

4.3 Arguments favouring restrictions on equities

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[6] Besides the larger sample size in the OECD's work, differences between our data with OECD's might be due to the different methods used to calculate the average. In other words, OECD uses the weighted average by GDP, while we use the simple average.

[7] Since the early 1980s, the UK domestic financial markets have been in the process of deregulation, easing capital controls and reducing transaction costs.

The main argument in favour of a constraint on equity investment is the high risk associated with equities. Equities and bonds are two major investment instruments for pension fund investment. It has been widely known that equity investment has higher volatility than bonds, but is rewarded by corresponding higher returns. In our empirical part of this paper, we present the descriptive statistics of assets returns on equities and bonds. In comparison to returns on bonds, equities are more risky, but have higher returns. Give these observations, it is arguably agreed that equities are a good investment instrument for long-lived assets, e.g. pension funds, and pension plans in many countries indeed hold large volume of equities in their portfolios, for example, UK pension plans (Clark and Hu 2005a), and Australian superannuation plans (Clare 2005).

Bodie (2004, 2001), however, does not agree with the current investment practice. As we noted earlier, he is a strong supporter of the bond-based investment approach, as he does not believe the higher risk related to equities is rewarded sufficiently by the corresponding higher return. In addition, he argues that the traditional pension investment approach underestimates or simply dismisses the severity of the high risk of equities, i.e. the extreme cases of stock market failure, whereby any potential large loss, e.g. due to a major war, would have devastating negative impact on pension assets. This is a real concern for retirees, as most of them are risk-averse. Comparatively, government and corporate bonds are safer, hence Bodie suggests the most appropriate investment approach should invest only on inflation-indexed bonds. However, as noted, the reality is that total outstanding inflation protected bonds were much below the total pension assets (GFSR 2004). Taking the UK as an example, as for 2003, pension fund assets reached at $945bn, while the inflation indexed bonds were only around $139bn. As discussed in Section 2.2, the scarcity of long-term bonds, particularly indexed-linked bonds, also leads to the mismatch between liabilities and cash flows for DB plans.

The above argument stresses the low risk associated with bonds, compared to equities. If this is true, risk averse members under DC plans might favour bonds, since they have to take any investment risk. If we consider DB plans, however, the consequence will be different. In the DB case, risk is transferred to sponsors, therefore members might not really care whether equities or bonds are invested in. There is more risk sharing between pensioners and workers in DB than DC plans. Meanwhile, if we view DB plan sponsors as risk averse agents, same as ordinary individual investors, a bond investment approach might be still justified from their point of view. This is, to some extent, in line with what happened in 2001, when the UK's Boots pension funds switched all assets into bonds (Blake 2003a). Despite the high profile case of Boots pension funds' composition change, corporation pension plans in many countries still hold large volume of assets in equities, as mentioned at the outset in this section. Gold (2000) argues that the heavy allocation of pension assets to equities for DB plans in the US, is attributable to biased accounting/actuarial methods. In other words, by investing in equities, accountants can manipulate financial reports to the extent that profits are overstated, and pension liabilities underestimated.

5 Empirical work

As discussed above, concerning pension fund regulation, there are two approaches (Davis 2002); one is the QAR (strict quantitative asset restriction), the other one is the

PPR (prudent person rule). We believe a priori that the latter is more desirable than the former. In this section, we seek to empirically analyse whether this hypothesis is valid and if so, to what extent. The methodology is based on the well-known mean-variance framework (Markowitz 1959).

5.1 Data description

Data used in this section cover 39 countries, as shown in Tables 1 and 2. Among them, 17 are emerging market economies (EMEs), i.e. Argentina (ARG), Brazil (BRA), Chile (CHL), China (CHN), Hong Kong (HKG), Indonesia (IDN), India (IND), Israel (ISR), South Korea (KOR), Mexico (MEX), Malaysia (MYS), Pakistan (PAK), Peru (PER), Philippine (PHL), Singapore (SGP), Thailand (THA), and South Africa (ZAF), while 22 are OECD countries, i.e. Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Switzerland (CHE), Germany (DEU), Denmark (DNK), Spain (ESP), Finland (FIN), France (FRA), Great Britain (GBR), Greece (GRE), Ireland (IRL), Italy (ITA), Japan (JPN), Luxembourg (LUX), Netherlands (NLD), Norway (NOR), New Zealand (NZL), Portugal (PRT), Sweden (SWE), and the US (USA).

We have annual returns on 9 different classes of assets over 39 years from 1966-2004; those returns are short-term asset yields (MPY), bank loans yields (BLY), mortgage yields (MOY), domestic corporate bond yields (CBY), domestic government bond yields (GBY), domestic equity yields (EQY), property yields (PRY), foreign equity yields (FEQY), and foreign bond yields (FBY). We expect these assets to be the sort of asset section from which the optimal pension fund portfolio should be constructed. To our knowledge, it is the most detailed dataset of this kind, although in Davis (2005a) and Davis and Steil (2001), they use a similar dataset but with shorter time periods, i.e. 1967-1995. It is noting, however, that for our computation, we consider one basic model and four variants. The basic model refers to the case where 7 asset classes are used, i.e. MP, CB, GB, EQ, PR, FEQ, and FB. In order to check robustness of our results, we have four variants, i.e. a) with BL&MO, b) with MO, c) with BL, and d) with BL and MO but without PR. These four variants are selected in that the preliminary analysis shows that their optimisation results are not plausible[8].

As shown in Tables 1 and 2, the observation periods for different classes of assets are not the same, i.e. our dataset for each country is not balanced. Therefore, in order to make our data balanced, we simulate those missing values, according to the assumption of normal distribution (see the next section for details). After such data manipulation, datasets for all countries are balanced. The last columns of Tables 1 and 2 give the observation periods for each country after such manipulation.

In addition, in Davis (2005a), the global equity/bond returns are calculated by using domestic assets for G-7 countries, i.e. AUS, CAN, DNK, DEU, JPN, NLD, SWE, GBR and USA. Ideally, however, more countries should be used, since other countries, particularly some emerging markets, are playing an increasingly important role in the global financial markets. For this study, we construct the global equity/bond returns, based on our own designed formula, i.e. Equation 1 as follows:

[8] One relevant point is that pension funds in most countries do not invest heavily in bank loans. In addition, the returns we have in our dataset may be incorrect, i.e. exaggerated, since they do not account for bank default.

$$R_i^* = \sum_{i=n}^{I} (R_{i,t} - Inf_{i,t} + \Delta EX_{i,t}) \times W_{i,t}$$

$$\Delta EX_{i,t} = \frac{EX_{i,t} - EX_{i,t-1}}{EX_{i,t-1}}$$

$$\forall i \in [n_1, n_{41}]$$

$$\forall t \in [1966, 2004]$$

(1)

R* is the global returns for a particular country, and R is the domestic returns for all the other countries. Inf is inflation rates in the particular country, i.e. changes in the CPI (consumer price index); inflation rates are obtained from the WDI (World Development Indicators) (2005). ΔEX is changes in bilateral exchange rates, as calculated by the author, using the exchange rate dataset from the IMF database. In the paper, we adopt direct quotation, i.e. using a particular country's currency as the price currency, and quoted as home currency/foreign currency (home currency for one unit of all the other currencies). According to our direct quotation, when the value of EX increases, equivalent to home currency's depreciation, the returns denominated in the home currency should increase. W (varying year by year) is global weights by market capitalisation, and those data for market capitalisation are obtained from the WDI 2005 and Datastream. In Equation 1, i denotes the country dimension, and we have data for 41 countries in total, including 18 EMEs and 23 OECD countries. Compared to the number of countries in Tables 1 and 2, when calculating the global equity and bond returns, we have data for one more country, i.e. Poland and Iceland, respectively. In other words, data for 40 countries are available when computing global equity and bond returns. t is the time dimension, and the observation period is 1966-2004, i.e. 39 observations.

It should be noted that in order to obtain the *pure* global returns for one country, e.g. country A, we drop country A from our dataset, and only use the data relating to all remaining 39 countries. For example, to construct the global equity return for Australia, we use the equity return data for all countries, but Australian data. By constructing the global returns under this method, we expect one country's global returns will not be correlated in a material manner with the returns of other assets, e.g. domestic equities, thus maximising the beneficial effects arising from global diversification; as the lesser the correlation between assets, the more benefits achieved from diversification. Note that by our definition, the global returns for each country are different.

Descriptive statistics for these real return data, i.e. mean and standard deviation, are given in Tables 3 (OECD countries) and 4 (EMEs). By comparing data in these two tables, it is indicated that the real asset returns in EMEs are much more volatile than those in OECD countries, and at the same time, the former is higher than the latter in many cases. For example, as regards the government bond yield, the average value for OECD countries was 4.1% (mean) with 1% (standard deviation, SD), while it was 5.5% and 12.6% for EMEs. When we excluded ARG, BRA, CHL and PER from our

EMEs dataset, given extreme numbers associated with these 4 countries associated with hyperinflation, the average mean and SD of the government bond yield was 6.9% and 12.5%, respectively. As shown in Table 4, returns in EMEs were quite volatile, and one contributing reason for foreign assets was the large exchange movement occurred in individual countries' history. Indeed, it is such large changes in exchange rate, mainly in the form of home currency's continuous depreciation, that lead to high returns on foreign investment for EMEs, which is particularly relevant to Latin American countries (Jackson et al 2005).

All return data, except the global returns, were collected from a variety of sources, i.e. Davis and Steil (2001), Datastream, Global Financial Data, IMF database, Jakob Madsen (Copenhagen), national central banks and the WDI (World Bank Indicators) 2005. The global equity and bond returns were calculated by the author, based on the formula as in Equation 1. In addition, all return data are in real terms, i.e. adjusted for inflation. Detailed information about observation periods and data sources are given in Tables 1 and 2.

5. 2 Model and methodology

5.2.1 Theoretical model and mean-variance approach

The theoretical models or arguments supporting international diversification are derived from the classic mean-variance model, which Markowitz (1959) first designed and introduced to finance studies, particularly in the field of portfolio management. He says that the efficient set of feasible mean-variance opportunities can be found by solving two standard optimisation problems. First, we can maximise portfolio returns for a given risk, i.e.

$$MAX\,(E[R_p]) \quad subject \;\; to \;\; \sigma_p{}^2 = \gamma \tag{2}$$

where, $E[R_p]$ is the expected portfolio return, and $\sigma_p{}^2$ is the portfolio variance, i.e. risk. In the paper, however, we follow the other strategy, i.e. minimising portfolio risks for a given return:

$$MIN(\sigma_p{}^2) \tag{3}$$

subject to:

$$E[R_p] = \gamma \tag{3.1}$$

$$\sum_{i=1}^{n} w_i = 1 \tag{3.2}$$

$$0 \le w_i \le 1 \tag{3.3}$$

where:

$$\sigma_p{}^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \rho_{i,j}\sigma_i\sigma_j \quad \text{(portfolio risk)} \tag{4.1}$$

$E[R_i] = w_i r_i$ (4.2)

r_i : returns on asset i (4.3)

w_i : weight of asset i (4.4)

w_j : weight of asset j (4.5)

$\rho_{i,j}$: correlation between asset i and asset j (4.6)

σ_i : standard deviation of asset i (4.7)

σ_j : standard deviation of asset j (4.8)

Solving Equation 3.1 could be achieved with the Lagrangian function. First, we set two Lagrangian multipliers, i.e. α and β , then Equation 3 is equivalent to the following equation:

$$L(w,\alpha,\beta) = f(w) - \alpha(w) - \beta(w) \quad (5.1)$$

$$0 \le w_i \le 1$$

or

$$L = \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \rho_{i,j}\sigma_i\sigma_j - \alpha\left(\sum_{i=1}^{n} w_i r_i - \gamma\right) - \beta\left(\sum_{i=1}^{n} w_i - 1\right) \quad (5.2)$$

$$0 \le w_i \le 1$$

To find the solution of the Markowitz problem, we can differentiate Equation 5.2 with respect to w_i and set the subsequent first derivatives to zero. Therefore, we have the following four equations with the last equation being the constraint function:

$$\sum_{j=1}^{n} w_j \rho_{i,j}\sigma_i\sigma_j - \alpha r_i - \beta = 0 \quad (6.1)$$

$$\sum_{i=1}^{n} w_i r - \gamma = 0 \quad (6.2)$$

$$\sum_{i=1}^{n} w_i - 1 = 0 \quad (6.3)$$

$$0 \le w_i \le 1 \quad (6.4)$$

Solutions to the above 4 equations will produce the weights we expect for an optimal portfolio, subject to restrictions, i.e. Equations 3.1, 3.2 and 3.3.

Above we described the mathematical procedure of finding the optimal weights, under Markowitz's mean-variance approach. Behind this model is the common belief that the portfolio risk is lower, if more assets are included in a portfolio, especially when these assets are not correlated to each other. The reason is that, based on the mean-variance calculation procedure, the lesser correlation between assets leads to a smaller value of $\sigma_p{}^2$, as shown in Equation 3, given that expected returns are fixed. This reasoning, addressing the old wisdom to "Never put all eggs in one basket", is particularly useful for portfolio management, since it lays out an evolutional theoretical foundation about how to undertake portfolio investment.

In view of the fact that markets across countries are not correlated, or move in one direction, Levy and Sarnat (1970) and Solnik (1974; 1998), among others, extend Markowitz's mean-variance framework into global investment. They believe that substantial advantages in risk reduction could be achieved by investing in foreign assets, as depicted in Figure 1. In this context, the total risk of a portfolio will depend on, not only the number of securities, but also most importantly the riskiness of each security, and the extent to which these individual securities are correlated to each other. In other words, a portfolio selection strategy of choosing 10 shares from one country is almost certain to be less desirable than another strategy of choosing 1 share from 10 different countries.

In terms of the issue of pension funds' asset allocation, it has been a norm to apply the mean-variance approach to find the optimal portfolio. For example, by incorporating liabilities into the analysis of optimal asset allocation, Yang (2003) seeks to quantify the gains from international diversification, and Inkmann and Blake (2004) identify the linkage between discount rates and asset alloction. Both studies are conducted under the mean-variance framework, which involves a maximisation of objective functions in the surplus of assets over liabilities in DB plans. It is worth noting that the mean-variance approach applies to both DC and DB plans. For both cases, some objective functions should be maximised, while the difference is that for the DC plan, we only consider the asset-side, while for the DB plan, pension liabilities should be included into the function. In this paper, we use a simple optimisation model as shown in Equation 2. Note that our analysis does not allow for liabilities; therefore, our results are more relevant to the DC plan. Implementation of the herein approach, however, needs some caution. For example, Britten-Jones (1999) finds that the sample error when estimating the weights of a global efficient portfolio is large, which might lead to sub-optimal asset allocation and results.

5.2.2 Methodology

One assumption of the mean-variance approach is that the returns are normally distributed, i.e. with a smooth bell-shaped probability distribution curve. If the returns are expected to have a normal distribution, the mean-variance framework holds that mean and variance are the only two statistics needed to characterise the distribution of asset returns. Thus, higher order moments of the distribution, i.e. skewness and kurtosis are not necessary to be considered in the portfolio optimisation construction. In addition, there are two arguments which do not strongly favour the use of higher moments of the distribution in portfolio analysis. First, from the purely statistical standpoint, higher moments or statistics involving higher powers of input data, are almost always less robust than lower moments (Cramer 1946). Secondly, individual and institutional investors might have different views on the importance of higher moments, i.e. mean-variance-skewness analysis (Amin and Kat 2004). Regarding individuals, as investors with relatively short investment horizon, they are more concerned about and vulnerable to short-term loss, therefore the mean-variance approach might not be appropriate. For institutional investors, e.g. pension funds, however, they are well positioned to deal with any temporary large loss, since they are all long term investors (Davis and Steil 2001).

A formal and widely used statistic to check normality is the Jarque-Bera statistic, which is expressed as Equation 7.1.

$$JB\ statistic = \frac{N-k}{6}\left(S^2 + \frac{(K-3)^2}{4}\right) \longrightarrow \chi^2(2) \tag{7.1}$$

$$S = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{x_i - \bar{x}}{\sigma}\right)^3 \tag{7.2}$$

$$K = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{x_i - \bar{x}}{\sigma}\right)^4 \tag{7.3}$$

where S is the third-order moment of distribution, i.e. skewness in Equation 7.2, K is the fourth-order moment of distribution, i.e. kurtosis in Equation 7.3, and k is the number of estimated coefficients used to create the series. In addition, N is the number of observations, x returns, and σ the standard deviation. The JB statistic follows a Chi-square distribution with 2 degrees of freedom, under the null hypotheses of a normal distribution. Therefore, when data are normally distributed by not rejecting the JB statistic, we conclude that the mean-variance framework is an appropriate approach in the context of portfolio optimisation.

In passing, skewness is a measurement of the symmetric distribution. It is expected to be zero if returns are normally distributed. Positive/negative skewness implies that the distribution has a long right/left tail. The fourth order moment of the distribution - kurtosis, measures the peakness or flatness of the distribution. We expect this statistic to be 3 for a normal distribution. If the value of kurtosis is greater than 3, the distribution is peaked (leptokurtic) relative to the normal, while it is flat (platykurtic) relative to the normal if the value is less than 3.

Jarque-Bera statistics for all asset returns across both OECD countries and EMEs are given in Tables 5 and 6. For OECD countries, the null hypothesis of normality is frequently accepted across all classes of assets, except GBR and JPN. Results concerning EMEs have the similar picture, but we do have few outliers, i.e. ARG, IDN. The fact that Jarque-Bera statistics are less encouraging for EMEs than OECD might be due to the short observation period of our dataset. In the long run, however, we expect the asset returns for EMEs to be normally distributed, as they are in OECD countries. In addition, normality of most our data validates the simulation methodology used to patch up missing data, as noted in Section 5.1.

After checking our data's normality, and thus validating the appropriateness of the mean-variance approach, we move on to the portfolio optimisation. In this paper, we conduct two empirical studies; one relates to what quantitative benefits will be brought in, after the move from a regulatory regime prohibiting overseas investment only to a regime without such restrictions, while the other is concerned with what are the optimal portfolios for each country at the national level, based on our dataset and methodology.

To complete the first work, we design one statistic, i.e. rates of change (RC) in risk. RC is expressed in Equation 8.

$$RC_i = \frac{\sum_{m}^{M} \frac{\sigma_{i,m} - \sigma^*_{i,m}}{\sigma^*_{i,m}} \times 100}{n_i} \qquad (8)$$

σ^* is the standard deviation (SD) under the scenario of foreign investment restriction, a hypothesis consistent with the QAR, while σ is the standard deviation under the scenario of allowing foreign investment, in line with the PPR (Davis 2002). Letter i is the country index. Lower case m refers to the start SD, while upper case M refers to the end SD. n is the number of intervals between m and M with the increment of 0.5% (Levy and Sarnat 1970). The formula is $n_i = (R_{i,M} - R_{i,m})/0.5$, where R is the return on the optimal portfolio, and R_m and R_M correspond to the lowest and highest possible returns achieved in optimal portfolios. To make values of n_i to be integers, we round the lowest and highest possible returns to the nearest integers. Meanwhile, in order to make our calculation in the optimisation process meaningful, all those portfolio returns used between $R_{i,M}$ and $R_{i,m}$ have to be available to both scenarios, i.e. a regime with investment overseas restriction and a regime without such restriction. It means implicitly that some possible returns available to the latter scenario cannot be achieved under the former scenario, and thus ignored in our calculation. In addition, it is worth noting that portfolio returns used to compute RC_i vary across countries (see Tables 7A till 10B).

According to the above method, RC_i gives us the average risk-changes across n intervals for country i, after a hypothetical move from the QAR to the PPR. If the values of RC_i are negative, it indicates the positive effects, i.e. a drop in risk across all possible returns. Besides the risk-change ratio we introduced, we used another statistic, i.e. Sharpe ratio. Sharpe ratio is defined as the ratio of return to standard deviation; it is widely used as a measure of reward-to-risk. Normally, investors seek to have a portfolio with the highest Sharpe ratio. We compute Sharpe ratios for both scenarios, i.e. the PPR and the QAR, and further calculated the percentage change in Sharpe ratios (RC^*), in order to discern the pattern of Sharpe ratio movement. The mathematical formula is as follows:

$$RC^*_i = \frac{\sum_{m}^{M} \frac{SR_{i,m} - SR^*_{i,m}}{SR^*_{i,m}} \times 100}{n_i} \qquad (9.1)$$

$$SR_{i,m} = \frac{R_{i,m} - R_{i,f}}{\sigma_{i,m}} \qquad (9.2)$$

$$SR^*_{i,m} = \frac{R_{i,m}{}^* - R^*_{i,f}}{\sigma^*_{i,m}} \tag{9.3}$$

If we assume that $R_{i,f}$ and $R^*_{i,f}$ equal zero, i.e. they are risk free assets, Equations 9.2 and 9.3 are reduced to

$$SR_{i,m} = \frac{R_{i,m}}{\sigma_{i,m}} \tag{9.4}$$

$$SR^*_{i,m} = \frac{R_{i,m}{}^*}{\sigma^*_{i,m}} \tag{9.5}$$

Then, substituting Equations 9.4 and 9.5 into Equation 9.1, we have

$$RC^*_i = \frac{\sum_m^M \frac{(R_{i,m}/\sigma_{i,m}) - (R^*_{i,m}/\sigma^*_{i,m})}{R^*_{i,m}/\sigma^*_{i,m}} \times 100}{n_i} \tag{9.6}$$

Given that

$$R_{i,m} = R^*_{i,m} \tag{9.7}$$

and after some manipulations, e.g. cancelling the common terms, Equation 9.6 is reduced to

$$RC^*_i = \frac{\sum_m^M \frac{\sigma^*_{i,m} - \sigma_{i,m}}{\sigma_{i,m}} \times 100}{n_i} \tag{9.8}$$

Positive values of RC^* indicate that Sharpe ratios increase, a desirable effect after relaxing pension fund's foreign investment.

The second empirical work relates to pension asset's optimal allocation for each country under the PPR scenario. In this part, we consider returns in real term at 3 levels, i.e. 5%, 7% and 9%. In order to check robustness of our results for both empirical studies, we conduct portfolio optimisation for different sub-samples. For example, for OECD countries, we first employ the dataset relating to the sub-sample period between 1966 and 1995, then incorporate the observations for the next year in sequence into the previous sub-sample dataset to obtain all the other 9 datasets. In total, we are expected to have 10 sets of results for each OECD country. For EMEs, given their less observations, we only use 5 sub-samples, and the first one ends in 2000; the subsequent 4 sub-samples are obtained by adding one more year observations each time. It is noted, however, that for many countries, estimates for some particular sub-sample datasets are not available under the mean-variance optimisation algorithm. In other words, 10/5 sets of optimisation results are not always computable for all OECD/EMEs countries at all three return levels (see the next section for details). Meanwhile, according to our methodology it is always certain that an investment approach with restrictions perform worse than that without those restrictions in terms of risk-return trade-off. However, it is interesting to investigate the quantitative magnitude of such diversification benefits. In addition, the extent to which such benefits varies across countries warrants a vigorous study. It is noted that all empirical work is conducted with Matlab 6.5.

5.3 Empirical results

5.3.1 Diversification benefit without foreign investment constraint

In this part, we test the hypothesis whether pension fund portfolios can benefit from relaxing foreign investment restrictions. In other words, in Scenario I (QAR), investment in foreign assets, i.e. FEQ (foreign equity) and FB (foreign bonds) is not permitted, while in Scenario II (PPR) we assume that pension funds are allowed to invest in all classes of assets. For EMEs pension funds, the hypothetical portfolio includes 8 asset classes (except mortgage), while for OECD pension funds, all 9 asset classes are used, as mentioned in Section 5.1. According to Equation 8, the rates of change in risk, i.e. RC are calculated for each country, and these ratios are then averaged across different returns. It is noted again that the returns used to compute RC ratios for each country are in 0.5% increment, and the lower and upper bounds for each country are not the same across countries.

Results for EMEs are presented in Tables 7A and 7B. Table 7A gives results relating to 5 sub-samples for the purpose of checking the results' stability, as noted in the previous section, while Table 7B gives the statistical summary. As shown in both tables, regardless of sub-sample and country, all RC ratios are less than 0 (inclusive), which indicates the positive impact of the move from the QAR to the PPR, i.e. reduced portfolio risk for given returns. Despite consistent risk reduction for all EMEs, results show a large heterogeneity between these countries. For example, in terms of mean value across sub-samples as shown in Table 7B, PHL enjoys the largest benefit (-64.5%), and HKG has the smallest benefit (-8.6%). Specially, if the regulatory regime changes from the QAR to the PPR, investment risk could decrease by 65% for PHL pension funds and 8.6% for HKG pension funds, giving returns. The simple average of RC ratios across all EMEs is –33.4%, which means that on average pension investment without any restriction across borders will potentially have a risk, 33.4% lower than the case where pension funds are not allowed to invest abroad. Even if IDN, IND, PAK, PER and PHL are excluded from our dataset, given concern about their relatively large figures, the mean of RC ratios is still high at the level of –20.2%.

The Sharpe ratio measures the extent to which high risk is rewarded by corresponding high return. We compute the rates of change in Sharpe ratios, based on Equation 9.8. Results are given in Tables 8A and 8B. All estimates are positive, and in some cases, the values are quite large. For example, based on estimates from all 5 sub-samples, Sharpe ratios for ARG pension funds are all well above 30%, with the highest value at 190% when using the dataset ending in 2002. The average Sharpe ratio for ARG is 93.6%, which implies that if ARG pension funds are permitted to invest overseas without any constraint, the Sharpe ratio could increase by 94%. When looking at the overall picture of EMEs, on average the Sharpe ratio could increase by 92%, with a median value at 84%. When we exclude IDN, IND, PAK, PER and PHL, (their mean values are above 100%), the mean and median values decrease to 34% and 31% respectively, which are still sizeable, however.

When turning to OECD countries, the results are similar, i.e. there is always a positive effect after the regulatory move from the QAR to the PPR. In terms of rates of change in risk, i.e. RC, Table 9A gives the full results, and the statistical summary is given in Table 9B. After averaging across sub-samples and countries, the value of the RC ratio is between –15.8% and –8.6%, with the median value at –11.2% and the mean at – 11.6%. For example, for UK pension funds, risk could decline hypothetically by 14.4% under the PPR, compared to the QAR. The country which benefits most is PRT, i.e. risk could decrease by 63.4%. When excluding PRT from the dataset, the average RC across OECD countries is –8.7%. Regarding Sharpe ratios, results are shown in Tables 10A and 10B, and all estimates are as expected. For example, all figures in Table 10A are greater than 0 (inclusive), which indicates the positive impact of adopting the PPR. Countries which benefit significantly include FRA, GRE and PRT, among others. Meanwhile, our results are robust across different sub-samples. Concerning the statistical summary in Table 10B, the average across all OECD countries is 22.4%, while the figure without PRT is 13.9%.

Statistics presented above give strong evidence in favour of the PPR investment approach. This policy benefits EMEs more than OECD countries. For example, on average, a QAR-PPR move will reduce investment risk by 33% for the former, and 12% for the latter, as given in Table 11. At the same time, it will increase the Sharpe ratio by 92% for EMEs, and 92% for OECD countries. Similar results are obtained even if we exclude these countries with large figures from our dataset. Meanwhile, it is mentioned earlier that in order to complement our results, we run a number of variants, i.e. including or excluding some particular asset classes from our basic model. There are, i.e. a) with BL&MO, b) with MO, c) with BL, and d) with BL and MO but without PR. All statistical summaries are given in Table 11, in comparison to the results from our basic model. It is shown that there is a full consistency of negative effect on the RC (rate of change in risk), and positive effect on the RC* (rate of change in Sharpe ratio), following a shift from the QAR to the PPR. For example, for the With BL&MO and OECD case, the mean values of the RC are –9.0, -10.0, -9.4 and –11.5, respectively.

As given in Table 11, in general, there is a large impact on OECD countries than EMEs. Underlying reasons include market inefficiency, i.e. EMEs markets are not fully integrated between countries, and high volatility in domestic markets in EMEs. The issue is less serious for advanced OECD countries, as stock markets between those countries are highly linked to each other. For example, Davis (2005a) shows that the correlation of monthly percent changes in MSCI indices between US and UK is 0.51 over 1970-2002, while the figure rises to 0.64 over 1985-2002. Similar results, but with a longer observation period, are reported in Goetzmann et al (2005). The correlation between OECD countries and EMEs is much less, as markets in EMEs experience different business cycles from OECD, and some of them are relatively immune to shocks in the outside world. In addition, strict capital controls in emerging markets might explain this difference as well, which in turn is in line with the arguments as regards international diversification benefits in Section 3 (Levy and Sarnat 1970; Backus et al 1992; Solnik 1998).

5.3.2 Pension fund's optimal portfolio composition

Beside the issue of potential gains arising from international investments, another key issue is what proportion of pension funds should be invested in equities, and what proportion should be in bonds, etc. In this section, we seek to address the issue. In addition, given the dynamic structure of investment, we report results by using 10 sub-samples, to see how results change.

We conduct portfolio optimisation at 3 real return levels, namely 5%, 7% and 9%, for both OECD countries and EMEs. Under the mean-variance framework, as highlighted in Equation 3 in Section 5.2, we minimise variance or risk by fixing returns at these three values. Then, the optimal weights for each asset class are found, subject to the restrictions of disallowing short sales (Equation 3.3) and the total weights summing to unity (Equation 3.2). For some countries, particularly EMEs, due to the difficulty of accessing return data for some asset classes, we construct optimal portfolios only using available data. In addition, we analyse those countries which have data including CBY or GBY, EQY, FBY and FEQY at least, in that equity and bond are two of the most important investment vehicles in pension fund portfolios.

Optimal portfolio results for EMEs pension funds are shown in Tables 12 through 14, and they vary significantly across countries. For example, in order to achieve a 5% real return, for PHL pension funds, ideally 79% should be allocated to government bonds, while for SGP pension funds, government bond investment is much lower, because its optimal share is 17%. The difference are due to the different asset return characteristics. In Table 4, statistics show that the average GBY for PHL is 6.3% with standard deviation at 1.1%, while those two figures are 2.7% and 12.6% for ZAF. In addition, we do not have CBY data for ZAF, which surely will have impact on the resultant portfolio compositions. Therefore, when explaining results reported in these data and comparing optimal weights between countries, it is more sensible to compare countries having same asset classes. On average, as shown in Table 12, for all EMEs at the 5% return level, 10% of pension funds should be allocated to corporate bonds, 23% to government bonds, 4% to domestic equities, 30% to short-term assets, 14% to property, 0.8% to foreign equities, 18% to foreign bonds. All statistics here are standardised average, in order to make the sum of all components equal to 1. The formula is as follows:

$$SAV_i = \frac{AV_i}{\sum_{i}^{I} AV_i} \tag{10}$$

SAV: standardised average
AV: normal average across countries
i: asset class

Collectively, 19.1% of pension funds should be invested in foreign assets, including both foreign bonds and foreign equities. In addition, the combined equity investment (domestic and foreign equities) share is 4.8%, and the combined bonds investment share is around 52%. When looking at the statistics related to all 16 EMEs, the trend is roughly the same.

In order to discern the trend of changes in asset allocation with different return levels, we re-calculate optimal portfolios with two more return levels, i.e. 7% and 9%. Results are in Tables 13 and 14, respectively. Not surprisingly, asset compositions changed markedly for all EMEs. On average, the combined foreign asset share increases to 21% at the 7% return and peaks at 22% at the 9% return. As regards allocation to equities, it starts from 4.8% at the 5% return, rises to 6.7% at the 7% return, and further to 9.6% at the 9% return. This trend fits the financial theory well, in that it is widely recognised that a larger proportion of pension assets invested in high-yield assets, notably equities and foreign assets for EMEs will lead to a higher portfolio return. Meanwhile, for three cases, the combined bond investment (CB, GB and FB) share remains at a relatively high level, ranging 52% to 56%. In addition, we also notice that at the same level of returns, portfolio risk, as proxied by standard deviations (STDEV) differ sizeably between countries. For example, at the 5% return, STDEV is 4.9% for Chile, while it is 9.8% for South Africa. This large difference to some extent explains the market's imperfect correlation between EMEs, and also the potential benefits of international investment.

As noted earlier, optimal portfolio construction is a dynamic process and subject to ongoing changes. To this end, we calculate the optimal weights, using a number of different sub-samples. For EMEs, we employ 5 sample periods, with each ending in 2000 through 2004. For the purpose of saving space, we will not report these results for all countries. We, however, report these detailed results for Singapore for the illustrative purpose. As given in Appendix 1, statistics remain stable in most cases, i.e. the optimal weights do not change too much when using different samples. For example, concerning the optimal allocation to government bonds (GB), standard deviation across 5 estimates under 7% return is quite small, i.e. 1.1%, implying a small change.

OECD countries' results are given in Tables 15 through 17. As shown in these 3 tables, the optimal pension fund portfolios between OECD countries vary markedly. Again, it might be due to the different asset characteristics. As in the EMEs case, we compute the average portfolio compositions. By averaging asset shares across all 22 OECD countries, we found that if a real return of 5% is required, 13.3% of pension funds should be allocated to foreign bonds and equities, while equities (both domestic and foreign) should have a 10.5% share. Domestic and foreign bond markets have 49% of the pie as shown in Table 15. When we repeat the optimisation process with two other return levels, i.e. 7% and 9%, interesting results arise. Firstly, equity investment gains importance in terms of optimal allocation. For example, the share increases from 10.5% at 5% return to 25.8 at the 7% return, and further to 35.7% at the 9% return. The trend is the same as that in the EMEs case, i.e. equities (including both domestic and foreign assets) increase their weights in the optimal portfolios, when higher portfolio returns are required.

Secondly, when the return requirement is low, e.g. 5%, foreign assets do not comprise a large share. When higher returns are demanded, however, more pension assets should be allocated to foreign assets. For example, for 3 return levels, i.e. 5%, 7% and

9%, the corresponding shares of foreign assets are 13.3%, 25.8% and 41.4%. This is consistent with the return characteristics presented in Table 3, where FEQY has the highest mean value, although it also has the highest standard deviation. Thirdly, when comparing OECD countries and EMEs in terms of optimal asset allocation to equities, it is shown that OECD pension funds favour equities more than pension funds in EMEs, particularly when higher returns are required. For example, at the 7% return, the optimal weights are 26% for OECD countries, and 7% for EMEs. It might be due to the high volatility related to emerging markets. For example, Tables 3 and 4 show that the standard deviation of domestic equity was 203.5% (all-country case) and 41.7% (sub-sample case), while it is 31.3% for OECD countries. In other words, the increase in returns on both domestic and foreign equities for EMEs pension funds is not much enough to compensate the larger increase in volatility, i.e. investment risk. It is worth noting, however, our results are based on the historical data; therefore, if we forecast markets in EMEs will not be as volatile in the future as in the past, allocation to domestic and foreign equities should be higher.

Fourthly, we find evidence of the importance of property investment for both pension fund portfolios in both OECD countries and EMEs. The results related to EMEs should be taken with caution, as we only have data for two countries. For OECD countries, at the 5% return level, the average property investment is 11%, but the figure increases to16% at the 7% return, and further to 22% when the return required is 9%. This finding is consistent with the arguments by Booth and Matysiak (2001), and Booth (2002), who argue that real estate has a low correlation with other asset classes, and thus the large scope of diversification scope.

Fifthly, we combine all portfolio returns and corresponding standard deviations (SD) in Table 18. It is indicated that in order to achieve the same level of portfolio returns, different risks should be sacrificed across countries. For example, for Australia, the SD is 5.0% at the 5% return, while it increases to 9.9% at the 7% return, and 16.0% at the 9% return. On average, these 3 values are 3.5%, 7.3% and 12.2% for OECD countries. In comparison, pension funds in EMEs have small values on the SD for each portfolio return level, as given in Table 18. The smaller SD associated with EMEs seems counterintuitive. However, it is exactly consistent with our results presented in the previous sections, i.e. the larger beneficial impacts for EMEs pension funds from global investment. In addition, $\rho_{i,j}$ for EMEs (correlation between asset i and asset j) is very likely to be less than $\rho_{i,j}$ for OECD countries, and in some cases, the former might be negative. In consequence, portfolio risk, as shown by ρ_p^2 in Equation 4.1 for EMEs pension funds should be lower than OECD pension funds.

Sixthly, as in the EMEs case, we calculate optimal portfolio composition for different samples. But given the concern of saving space, we do not present these results for all countries. Instead, we report results relating to the UK pension funds as an example. In general, results, as shown in Appendix 2, only change slightly between sample periods. This is revealed by the small value of standard deviations.

Last, before moving to the next section, we talk about briefly the results relating to the four variants, i.e. a) with BL&MO, b) with MO, c) with BL, and d) with BL&MO but without PR. Results are given in Table 19. On average, when higher portfolio returns are required, more assets are allocated to high return assets, i.e. domestic equity, property, and foreign bond and equity. This is consistent with our earlier results with the basic model. However, it is also noticed that allocation to bank loans frequently dominates in the portfolios; this implausible result is the main reason we drop BL from our basic model. In addition, MO becomes dominant in the second scenario, i.e. without BL, which again leads us to drop MO from our basic model.

5.3.3 Comparison between actual portfolios and optimal portfolios

In the previous section we presented the results of optimal portfolios for each country. An immediate question is how our results differ from the actual portfolios. Table 21 gives the comparison results for selected 6 OECD countries. A quick look shows that the actual pension fund portfolios differ from our results for all countries, with the degree of difference varying across countries. For example, as to the UK pension funds, optimally 22.9% should be allocated to domestic equities when the required return is 9%. The actual portfolio, however, shows that 35.9% was invested in domestic equities as of 2003. Concerning foreign investment, 18.2% was allocated to foreign equities and 4.2% was to foreign bonds in the actual portfolios. In comparison, our optimisation results show that 27.4% should be invested in foreign equities, and 37.7% in foreign bonds. The difference indicates that the UK pension funds could benefit from more international investment. This under-investment in foreign assets is also observable for AUS, CAN and USA, as shown in Table 21. For JPN and CHE, however, we find evidence of over-investment in foreign assets. For example, for JPN, the optimal allocation to foreign equities and bonds should be 8.5%, while in the reality, 27% was allocated to international assets.

When explaining our results, however, caution is needed. Firstly, our results are based on historical data; therefore, given the fact that pension fund investment is a dynamic and ongoing process, new data should be added into the old dataset, whenever they become available. In other words, what happened in the past should be considered only as a rough guide of what will happen in the future. Secondly, in the actual pension portfolios, there is a special asset class, i.e. "others", while in the optimal portfolios we assume that allocation to "others" is zero. Therefore, this unrealistic assumption will affect the accurateness of our comparison.

6. Conclusion

People are living longer and healthier lives, and the issue of how to tackle the problem of the ageing population has been at the top of government's agenda. The current trend concerning the social security system is the shift from unfunded schemes, e.g. pay-as-you-go (PAYG) to funded schemes, e.g. the World Bank model (Hu 2005a). Givn the funded nature of the new pension schemes, pension fund assets have and are expected to increase significantly in the following decades. Hu (2005b) gives estimates that as of 2003, pension fund assets were equal to US$ 15 trillion for 19 advanced OECD countries, and they were equivalent to US$ 390 billion within 36 EMEs.

With the rapid accumulation of pension assets, one very important issue relates to pension fund management. In this paper, we sought to address the issue, and particularly focused on the arguments relating to the prudent person rule (PPR) and the quantitative asset restriction (QAR), in terms of pension fund international investment (Davis 2005a, 2005b). We used a unique dataset covering returns on 9 different assets, i.e. short-term asset yields (MPY), bank loans yields (BLY), mortgages yields (MOY), domestic corporate bond yields (CBY), domestic government bond yields (GBY), domestic equity yields (EQY), property yields (PRY), foreign equity yields (FEQY), and foreign bond yields (FBY). In addition, our dataset includes 39 countries (17 EMEs and 22 OECD) with the observation period ranging from 1966 to 2004. To our knowledge, it is by far the largest database from which optimal portfolios are derived. Under the mean-variance framework (Markowitz 1959), we found a number of interesting and important results, which contributed to the current pensions literature.

First, the results of RC (rate of change in risk) ratios, which we designed in the paper, indicated that the QAR investment approach, limiting international investment, on average materially increases pension fund's risk for given returns. This finding applies to pension funds in both OECD countries and EME, with a larger effect on the latter.

Second, it was found that the shift from the PPR to QAR jeopardized the reward-to-risk, i.e. the Sharpe ratio. Again, the negative impact was more serious for EME pension funds than OECD funds.

Third, due to the different asset return characteristics (Davis 2005a), optimal pension fund portfolio compositions found in the paper varied markedly across countries. We, however, found that if higher portfolio returns are required, more investment in equities and foreign assets are needed, which is consistent with financial theory.

Fourth, as the higher proportion of foreign assets is required to achieve higher returns, the majority of increase in foreign assets is accounted for by foreign bonds for EMEs, while the trend is not discernable for OECD countries.

Last but not least, our statistics suggested the importance of property investment in pension fund portfolio optimisation, and the results were applicable to both OECD countries and EMEs. It might serve as empirical findings supporting the arguments of Booth (2002).

In summary, in the paper, we found results which are in favour of the prudent person rule (PPR) investment approach and against the quantitative asset constraint (QAR) approach in terms of foreign investment. Also, our findings frequently recognised the potential large benefit arising from international investment for pension funds in EMEs. One caution, however is that in order to take advantage of the diversification benefit available for EMEs, they have to meet some pre-conditions (Davis 2005b; Blake 2003b, b; Hu 2005c). For example, there should have a sound banking systems, relatively developed securities markets, experienced regulations, etc. Without these minimum conditions, it is hardly to achieve the large benefit as identified in this paper.

References:

Aaron, H., 1966, The Social Insurance Paradox, *The Canadian Journal of Economics and Political Scienc*e, Vol. 32, pp371-374

Acuna, R. R and A. Iglesias, 2001, *Chile's Pension Reform After 20 Years*, Social Protection Discussion Paper Series, No. 0129, The World Bank, Washington

Aggarwal, R., L. Klapper and P. D. Wysocki, 2005, Portfolio Preferences of Foreign Institutional Investors, *Journal of Banking and Finance,* Vol. 29, pp 2919-2946

Amin, G. S. and H. M. Kat, 2004, *Stocks, Bonds and Hedge Funds: Not A Free Lunch!* Working Paper 0009, Alternative Investment Research Centre, City University, London

Ando, A. and F. Modigliani, 1963, The Life Cycle Hypothesis of Saving: Aggregate Implications and Tests, *American Economic Review*, Vol. 53, pp55-84

Ang, Andrew and A. Maddaloni, 2003, *Do Demographic Changes Affect Risk Premiums? Evidence From International Data*, Working Paper 9677, National Bureau of Economics Research

Arestis, P, P.O. Demetirades., and K. B. Luintel, 2001, Financial Development And Economic Growth: The Role Of Stock Markets, *Journal of Money Credit and Banking*, Vol. 33, No. 1, pp16-41

Backus, D., P. Kehoe, and F. Kydland, 1992, International Real Business Cycles*, Journal of Political Economy*, Vol. 100, pp745-775

Baker, A. J., D. E. Logue and J. S. Rader, 2005, *Managing Pension and Retirement Plans: A Guide for Employers, Administrators, and Other Fiduciaries*, Oxford University, Oxford

Bateman, H. and S. Thorp, 2005, *Decentralised Portfolio Management: Analysis of Australian Accumulation Funds*, presented at The 13th Australian Colloquium of Superannuation Researchers, 4-5th July, Sydney, Australia

Baxter, M. and U. J. Jermann; 1997; The International Diversification Puzzle Is Worse than You Think; *American Economic Review*; Vol. 87 (1), pp170-180.

Beckers, Stan, Gragory Connor, and Ross Curds, 1996, National versus global influences on equity returns, *Financial Analysts Journal*, pp31–39

Bernanke, B., 2005, *The Global Saving Glut and The US Current Account Deficit*, The Federal Reserve

Blake, D.; 1997; Pension Funds and Capital Market; Discussion Paper PI-9706; The Pension Institute, City University, London.

Blake, D.; 2001; *UK Pension Fund Management: How is Asset Allocation Influenced by the Valuation of Liabilities?* Discussion Paper PI-004; The Pension Institute, City University, London.

Blake, D., 2003a, *Pension Schemes And Pension Funds In The United Kingdom*, Oxford University Press, Oxford

Blake, D.; 2003b, *Financial System Requirements for Successful Pension Reform*, UBS PRP Discussion Paper No. 13 (FMG 457), London School of Economics, London

Blanchard, O. J., 1993, "The Vanishing Equity Premium", in ed. R O'Brien, *Finance and The International Economy*, Oxford University Press

Bodie, Z., 1998, *Pension Fund Investment Policy*, Working Paper No. W2752, National Bureau of Economic Research

Bodie, Z.; 2001; *Retirement Investing: A New Approach*; Working Paper 2001-03, Boston University School of Management, Boston.

Bodie, Z.; 2004a, *Life-Cycle Finance and Defined Contribution Pensions*, Public Lecture on 10 June London School of Economics, London

Bodie, Z., 2004b, *Pensions: A Corporate Finance Perspective*, presented at the seminar on Pension Finance and Economics, London

Bodie, Z. and E. P. Davis; 2000; *The Foundations of Pension Finance* eds; Edward Elgar.

Bodie, Z., A. Kane and A. J. Marcus, 2002*, Investments*, McGraw-Hill Higher Education.

Bodie, Z. and R. C. Merton, 2002, *Journal of Pension Economics and Finance*, Vol.1

Bodie, Z., R. C. Merton and W. F. Samuelson, 1992, Labour Supply Flexibility and Portfolio Choice in a Life Cycle Model, *Journal of Economic Dynamics and Control*, Vol. 16, pp427-449

Booth, P. M. and G. A. Matysiak, 2001, *Unsmoothing Real Estate Returns: How Does It Affect Optimal Pension Fund Asset Allocation?,* Proceedings of the 2001 Cutting Edge Conference, RICS, 2001

Booth, P.M., 2002, Real Estate Investment In An Asset/Liability Modelling Context, *Journal of Real Estate Portfolio Management*, Vol. 8 (3), pp183-198

Bosworth, B.P., R. C. Bryant, and G. Burtless, 2004, *The Impact of Ageing on Financial Markets and The Economy: A Survey*, The Brookings Institution

Boyer, B. and L. Zheng, 2003, *Who Moves the Market? A Study of Stock Prices and Sector Cashflows*, mimeo, University of Michigan Business School

Britten-Jones, M., 1999, The Sample Error in Estimates of Mean-Variance Efficient Portfolio, *Journal of Finance*, Vol. 54(2), pp655-671

Cahill, K. E. and S. Campbell; 2004; *Basic Investment Theory Explained*; Just The Facts On Retirement Issues; No. 9 January; Centre for Retirement Research At Boston College.

Cai, F. and L. Zheng, 2004, Institutional Trading and Stock Returns, *Finance Research Letters*, Vol. 1, Issue 3, September, p178-189

Campa, J. M. and N. Fernandes, 2005, *Sources of Gains From International Portfolio Diversification*, Emerging Markets Finance, Cass Business School, London

Campell, J. Y.; 2002; *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*; Presented to the American Economic Association and American Finance Association, January.

Campbell, J. Y., Y. L. Chan, L. M. Viceira, 2003, A Multivariate Model of Strategic Asset Allocation, *Journal of Financial Economics*, Vol. 67, pp41-80

Campell, J. Y. and L. M. Viceira, 2001, Who Should Buy Long-Term Bonds? *American Economic Review*, Vol. 91, pp99-127

Campell, J. Y. and L. M. Viceira; 2002; *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*; Oxford University Press.

Cannon, E., 2003, *The Elusive Effects of Demography on Rates of Return*, Bristol Macroeconomics Research Group Discussion Paper, University of Bristol

Chan-Lau, J. A., 2004, *Pension Funds and Emerging Markets*, IMF Working Paper WP/04/181, International Monetary Fund

Choudhry, T., 2003, Stock Market Volatility and The US Consumer Expenditure, *Journal of Macroeconomics*, Vol. 25, pp367-385

Clare, R., 2005, *Uniformity and Diversity in Superannuation Fund Investment Portfolios*, presented at The 13th Australian Colloquium of Superannuation Researchers, 4-5th July, Sydney, Australia

Clark, G. L., E. Caerlewy-Smith, and John Marshall, 2005, Trustee Decision-Making In Theory and Practice, WPG 0514, Economic Geography Working Paper, The University of Oxford, England

Clark, G. L. and Hu, Y, 2005a, *Re-Writing Pension Fund Capitalism 2: The UK Pension Crisis and Trends in Occupational Pension Plan Benefits, 1950-2004*, WPG 0509, Economic Geography Working Paper, The University of Oxford, England

Clark, G. L. and Y. Hu, 2005b, *Re-Writing Pension Fund Capitalism 3 – Defined Contribution and Defined Benefit Schemes With Reference to Demographic and Financial Flows*, WPG 0510, Economic Geography Working Paper, The University of Oxford, England

Copeland, T. E. and J. F. Weston, 1992, *Financial Theory and Corporate Policy*, 3rd edition, Addison-Wesley Publishing Company

Davis E. P., 1995, *Pension Funds, Retirement Income Security and Capital Markets*, Oxford University Press

de Martel, V., *Liability-driven Solutions for Pensions: When Bonds Are Not Enough*, presented at 2nd EIR/OECD Conference in Pensions and Long-run Investments, Paris

CSFB (Credit Suisse First Boston), 2005, *A Framework To Reduce Volatility and Improve Asset Returns*, manuscript

Coronado J. L. and S. A. Sharpe; 2003; *Did Pension Plan Accounting Contribute to a Stock Market Bubble?* Brookings Papers on Economic Activity (1), Washington.

Cramer, H. 1946, *Mathematical Methods of Statistics*, Princeton, Princeton University Press

Davis E. P.; 1995; *Pension Funds, Retirement Income Security and Capital Markets*; Oxford University Press.

Davis E. P.; 1998; *Investment of Mandatory Funded Pension Schemes*; Discussion Paper PI-9908; The Pension Institute, City University, London.

Davis E P.; 2000; *Pension Fund, Financial Intermediation and the New Financial Landscape*; July; Discussion Paper PI-0010; The Pensions Institute, City University, London.

Davis, E. P.; 2001; *Portfolio Regulation of Life Insurance Companies and Pension Funds;* Discussion Paper PI-0101; The Pensions Institute, City University, London

Davis, E. P.; 2002; *Issues In the Regulation of Annuities Markets*; Working Paper, Center for Research on Pensions and Welfare Policies, Turin, Italy.

Davis, E. P., 2003, Comparing Bear Markets – 1973 and 2000, *National Institute Economic Review*, No. 183, London

Davis, E. P.; 2004; Financial development, institutional investors and economic performance; in ed C A E Goodhart, "*Financial Development and Economic Growth*", Palgrave-Macmillan

Davis, E. P., 2005a, *Pension Fund Management and International Investment – A Global Perspective, Pensions.*

Davis, E. P., 2005b, *The Role of Pension Funds As Institutional Investors in Emerging Markets*, presented at the Korean Development Institute conference, “Population Aging in Korea: Economic Impacts and Policy Issues”, Seoul, March

Davis, E. P., 2005c, Demographic and Pension-System Challenges To Financial and Monetary Stability, *Geneva Papers on Risk and Insurance*, forthcoming

Davis, E. P. and Y. Hu; 2005a, *Is There a Link Between Pension-Fund Assets and Economic Growth? – A Cross-Country Study*, Pension Institute Discussion Paper PI-0502, City University

Davis, E. P and Y. Hu; 2005b, Saving, Funding and Economic Growth in ed G Clark, *Oxford Handbook of Pension Economics and Finance*, Oxford University Press

Davis, E. P. and C. Li, 2003, *Demographics and Financial Asset Prices in The Major Industrial Economics*, Working Paper 03-07, Brunel University

Davis, E. P. and B. Steil, 2001*, Institutional Investors*, MIT press

Dennis, P. J. and D. Strickland, 2002, Who Blinks in Volatile Markets, Individuals or Institutions? *Journal of Finance*, Vol. 57, pp1923-1950

De Roon, F. A., T. E. Nijman, and B. J. M. Werker, 2001, Testing For Mean-Variance Spanning With Short Sales Constraints And Transaction Costs: The Case Of Emerging Markets, *Journal of Finance*, Vol. 56(2), pp721-742

Eichengreen, B. and H. Tong, 2003, *Stock Market Volatility and Monetary Policy: What the Historical Record Shows*, presented at the Reserve Bank of Australia’s annual research conference on Asset Prices and Monetary Policy, Sydney, 18-19 August, 2003

Engen, E. M., 2000, *Mutual Funds and the US Equity Market*, Federal Reserve Bulletin, Issue December, pp797-812

Engle, J. P. W., H. M. Kat and T. P. Kocken, 2005, *Strategic Interest Rate Hedges Or How Derivatives Can Help Solve The Pension Fund Crisis Part II*, Working Paper WP0507, Pensions Institute, London

Fama, E. and K. French, 1988, Permanent And Temporary Components Of Stock Prices, *Journal of Political Economy*, Vol. 96, pp246-273

Faruqee, H, S. Li and I. K. Yan; 2004; *The Determinants of International Portfolio Holdings and Home Bias*; IMF Working Paper WP/04/34; International Monetary Fund, Washington.

Ferreira, M., and P. Gama, 2004, Have World, Country and Industry Risk Changed Over Time? An Investigation of the Developed Stock Markets Volatility, *Journal of Financial and Quantitative Analysis,* Vol. 40, pp195-222

Fischer, B. and H. Reisen; 1993; *Liberalising Capital Flows in Developing Countries: Pitfalls, Prerequisites and Perspectives*: OECD Development Centre Studies; Paris.

Fontaine, J. A.; 1997; Are There (good) Macroeconomic Reasons for Limiting External Investments by Pension Funds? The Chilean Experience; ed. S. Valdes-Prieto; *The Economics of Pensions*; Cambridge University Press.

Fore, D.; 2004; *Changes in Accounting Practices Will Drive Pension Paradigm Shift*; PRC WP 2004-8; Pension Research Council, The Wharton School, University of Pennsylvania.

French, K. R. and J. M. Poterba, 1991, Investor Diversification and International Equity Markets, *American Economic Review*, Vol. 81, pp222-226

Galer, R.; 2002; “Prudent Pension Rule” Standard For the Investment of Pension Fund Assets, in *Financial Market Trends* No. 83; OECD, Paris.

Gerrans, P., D. Gardner, M. Clark-Murphy and C. Speelman, 2005, Member Investment Choice and International Asset Exposure: A Preliminary Investigation of Home Bias, presented at The 13th Australian Colloquium of Superannuation Researchers, 4-5th July, Sydney, Australia

GFSR (Global Financial Stability Report), 2004, *Risk Management and the Pension Fund Industry* Chapter 2, International Monetary Fund, Washington

Goetzmann, W. N., L. Li and K. G. Rouwenhorst, 2005, Long-Term Global Market Correlations, *The Journal of Business*, Vol. 78(1), pp1-38

Gold, J., 2001, *Accounting/Actuarial Bias Enables Equity Investment By Defined Benefit Pension Plans*, Working Paper No. 2001-5, Pension Research Council, The Wharton School, Philadelphia

Heaton, J. and D. Lucas, 1997, Market Frictions, Savings Behaviour and Portfolio Choice, *Macroeconomic Dynamics*, Vol. 1, pp76-101

Hedesstrom, T. M., H. Svedsater and T. Garling, 2004, Identifying Heuristic Choice Rules in the Swedish Premium Pension Scheme*, The Journal of Behavioural Finance*, Vol. 5 (1), pp32-42

Herold, U. and R. Maurer, 2003, Bayesian Asset Allocation and US Domestic Bias, *Financial Analysts Journal*, Vol. 59 (6), pp54-65

Hinz, R., R. Rocha, and J. Gutierrez, 1999, *Improving The Regulation and Supervision Of Pension Funds: Are There Lessons From The Banking Sector?* Social Protection Discussion Paper No. 9929, World Bank, Washington

Holzmann, R.; 1997; "Pension Reform, Financial Market and Economic Growth, Preliminary Evidence from Chile"*; International Monetary Fund Staff Papers;* June; International Monetary Fund, Washington.

Holzmann, R.; 2000; *Can Investment in Emerging Markets Help to Solve the Aging Problem?* Social Protection Discussion Paper Series No. 0010; World Bank.

Holzmann, R., R. Palacios and A. Zviniene, 2004, *Implicit Pension Debt: Issues, Measurement and Scope in International Perspective*, Social Protection Discussion Paper Series No. 0403, The World Bank

Holzmann R and R. Hinz, 2005, Old age income support in the Twenty First Century; an international perspective on pension systems and reform, The World Bank

Hu, Y., 2005a, *Pension Reform, Economic Growth and Financial Development* - An Empirical Study, Working Paper 0505, Brunel University

Hu, Y., 2005b, Pension Fund Assets, Economic Growth And Financial Development: New Evidence From The Panel Granger Causality Test, presented at 2nd PhD Economics conference, 10th May, Leicester, UK

Hu, Y., 2005c*, Pension Reform In China - A Case Study*, Brunel University, mimeo

IMF (International Monetary Fund), 2005, *World Economic Outlook*, September, Washington

Inkmann J. and D. Blake, 2004, *Liability Valuation and Optimal Asset Allocation,* Discussion Paper No. 27, LSE-UBS Pension Research Programme, London

IPE (Investment and Pensions Europe), 2004, *Hedge Funds Investing*, supplement, May

Jackson, D., S. Bai and J. Wiggenhorn, 2005, *Effects of Currency Devaluation on ADRS and Their Underlying Stock: Evidence from Emerging Markets*, NO. 12/2005, Working Paper, Department of Economics and Finance, The University of Texas Pan American

Kang, J. K. and R.M. Stulz; 1997; Why Is There Home Bias? An Analysis of Foreign Portfolio Equity Ownership in Japan; *Journal of Financial Economics*, Vol. 46(1), pp3-28

Kat, H. M., 2005, *Integrating Hedge Funds Into The Traditional Portfolio*, Alternative Investment Research Centre, Working Paper # 0022, Cass Business School, London

Koo, H. K., 1998, Consumption and Portfolio Selection With Labour Income: A Continuous Time Approach, *Mathematical Finance*, Vol. 8(1), pp49-65

Levy, H. and M. Sarnat, 1970, International Diversification Of Investment Portfolios, *American Economic Review*, Vol. 60(4), pp668-675

Lewis, K. K.; 1999; Trying to Explain Home Bias in Equities and Consumption; *Journal of Economic Literature*; Vol. 37 No. 2, pp571-608.

Luenberger, D. G.; 1998*; Investment Science*; Oxford University Press.

Markowitz, H. M., 1959, *Portfolio Selection: Efficient Diversification of Investment*, Yale University Press, New Haven.

Markowitz, H. M.; 1991; Foundations of Portfolio Theory; *Journal of Finance*, Vol. 46. No. 2; pp469-477.

Menil, G. de, 2005, Why Should The Portfolios of Mandatory, Private Pension Funds Be Captive? (The Foreign Investment Question), *Journal of Banking and Finance*, Vol. 29, pp123-141

Merton, R. C., 1990, The Financial System and Economic Performance, *Journal of Financial Services Research*, Vol. 4, pp263-300

Mitchell, O. S.; 2000; Building an Environment for Pension Reform in Developing Countries; in *Foundations of Pension Finance*; ed. Bodie and Davis; Edward Elgar, London.

Muermann, A. and O. S. Mitchell, J. M. Volkman, 2005, *Regret, Portfolio Choice, and Guarantees in Defined Contribution Schemes*, Working Paper 2005-17, Pension Research Council, The Wharton School, Philadelphia

NAPF (National Association of Pension Funds), *Trustee Decision-Making in Theory and Practice*, London

OECD, 2001, *Survey of Investment Regulations of Pension Funds*, Paris
OECD, 2003, Institutional Investors Statistics, Paris

OECD, 2004, *OECD Recommendation on Core Principles of Occupational Pension Regulation*, Paris

OECD, 2005, *Pension Markets in Focus*, Newsletter, June, Paris

Phylaktis, K. and L. Xia, 2005*, Sources of Firms' Industry and Country Effects in Emerging Markets*, Emerging Markets Finance, Cass Business School, London

Poterba, J., 2004, *The Impact of Population Ageing On Financial Markets,* Working Paper 10851, National Bureau of Economic Research

Poterba, J., 2001, Demographic Structure and Asset Returns, *Review of Economics and Statistics*, Vol. 83, pp565-584

Reisen, H.; 1997; Liberalizing Foreign Investments by Pension Funds: Positive and Normative Aspects; *World Development*, Vol. 25 (7); pp1173-1182.

Reisen, H. and J. Williamson; 1997; Pension Funds, Capital Controls and Macroeconomic Stability; ed. S. Valdes-Prieto; *The Economics of Pensions*; Cambridge University Press.

Rocha, R., R. Hinz, and J. Gutierrez, 1999, *Improving The Regulation and Supervision of Pension Funds: Are There Lessons From The Banking Sector*? Social Protection Discussion Paper No. 9929, World Bank

Rothschild, M. and J. Stiglitz; 1976; Equilibrium in Competitive Insurance Markets; *Quarterly Journal of Economics*; pp 630-649.

Rouwenhorst, K. G., 1999, European Equity Markets and the EMU, *Financial Analysts Journal,* Vol. 55, pp27–34

Ryan, R. J., 2004, Pension Fund Management: Addressing The Problem of Asset/Liabilities Mismatch, *The New World of Pension Fund Management*, pp32-42

Sanyal, S., Demographics And Global Savings Glut*, eSocialSciences*, New Delhi

Seater, J. J.; 1993; "Ricardian Equivalence"; *Journal of Economic Literature*; Vol 31; No. 1 March; pp142-190.

Sharpe, W., 2002, Budgeting and Monitoring Pension Fund Risk, *Financial Analysts Journal*, Vol. 58 (5), pp74-86

Schwert, G. W., 1998, Why Does Stock Market Volatility Change Over Time, *Journal of Finance*, Vol. 44, No. 5, pp1115-1153

SFRC (Shadow Financial Regulatory Committees of Asia, Europe, Japan and the US), 2005, *Aging and Pensions: A Ticking Bomb*, Seoul, Korea

Shirvani, H., and B. Wilbratte, 2000, Does Consumption Respond More Strongly to Stock Market Declines Than To Increases? *International Economic Journal*, Vol. 14, pp41-49

Siegel, L. B., 2003, *Benchmarks and Investment Management*, The Research Foundation of CFA Institute

Siegel, L. B. and M. B. Waring, 2004, TIPS, The Dual Duration, and The Pension Plan, *Financial Analysts Journal,* Vol. 60 (5), pp52-64

Skerratt, L., 2002, *An Introduction To Accounting For Pension Costs*, London
http://www.accounting-notes.com/

Solnik, B., 1974, Why Not Diversify Internationally Rather Than Domestically? Financial Analysts Journal, Vol. 30, pp48-54

Solnik, B., 1998, *International Investment*, Addison-Wesley, Reading, Mass

Srinivas, P. S., E. Whitehouse and J. Yermo; 2000; *Regulating Private Pension Funds' Structure, Performance and Investments: Cross-Country Evidence*; Social Protection Discussion Paper Series No. 0113; The World Bank, Washington.

Thorp, S. and G. Milunovich, 2005, Asymmetric Risk and International Portfolio Choice, presented at The 13th Australian Colloquium of Superannuation Researchers, 4-5th July, Sydney, Australia

Thorbecke, W., 1997, On Stock Market Returns and Monetary Policy, *Journal of Finance*, Vol. 52, pp635-654

UBS (Union Bank of Switzerland), 2005, *UBS Pension Fund Indicators 2005*, UBS Global Asset Management UK, London

Van Dootingh, S., 2005, *Using Pooled Inflation Swaps To Better Match Pension Liabilities*, State Street Global Advisors

Viceira, L. M., 2001, Optimal Portfolio Choice For Long-Horizon Investors With Nontradable Labour Income, *Journal of Finance*, Vol. 56, pp433-470

Vittas, D. 1998, *Regulatory Controversies of Private Pension Funds*, Development Research Group, The World Bank, Washington

Vittas, D., 2000; *Pension Reform and Capital Market Development "Feasibility" and "Impact" Preconditions*; Policy Research Working Paper No. 2414; August; The World Bank.

Walker, E. and F. Lefort, 2002, *Pension reform and capital markets: are there any (hard) links?* Social Protection Discussion Paper No. 0201, January, The World Bank

Watson Wyatt, 2004, *How Can Pension Funds Benefit From Great Diversity?* Watson Wyatt Europe, Reigate

Wolf, M., 2005, The Paradox of Thrift: Excess Savings Are Storing Up Trouble For The World Economy, *Financial Times*, 13th June

Yang, T., 2003, *Defined Benefit Pension Plan Liabilities and International Asset Allocation*, Working Paper WP 2003-058, Michigan Retirement Research Centre

Yermo, J., 2003, *Survey of Investment Regulation of Pension Funds*, OECD, Paris

Yermo, J., 2005, *OECD Principles On Pension Fund Investment And The Implications For Accessing Global Markets*, 13th Australian Colloquium of Superannuation Researchers, Sdyney

Table 1 Observation period, data source for different assets, OECD countries (22)

	CBY	GBY	EQY	BLY	MPY	MOY	PRY	FEQY[a]	FBY[a]	Period[b]
AUS	1967-2004	1966-2004	1966-2004	1975-2004	1966-2004	1966-2004	1974-2003	1973-2004	1973-2004	1966-2004
	DS&Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
AUT		1966-2004	1970-2004		1966-2004		1990-2003	1973-2004	1973-2004	1966-2004
		GFD	GFD		GFD		DS			
BEL		1966-2004	1966-2004	1981-2004	1966-2004		1988-2003	1973-2004	1973-2004	1966-2004
		GFD	GFD	WDI	GFD		DS			
CAN	1967-2003	1966-2004	1966-2004	1966-2004	1966-2004	1966-2004	1967-2003	1973-2004	1973-2004	1966-2004
	CB&Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
CHE	1967-2004	1966-2004	1967-2004	1981-2004	1966-2004	1966-2004	1966-2004	1973-2004	1973-2004	1966-2004
	DS&Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
DEU	1967-1995	1966-2004	1966-2004	1978-2002	1966-2004	1967-2002	1967-2003	1973-2004	1973-2004	1966-2004
	Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
DNK	1967-1995	1966-2004	1967-2004	1978-2002	1966-2004	1966-2004	1985-1995	1973-2004	1973-2004	1966-2004
	Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
ESP	1986-1998	1966-2004	1966-2004	1978-2002	1966-2004		1988-2003	1973-2004	1973-2004	1966-2004
	Davis	GFD	GFD	WDI	GFD		DS			
FIN		1966-2004	1966-2004	1977-2002	1966-2004			1973-2004	1973-2004	1966-2004
		GFD	GFD	WDI	GFD					
FRA	1983-1998	1966-2004	1966-2004	1966-2004	1966-2004	1966-2004	1981-2003	1973-2004	1973-2004	1966-2004
	Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
GBR	1967-2004	1966-2004	1966-2004	1967-2004	1966-2004	1966-2004	1967-2003	1973-2004	1973-2004	1966-2004
	DS&Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
GRE		1966-2004	1966-2004	1966-2004	1966-2004			1973-2004	1973-2004	1966-2004
		Madsen&CB	GFD	WDI	GFD					
IRL		1966-2004	1966-2004	1975-2003	1966-2004		1987-2002	1973-2004	1973-2004	1966-2004
		GFD	GFD&Madsen	WDI	GFD		DS			
ITA	1983-1998	1966-2004	1966-2004	1978-2003	1966-2004	1966-2004	1985-2003	1973-2004	1973-2004	1966-2004
	DS	GFD	GFD	WDI	GFD		DS			
JPN	1967-2004	1966-2004	1966-2004	1966-2004	1966-2004	1967-2004	1967-2003	1973-2004	1973-2004	1966-2004
	DS&Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
LUX		1970-1998	1966-2004	1980-1998	1980-1998			1973-2004	1973-2004	1966-2004
		CB	GFD&Madsen	WDI	CB					
NLD	1968-1998	1966-2004	1966-2004	1967-2004	1966-2004	1967-1995	1967-2003	1973-2004	1973-2004	1966-2004
	DS&Davis	GFD	GFD	WDI	GFD	Davis	DS&Davis			
NOR		1966-2004	1966-2004	1979-2004	1966-2004		1985-2003	1973-2004	1973-2004	1966-2004
		GFD	GFD	WDI	GFD		DS			
NZL		1966-2004	1966-2004	1977-2004	1966-2004	1980-2004	1990-2003	1973-2004	1973-2004	1966-2004
		GFD	GFD&Madsen	WDI	GFD	CB	DS			
PRT		1976-2004	1966-2004	1976-1999	1966-2004		1991-2001	1973-2004	1973-2004	1966-2004
		GFD	GFD&Madsen	WDI	GFD		DS			
SWE	1967-2004	1966-2004	1966-2004	1970-2004	1966-2004	1966-2004	1981-2003	1973-2004	1973-2004	1966-2004
	DS&Davis	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			
USA	1966-2004	1966-2004	1966-2004	1966-2004	1966-2004	1966-2004	1981-2003	1973-2004	1973-2004	1966-2004
	GFD	GFD	GFD	WDI	GFD	CB&Davis	DS&Davis			

Source: CB: national central banks, Davis: Davis and Steil (2001), DS: Datastream, GFD (Global Financial Data), Madsen: Jakob Madsen, WDI (World Development Indicators 2005). CBY, corporate bond yield, GBY, government bond yield, EQY, equity yield, BLY, bond loan yield, MPY, short-term asset yield, MOY, mortgage yield, PRY, property yield, FEQY, foreign equity yield, and FBY, foreign bond yield; blank entries mean data are not available; a, FEQY and FBY are calculated by the author; b, observation period for all asset classes for each country after filling in these years data are not available by simulation (see main text for detail); all returns are in real term, i.e. adjusted for inflation.

Table 2 Observation period, data source for different assets, EMEs (17)

	CBY	GBY	EQY	BLY	MPY	MOY	PRY	FEQY[a]	FBY[a]	Period[b]
ARG	1993-2004	1992-2004	1988-2004	1994-2003	1978-2004		1994-2003	1973-2004	1973-2004	1991-2004
	DS	GFD	GFD	WDI	GFD		DS			
BRA	1993-2004		1988-2004	1997-2004				1973-2004	1973-2004	1991-2004
	DS		GFD	WDI						
CHL		1990-2004	1983-2004	1977-2003	1966-2004			1973-2004	1973-2004	1990-2004
		CB	GFD	WDI	GFD					
CHN		1993-2004	1993-2004	1980-2004				1973-2004	1973-2004	1991-2004
		DS	DS	WDI						
HKG		1994-2004	1973-2004	1990-2004	1968-2004			1973-2004	1973-2004	1991-2004
		GFD	GFD	WDI	GFD					
IDN	1997-2004		1991-2004	1986-2003	1973-2003		1991-2003	1973-2004	1973-2004	1991-2004
	DS		GFD	WB	GFD		DS			
IND		1966-2004	1988-2004	1986-2004	1966-2004			1973-2004	1973-2004	1988-2004
		GFD	GFD	WDI	GFD					
ISR		1994-2004	1993-2004		1987-2004			1973-2004	1973-2004	1991-2004
		GFD	GFD		GFD					
KOR	1992-2004	1966-2004	1966-2004	1980-2004	1966-2004			1973-2004	1973-2004	1991-2004
	DS	GFD	GFD	WDI	GFD					
MEX	1993-2004	1995-2004	1988-2004	1993-2004	1966-2004			1973-2004	1973-2004	1991-2004
	DS	GFD	GFD	WDI	GFD					
MYS		1966-2004	1973-2004	1987-2004	1966-2004			1973-2004	1973-2004	1987-2004
		GFD	GFD	WDI	GFD					
PAK		1966-2004	1988-2004		1966-2004			1973-2004	1973-2004	1988-2004
		GFD	GFD		GFD					
PER	1997-2004		1994-2004	1986-2004				1973-2004	1973-2004	1991-2004
	DS		GFD	WDI						
PHL	1997-2004	1994-2003	1982-2004	1976-2003	1966-2004			1973-2004	1973-2004	1991-2004
	DS	GFD	GFD	WDI	GFD					
SGP		1988-2004	1973-2004	1978-2004	1966-2004		1985-2004	1973-2004	1973-2004	1988-2004
		GFD	GFD	WDI	GFD		DS			
THA	1998-2004	1976-2004	1976-2004	1976-2004	1966-2004		1992-1999	1973-2004	1973-2004	1976-2004
	DS	GFD&DS	GFD	WDI	GFD		DS			
ZAF	1997-2004	1966-2004	1966-2004	1966-2004	1966-2004			1973-2004	1973-2004	1973-2004
	DS	GFD	GFD	WDI	GFD					

Source: CB: national central banks, Davis: Davis and Steil (2001), DS: Datastream, GFD (Global Financial Data), Madsen: Jakob Madsen, WDI (World Development Indicators 2005). CBY, corporate bond yield, GBY, government bond yield, EQY, equity yield, BLY, bond loan yield, MPY, short-term asset yield, MOY, mortgage yield, PRY, property yield, FEQY, foreign equity yield, and FBY, foreign bond yield; blank entries mean data are not available; a, FEQY and FBY are calculated by the author; b, observation period for all asset classes for each country after filling in these years data are not available by simulation (see main text for detail); all returns are in real term, i.e. adjusted for inflation.

Table 3 Statistical summary of real asset returns in %, OECD countries (22)

		CBY	GBY	EQY	BLY	MPY	MOY	PRY	FEQY	FBY
AUS	Mean	6.6	4.0	9.7	5.9	2.5	3.7	5.3	10.2	6.3
	SD[a]	21.2	11.3	24.2	4.1	4.0	3.8	16.6	26.7	16.0
AUT	Mean		5.1	7.6		2.7		0.1	6.5	2.4
	SD		11.1	29.0		2.1		6.9	26.6	13.5
BEL	Mean		4.7	7.9	7.2	3.2		3.4	7.8	3.7
	SD		9.0	20.9	1.8	2.7		18.1	26.8	14.4
CAN	Mean	6.7	4.7	6.0	4.0	2.8	5.0	6.9	9.3	3.7
	SD	13.3	10.4	16.4	2.5	2.8	2.4	8.6	24.2	14.4
CHE	Mean	7.0	3.1		2.9	0.4	1.9	1.1	5.1	1.3
	SD	21.6	17.6		1.3	2.2	2.1	7.9	27.0	14.2
DEU	Mean	3.8	4.8	6.9	7.5	1.7	4.3	6.6	6.4	2.5
	SD	15.5	7.9	23.9	1.4	2.0	1.6	13.4	26.0	13.5
DNK	Mean	5.3	6.8	11.6	7.3	4.7	5.7	13.9	6.5	4.2
	SD	12.2	14.5	32.8	2.0	4.7	3.3	14.9	26.6	13.3
ESP	Mean	3.1	3.7	8.8	4.2	1.2		13.7	11.2	7.1
	SD	4.6	15.4	29.5	3.7	4.5		38.2	28.0	14.7
FIN	Mean		4.6	16.9	3.5	3.1		11.6	9.2	5.2
	SD		8.2	41.8	3.3	4.4		12.9	28.0	14.2
FRA	Mean	5.7	4.5	8.8	3.3	2.7	3.7	4.3	8.7	4.7
	SD	1.3	11.3	26.4	3.0	2.7	2.0	12.2	25.7	14.0
GBR	Mean	4.1	3.5	10.1	1.8	-0.1	2.8	13.5	9.1	5.6
	SD	13.1	8.5	29.5	4.3	6.0	4.5	62.6	25.2	13.4
GRE	Mean		5.2	11.7	4.7	0.0			15.9	12.0
	SD		6.9	56.5	6.8	5.4			28.6	15.3
IRL	Mean		4.2	10.1	2.7	-0.6		24.2	10.2	6.2
	SD		15.9	35.8	4.8	6.7		54.3	26.6	13.3
ITA	Mean	2.7	4.5	5.6	6.0	2.6		7.0	11.9	7.4
	SD	3.5	17.2	32.6	3.6	3.7		30.0	27.2	14.0

JPN	Mean	6.4	3.6	7.8	2.0	0.3	2.9	8.5	4.7	0.8
	SD	15.8	8.8	28.6	3.4	3.6	3.6	28.9	20.5	12.7
LUX	Mean		2.9	10.5	4.1	4.6			7.8	3.7
	SD		2.8	31.4	1.8	1.9			26.8	14.4
NLD	Mean	5.1	4.2	9.8	5.9	1.6	4.4	3.0	6.7	2.8
	SD	18.7	9.2	24.2	3.2	3.4	2.3	10.1	26.2	13.4
NOR	Mean		2.8	10.7	6.6	2.5		16.4	8.7	4.7
	SD		8.3	41.9	2.8	3.6		47.9	27.2	12.8
NZL	Mean		2.5	6.1	4.4	2.7	5.7	-2.5	10.6	6.7
	SD		13.6	31.2	7.5	4.9	3.5	19.7	26.7	15.8
PRT	Mean		4.0	12.0	4.1	-1.1		-2.2	14.7	10.7
	SD		20.8	53.6	7.0	6.0		22.4	28.8	16.2
SWE	Mean	4.2	3.9	12.5	5.3	2.4	4.1	-1.8	10.0	6.1
	SD	14.0	9.3	29.2	3.0	3.3	2.9	45.5	28.2	14.7
USA	Mean	4.6	3.7	7.1	3.8	1.5	4.4	3.5	5.7	2.6
	SD	10.1	11.9	17.6	2.5	2.2	2.8	17.9	19.7	6.5
Memo:										
Average mean		**5.0**	**4.1**	**9.4**	**4.6**	**1.9**	**4.0**	**6.8**	**8.9**	**5.0**
Average SD		**12.7**	**11.4**	**31.3**	**3.5**	**3.8**	**2.9**	**24.4**	**26.2**	**13.9**

Source and Key: see Table 1; blank entries mean data are not available; a, standard deviation.

Table 4 Statistical summary of real asset returns in %, EMEs (17)

		CBY	GBY	EQY	BLY	MPY	MOY	PRY	FEQY	FBY
ARG	Mean	10.2	-2.3	-315.2	12.4	212.2		17.0	314.4	316.7
	SD[a]	11.6	20.7	890.4	8.2	1255.2		71.9	804.1	824.1
BRA	Mean	-333.5		-332.3	60.7				342.5	342.5
	SD	775.1		1948.5	13.7				610.2	618.3
CHL	Mean		-3.0	24.3	17.1	-56.1			80.5	76.6
	SD		5.9	42.0	16.0	111.9			174.9	176.0
CHN	Mean		1.0	4.5	2.7				13.3	9.3
	SD		4.6	30.8	5.9				25.5	16.7
HKG	Mean		5.6	13.5	3.9	-1.2			9.5	5.6
	SD		13.2	43.4	5.4	6.7			25.1	11.8
IDN	Mean	-1.0		-6.8	10.0	1.1		-13.2	22.6	18.6
	SD	16.9		45.6	9.6	9.8		14.2	50.9	45.3
IND	Mean		0.4	13.9	7.1	1.6			14.4	10.4
	SD		9.8	32.1	2.4	5.7			26.8	14.3
ISR	Mean		6.3	6.9		1.1			55.3	52.1
	SD		7.0	29.6		7.9			92.0	90.7
KOR	Mean	6.5	13.6	20.5	3.9	6.6			12.3	8.4
	SD	5.5	19.2	40.7	4.1	6.3			26.3	15.2
MEX	Mean	-5.5	30.9	25.0	7.3	4.4		-14.5	38.1	34.4
	SD	9.7	46.0	43.3	6.4	14.7		81.0	56.1	52.2
MYS	Mean		4.0	9.2	6.1	1.1			9.6	5.7
	SD		8.0	35.0	1.3	3.3			27.0	14.4
PAK	Mean		2.0	21.2		0.6			14.8	10.7
	SD		13.8	63.7		5.4			25.8	13.1
PER	Mean	5.3		12.0	-235.1				348.0	352.2
	SD	3.6		36.3	752.9				1248.7	1294.8
PHL	Mean	4.1	6.3	16.6	5.5	2.5			15.9	11.9
	SD	2.3	1.1	68.6	6.4	7.5			27.9	17.6

SGP	Mean		2.9	6.0	5.0	1.0		14.1	7.0	3.0
	SD		3.8	33.3	1.6	4.6		44.7	25.4	12.1
THA	Mean	5.7	7.0	16.5	7.2	2.7		-15.9	10.7	6.7
	SD	2.5	10.6	50.6	3.8	4.8		51.7	25.2	13.7
ZAF	Mean	1.3	2.7	9.8	4.6	-5.1			16.0	12.1
	SD	2.7	12.6	25.2	4.9	5.9			28.9	20.3
Memo[b]:										
Average mean		**-34.1**	**5.5**	**-26.7**	**-5.4**	**12.3**		**-2.5**	**77.9**	**75.1**
Average SD		**92.2**	**12.6**	**203.5**	**56.2**	**103.6**		**52.7**	**194.2**	**191.2**
Memo[c]:										
Average mean		**1.9**	**6.9**	**12.1**	**5.8**	**1.4**		**-7.4**	**18.4**	**14.5**
Average SD		**6.6**	**12.5**	**41.7**	**4.7**	**6.9**		**47.9**	**35.6**	**25.9**

Source and Key: see Table 2; blank entries mean data are not available; a, standard deviation; b, refers to all EMEs; c, refers to all EMEs, excluding ARG, BRA, CHL and PER.

Table 5 Jarque-Bera statistics for normal distribution test, OECD countries (22)

		BLY	CBY	EQY	FBY	FEQY	GBY	MOY	MPY	PRY	No. of sig[a]
AUS	JB[b]	3.51	37.91*	0.80	0.37	0.68	0.34	1.28	1.14	0.33	1
AUT	JB			67.61*	1.50	1.30	0.69		0.27	2.59	1
BEL	JB	1.57		0.66	0.46	1.15	1.00		4.17	13.95*	1
CAN	JB	0.39	2.28	0.75	0.46	3.33	1.36	0.88	0.17	2.12	0
CHE	JB	10.08*	2.48	0.35	1.31	0.77	1.47	5.97*	4.29	3.10	1
DEU	JB	8.91*	1.59	0.58	1.38	1.48	0.87	2.17	7.96**	3.58	2
DNK	JB	1.16	0.23	0.83	1.31	0.06	0.25	0.86	0.84	1.00	0
ESP	JB	1.17	0.41	5.70	0.23	1.21	37.70*	1.68	2.08	1.00	1
FIN	JB	0.91		25.26*	0.24	12.40*	1.73		0.88		2
FRA	JB	3.71	1.16	1.30	0.31	1.71	1.41	2.10	0.47	0.81	0
GBR	JB	36.15*	26.11*	57.98*	0.20	8.26*	0.86	29.93*	13.59*	20.05*	7
GRE	JB	1.33		47.79*	1.31	0.74	2.45		5.39		1
IRL	JB	2.27		0.78	0.61	4.09	0.60		3.32	5.10	0
ITA	JB	1.98	0.71	9.23*	1.42	12.35*	1.54		0.89	1.04	2
JPN	JB	278.84*	17.66*	10.14*	0.03	0.63	7.32*	234.99*	171.20*	1.37	6
LUX	JB	0.28		55.87*	0.40	1.13	1.33		2.00		1
NLD	JB	0.95	20.99*	1.41	1.52	1.33	26.90*	1.97	1.60	3.55	2
NOR	JB	0.47		50.40*	0.58	2.67	0.30		0.50	12.52*	2
NZL	JB	8.15*		18.06*	0.49	0.11	0.24	3.57	2.04	2.94	2
PRT	JB	4.89		24.29*	1.20	0.97	1.35		22.97*	1.10	2
SWE	JB	0.85	2.65	1.73	1.17	19.79*	1.49	0.80	2.07	5.34	1
USA	JB	1.32	0.10	2.13	12.49*	20.32*	4.26	0.31	0.29	24.09*	3

Source: own calculations; key, see Table 1; blank entries mean data are not available; a, significant against null hypothesis of normality at 5%; b, JB: Jarque-Bera statistics.

Table 6 Jarque-Bera statistics for normal distribution test, EMEs (17)

		BLY	CBY	EQY	FBY	FEQY	GBY	MOY	MPY	PRY	No. of sig[a]
ARG	JB[b]	1.86	6.98*	19.42*	25.95*	7.97*	12.98*		41.31*	4.91	6
BRA	JB	1.11	7.19*	6.08*	5.60	5.70					2
CHL	JB	8.86*		1.53	2.90	3.28	3.25		3.31		1
CHN	JB	7.10*		0.97	1.19	2.35	3.93				1
HKG	JB	0.82		1.88	4.12	1.40	0.88		0.90		0
IDN	JB	34.92*	0.35	0.89	56.95*	35.77*			25.33*		4
IND	JB	6.62*		0.91	0.46	0.59	2.82		1.12		1
ISR	JB			0.59	0.63	3.32	0.53		1.16		0
KOR	JB	0.81	8.69*	0.71	1.88	0.76	2.99		1.58		1
MEX	JB	7.61*	2.53	0.93	44.20*	1.75	5.00		10.65*		3
MYS	JB	13.64*		1.93	12.51*	0.36	1.61		0.90		2
PAK	JB			5.91*	5.16	0.33	12.12		0.82		1
PER	JB	53.19*		0.80	52.44*	28.05*	0.72				3
PHL	JB	2.40	0.16	9.10*	0.50	0.46	0.72		0.40		1
SGP	JB	6.08*		4.86	12.57*	0.07	0.03		0.88	0.86	2
THA	JB	2.27		2.91	0.67	0.40	54.33*		4.90		1
ZAF	JB	1.31		2.58	0.90	0.58	1.32		5.80		0

Source: own calculations; key, see Table 2; blank entries mean data are not available; a, significant against null hypothesis of normality at 5%; b, JB: Jarque-Bera statistics.

Table 7A Rate of change (%) in risk (EMEs), from the QAR to the PPR

EMEs	Return bounds[a]	~2004[b]	~2003	~2002	~2001	~2000
ARG	[10,27]	-42.5	-40.4	-49.3	-26.3	-33.6
CHL	[4,17]	-47.4	-56.4	-63.4	-54.3	-51.7
HKG	[4,21]	-6.7	-7.0	-9.1	-8.6	-11.4
IDN	[6,8]			-23.9	-23.9	-32.8
IND	[7,15.5]	-53.2	-51.2	-58.0	-61.2	-50.2
ISR	[5,8]	-31.1	-31.4	-28.3	-5.6	-38.2
KOR	[5,13]	-4.1	-6.3	-1.5	-13.3	-17.3
MEX	[4,40]	-15.2	-16.0	-15.2	-15.6	-20.2
MYS	[4,11]	-18.6	-18.4	-15.6	-14.2	-20.9
PAK	[4,21]	-54.6	-54.3	-59.5	-73.9	-76.7
PER	[6,64]	-61.3	-62.4			
PHL	[6,12]	-64.9	-64.1			
SGP	[3,15]	-11.7	-10.3	-8.4	-9.6	-7.7
THA	[8,17]	-17.5	-14.8	-19.6	-24.7	-33.9
ZAF	[0,9]	-26.6	-26.5	-26.7	-26.2	-27.3

Note: a, lower and upper bounds of portfolio returns, (they are not necessarily same across countries); b, refers to the last year of the sub-sample

Table 7B Rate of change (%) in risk (EMEs), from the QAR to the PPR

EMEs	Min	Max	Median	Mean	SD[a]
ARG	-49.3	-26.3	-40.4	-38.4	8.8
CHL	-63.4	-47.4	-54.3	-54.6	6.0
HKG	-11.4	-6.7	-8.6	-8.6	1.9
IDN	-32.8	-23.9	-23.9	-26.9	5.1
IND	-61.2	-50.2	-53.2	-54.8	4.7
ISR	-38.2	-5.6	-31.1	-26.9	12.4
KOR	-17.3	-1.5	-6.3	-8.5	6.6
MEX	-20.2	-15.2	-15.6	-16.4	2.1
MYS	-20.9	-14.2	-18.4	-17.6	2.7
PAK	-76.7	-54.3	-59.5	-63.8	10.7
PER	-62.4	-61.3	-61.9	-61.9	0.8
PHL	-64.9	-64.1	-64.5	-64.5	0.5
SGP	-11.7	-7.7	-9.6	-9.6	1.6
THA	-33.9	-14.8	-19.6	-22.1	7.5
ZAF	-27.3	-26.2	-26.6	-26.6	0.4
AVERAGE	**-39.4**	**-28.0**	**-32.9**	**-33.4**	**4.8**
AVERAGE[b]	**-26.3**	**-14.2**	**-20.0**	**-20.2**	**4.9**

Note: a, standard deviation; b, average without CHL, IND, PAK, PER and PHL.

Table 8A Rate of change (%) in Sharpe ratio (EMEs), from the QAR to the PPR

EMEs	Return bounds[a]	~2004[b]	~2003	~2002	~2001	~2000
ARG	[10,27]	101.3	86.7	189.8	37.8	52.6
CHL	[4,17]	104.4	142.7	185.1	128.5	115.2
HKG	[4,21]	7.8	8.2	10.9	10.0	13.8
IDN	[6,8]			31.5	31.5	49.0
IND	[7,15.5]	121.5	113.3	160.9	164.1	108.7
ISR	[5,8]	45.7	46.3	39.4	6.0	125.5
KOR	[5,13]	4.3	7.0	1.6	16.2	22.4
MEX	[4,40]	20.5	21.7	20.5	20.7	29.3
MYS	[4,11]	25.6	25.3	21.1	19.3	31.8
PAK	[4,21]	145.8	142.9	181.7	394.5	379.7
PER	[6,64]	165.8	166.8			
PHL	[6,12]	312.6	391.7			
SGP	[3,15]	14.3	12.6	10.1	11.2	8.7
THA	[8,17]	23.4	18.9	29.4	44.2	67.3
ZAF	[0,9]	42.6	34.1	35.0	51.7	48.3

Note: a, lower and upper bounds of portfolio returns, (they are not necessarily same across countries); b, refers to the last year of the sub-sample

Table 8B Rate of change (%) in Sharpe ratio (EMEs), from the QAR to the PPR

EMEs	Min	Max	Median	Mean	SD[a]
ARG	37.8	189.8	86.7	93.6	59.5
CHL	104.4	185.1	128.5	135.2	31.4
HKG	7.8	13.8	10.0	10.2	2.4
IDN	31.5	49.0	31.5	37.4	10.1
IND	108.7	164.1	121.5	133.7	26.7
ISR	6.0	125.5	45.7	52.6	44.0
KOR	1.6	22.4	7.0	10.3	8.7
MEX	20.5	29.3	20.7	22.5	3.8
MYS	19.3	31.8	25.3	24.6	4.9
PAK	142.9	394.5	181.7	248.9	127.2
PER	165.8	166.8	166.3	166.3	0.7
PHL	312.6	391.7	352.1	352.1	56.0
SGP	8.7	14.3	11.2	11.4	2.2
THA	18.9	67.3	29.4	36.6	19.6
ZAF	34.1	51.7	42.6	42.3	7.8
AVERAGE	**68.0**	**126.5**	**84.0**	**91.9**	**27.0**
AVERAGE[b]	**18.1**	**59.5**	**31.4**	**34.1**	**16.3**

Note: a, standard deviation; b, average without CHL, IND, PAK, PER and PHL

Table 9A Rate of change (%) in risk (OECD), from the QAR to the PPR

OECD	Return bounds[a]	~2004[b]	~2003	~2002	~2001	~2000	~1999	~1998	~1997	~1996	~1995
AUS	[5, 8]	-10.0	-13.7	-14.2	-17.7	-17.2	-18.2	-15.6	-13.8	-15.3	-18.2
AUT	[3, 5]	0.0	0.0	0.0	-0.7	-1.8	-1.8	0.0	0.0	0.0	0.0
CAN	[5, 6]	0.0	0.0	0.0	0.0	-0.2	-3.1	-0.9	-0.4	-0.6	-1.5
CHE	[3, 8]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEU	[6, 7]	0.0	0.0	-0.1	-0.1	-0.4	-0.1	0.0	0.0	0.0	0.0
DNK	[8, 13]	-0.1	-0.2	-0.6	-0.4	-0.3	0.0	0.0	0.0	0.0	0.0
ESP	[6, 13]	-7.0	-9.6	-13.1	-17.3	-18.2	-13.8	-8.4	-11.5	-14.9	-20.3
FIN	[4, 16]	-1.7	-2.4	-4.4	-5.0	-4.3	-2.3	-2.1	-2.5	-1.9	-2.8
FRA	[6, 6.5]	-15.2	-17.7	-20.7	-16.8	-14.4	-13.7	-19.4	-26.9	-30.9	-46.3
GBR	[3, 13]	-11.4	-11.8	-16.1	-14.6	-13.4	-14.7	-15.4	-13.5	-14.1	-19.2
GRE	[2, 6.5]	-19.0	-19.8	-21.6	-28.6	-33.3	-33.9	-39.4	-42.0	-42.1	-48.0
IRL	[4, 24]	-19.1	-21.6	-24.3	-28.8	-27.6	-26.2	-24.7	-24.9	-26.8	-29.5
JPN	[2.5, 8]	-0.9	-0.9	-0.4	-0.6	-0.8	-2.4	-2.3	-2.6	-1.4	-0.6
LUX	[5, 10]	-0.9	-0.9	-0.4	-0.6	-0.8	-2.4	-2.3	-2.6	-1.4	-0.6
NLD	[5.5, 9]	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOR	[6, 17]	-15.5	-14.7	-15.1	-19.3	-20.5	-19.3	-17.8	-13.3	-13.9	-14.2
PRT	[3, 10.5]	-61.8	-62.8	-64.3	-64.2	-63.4	-63.9	-61.0	-62.0	-64.0	-66.7
SWE	[5.5, 12]	-6.4	-8.2	-12.7	-9.3	-6.9	-4.8	-5.9	-5.6	-5.5	-9.5
USA	[2, 7]	-2.7	-1.6	-1.3	-0.8	-1.3	-1.7	-1.6	-2.1	-2.8	-3.0

Note: a, lower and upper bounds of portfolio returns, (they are not necessarily same across countries); b, refers to the last year of the sub-sample

Table 9B Rate of change (%) in risk (OECD), from the QAR to the PPR

OECD	Min	Max	Median	Mean	SD[a]
AUS	-18.2	-10.0	-15.4	-15.4	2.6
AUT	-1.8	0.0	0.0	-0.4	0.7
CAN	-3.1	0.0	-0.3	-0.7	1.0
CHE	0.0	0.0	0.0	0.0	0.0
DEU	-0.4	0.0	0.0	-0.1	0.1
DNK	-0.6	0.0	-0.1	-0.2	0.2
ESP	-20.3	-7.0	-13.5	-13.4	4.4
FIN	-5.0	-1.7	-2.4	-2.9	1.2
FRA	-46.3	-13.7	-18.5	-22.2	10.1
GBR	-19.2	-11.4	-14.4	-14.4	2.2
GRE	-48.0	-19.0	-33.6	-32.8	10.3
IRL	-29.5	-19.1	-25.5	-25.3	3.2
JPN	-2.6	-0.4	-0.9	-1.3	0.8
LUX	-2.6	-0.4	-0.9	-1.3	0.8
NLD	-0.1	0.0	0.0	0.0	0.0
NOR	-20.5	-13.3	-15.3	-16.4	2.6
PRT	-66.7	-61.0	-63.7	-63.4	1.6
SWE	-12.7	-4.8	-6.6	-7.5	2.4
USA	-3.0	-0.8	-1.6	-1.9	0.7
AVERAGE	**-15.8**	**-8.6**	**-11.2**	**-11.6**	**2.4**
AVERAGE[b]	**-13.0**	**-5.6**	**-8.3**	**-8.7**	**2.4**

Note: a, standard deviation; b, average without PRT

Table 10A Rate of change (%) in Sharpe ratio (OECD), from the QAR to the PPR

OECD	Return bounds[a]	~2004[b]	~2003	~2002	~2001	~2000	~1999	~1998	~1997	~1996	~1995
AUS	[5, 8]	11.4	16.4	17.1	22.4	21.8	23.4	19.3	16.5	18.7	23.1
AUT	[3, 5]	0.0	0.0	0.0	0.7	1.8	1.8	0.0	0.0	0.0	0.0
CAN	[5, 6]	0.0	0.0	0.0	0.0	0.2	3.5	1.0	0.4	0.6	1.5
CHE	[3, 8]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEU	[6, 7]	0.0	0.0	0.1	0.1	0.4	0.1	0.0	0.0	0.0	0.0
DNK	[8, 13]	0.1	0.2	0.6	0.4	0.3	0.0	0.0	0.0	0.0	0.0
ESP	[6, 13]	7.6	10.6	15.3	21.1	22.7	16.3	9.3	13.1	17.7	25.8
FIN	[4, 16]	1.7	2.5	4.7	5.3	4.5	2.4	2.2	2.6	2.0	2.9
FRA	[6, 6.5]	17.9	21.5	26.0	20.2	16.9	15.9	24.5	38.7	48.4	106.1
GBR	[3, 13]	13.5	14.2	20.1	17.9	16.2	17.8	18.7	16.1	8.7	24.8
GRE	[2, 6.5]	29.5	31.4	35.6	58.9	74.4	73.9	107.7	148.3	165.8	202.3
IRL	[4, 24]	24.7	28.7	33.7	41.3	38.8	36.1	33.9	34.2	37.8	42.9
JPN	[2.5, 8]	0.9	0.9	0.4	0.6	0.8	2.5	2.3	2.7	1.4	0.6
LUX	[5, 10]	0.9	0.9	0.4	0.6	0.8	2.5	2.3	2.7	1.4	0.6
NLD	[5.5, 9]	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOR	[6, 17]	18.8	17.6	18.4	24.7	27.0	24.9	22.4	15.8	16.4	17.0
PRT	[3, 10.5]	167.3	174.5	187.5	186.3	178.8	182.8	161.9	112.7	200.1	193.8
SWE	[5.5, 12]	6.8	9.0	14.7	10.4	7.4	5.1	6.3	6.0	5.8	10.5
USA	[2, 7]	2.8	1.6	1.3	0.8	1.3	1.7	1.6	2.1	2.9	3.1

Note: a, lower and upper bounds of portfolio returns, (they are not necessarily same across countries); b, refers to the last year of the sub-sample

Table 10B Rate of change (%) in Sharpe ratio (OECD), from the QAR to the PPR

OECD	Min	Max	Median	Mean	SD[a]
AUS	11.4	23.4	19.0	19.0	3.8
AUT	0.0	1.8	0.0	0.4	0.8
CAN	0.0	3.5	0.3	0.7	1.1
CHE	0.0	0.0	0.0	0.0	0.0
DEU	0.0	0.4	0.0	0.1	0.1
DNK	0.0	0.6	0.1	0.2	0.2
ESP	7.6	25.8	15.8	15.9	6.0
FIN	1.7	5.3	2.5	3.1	1.3
FRA	15.9	106.1	23.0	33.6	27.5
GBR	8.7	24.8	17.0	16.8	4.3
GRE	29.5	202.3	74.2	92.8	61.0
IRL	24.7	42.9	35.1	35.2	5.5
JPN	0.4	2.7	0.9	1.3	0.9
LUX	0.4	2.7	0.9	1.3	0.9
NLD	0.0	0.1	0.0	0.0	0.0
NOR	15.8	27.0	18.6	20.3	4.1
PRT	112.7	200.1	180.8	174.6	24.6
SWE	5.1	14.7	7.1	8.2	3.0
USA	0.8	3.1	1.7	1.9	0.8
AVERAGE	**12.3**	**36.2**	**20.9**	**22.4**	**7.7**
AVERAGE[b]	**6.8**	**27.0**	**12.0**	**13.9**	**6.7**

Note: a, standard deviation; b, average without PRT

Table 11 Statistical summary, based on the basic model and four variants, OECD and EMEs

Panel 1: RC (rate of change in risk)											
		OECD					**EMEs**				
		Min	Max	Median	Mean	SD	Min	Max	Median	Mean	SD
Basic model[a]	**Without BL & MO**	**-15.8**	**-8.6**	**-11.2**	**-11.6**	**2.4**	**-39.4**	**-28.0**	**-32.9**	**-33.4**	**4.8**
		-13.0	**-5.6**	**-8.3**	**-8.7**	**2.4**	**-26.3**	**-14.2**	**-20.0**	**-20.2**	**4.9**
Four variants	With BL & MO	-14.5	-6.4	-9.0	-9.5	2.7	-37.7	-17.9	-25.5	-27.1	8.5
		-12.0	-3.7	-6.3	-6.9	2.7	-27.1	-9.0	-14.3	-16.2	7.8
	Without BL only[b]	-14.9	-7.4	-10.0	-10.4	2.5					
		-12.0	-4.4	-7.0	-7.4	2.6					
	Without MO only[c]	-14.4	-6.6	-9.4	-9.8	2.5					
		-12.0	-4.0	-6.8	-7.2	2.6					
	Without PR only	-17.0	-8.5	-11.5	-12.1	2.8	-38.9	-18.8	-26.7	-28.1	8.7
		-14.2	-5.9	-8.7	-9.3	2.8	-28.8	-10.2	-15.9	17.7	8.0
Panel 2: RC* (rate of change in Sharpe ratio)											
		OECD					**EMEs**				
		Min	Max	Median	Mean	SD	Min	Max	Median	Mean	SD
Basic model[a]	**Without BL & MO**	**12.3**	**36.2**	**20.9**	**22.4**	**7.7**	**68.0**	**126.5**	**84.0**	**91.9**	**27.0**
		6.8	**27.0**	**12.0**	**13.9**	**6.7**	**18.1**	**59.5**	**31.4**	**34.1**	**16.3**
Four variants	With BL & MO	12.5	33.9	17.6	19.9	7.2	35.5	128.0	71.3	78.2	39.8
		4.6	25.5	9.4	11.6	7.0	12.0	67.5	26.8	31.9	23.2
	Without BL only[b]	10.8	33.9	18.9	20.2	7.5					
		5.2	25.4	4.9	11.7	7.0					
	Without MO only[c]	12.8	33.9	18.2	20.3	7.0					
		5.0	25.5	10.0	12.0	6.8					
	Without PR only	16.0	42.0	22.9	25.5	8.5	36.6	130.1	73.0	79.8	40.3
		8.1	31.6	13.8	16.3	8.0	13.5	70.4	29.0	34.1	23.8

Source: the author's own calculations; key, see Table *; a, numbers in the first row under each heading relate to the average over all available countries, while those in the row underneath relate to the average excluding large values, i.e. potential outliers; b, data for EMEs under Without BL only are same as data for EMEs under Without BL&MO; c, data for EMEs under Without MO only are not available, in that we do not have MO data for EMEs (see Table 2).

Table 12 Optimal portfolio composition[a] at 5% real return level under the PPR scenario[b], EMEs

EMEs	STDEV	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Argentina[c]										
Brazil										
Chile	4.9		0.478	0.079		0.000			0.000	0.443
China	2.6		0.485	0.068					0.028	0.420
Hong Kong	7.8		0.078	0.106		0.338			0.015	0.463
Indonesia	4.0	0.065		0.073		0.800			0.015	0.046
India	3.5		0.065	0.000		0.822			0.022	0.091
Israle	3.4		0.184	0.000		0.693			0.003	0.120
Korea										
Mexico										
Malaysia	8.9		0.608	0.075		0.002			0.000	0.316
Pakistan	3.5		0.022	0.020		0.767			0.000	0.191
Peru										
Philippine	0.9	0.203	0.791	0.005		0.001			0.000	0.000
Singapore	7.9		0.329	0.000		0.000		0.181	0.000	0.490
Thailand	4.8		0.196	0.030		0.735			0.039	0.000
S. Africa	9.8		0.173	0.186		0.274			0.000	0.367
Average	5.2	0.134	0.310	0.053		0.403		0.181	0.010	0.245
Standardised average[d]	3.9	0.100	0.232	0.040		0.301		0.136	0.008	0.184
Combined foreign assets[e]:	0.191									
Combined equities[f]:	0.048									
Combined bonds[g]:	0.516									

Source: own calculations, based on Equation 3; key see Table 1; a, optimal weights reported here are the average between a set of estimates, i.e. estimates calculated by using different sub-samples (see main text for details); b, refers to the policy without any foreign investment constraint; c, blank entries mean data are not available or zero; d, standardised average, calculated by using Equation 10 in the main text; e, FEQ plus FB; f, EQ plus FEQ; g, CB plus GB plus FB

Table 13 Optimal portfolio composition[a] at 7% real return level under the PPR scenario[b], EMEs

EMEs	STDEV	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Argentina[c]										
Brazil										
Chile	6.3		0.350	0.080		0.000			0.000	0.570
China	3.4		0.358	0.094					0.042	0.506
Hong Kong	11.3		0.183	0.162		0.062			0.024	0.569
Indonesia	6.9	0.023		0.018		0.879			0.080	0.000
India	4.7		0.186	0.006		0.515			0.023	0.269
Israle	4.1		0.583	0.000		0.209			0.021	0.187
Korea										
Mexico										
Malaysia	15.1		0.118	0.193		0.000			0.223	0.466
Pakistan	4.3		0.004	0.018		0.600			0.000	0.377
Peru	3.4	0.956		0.011					0.028	0.005
Philippine	1.9	0.000	0.943	0.000		0.000			0.038	0.019
Singapore	14.9		0.005	0.000		0.000		0.383	0.027	0.586
Thailand	7.4		0.356	0.049		0.392			0.112	0.092
S. Africa	11.2		0.212	0.216		0.146			0.000	0.426
Average	7.3	0.326	0.300	0.065		0.255		0.383	0.047	0.313
Standardised average[d]	4.3	0.193	0.177	0.039	0.000	0.151		0.227	0.028	0.185
Combined foreign assets[e]:	0.214									
Combined equities[f]:	0.067									
Combined bonds[g]:	0.556									

Source: own calculations, based on Equation 3; key see Table 1; a, optimal weights reported here are the average between a set of estimates, i.e. estimates calculated by using different sub-samples (see main text for details); b, refers to the policy without any foreign investment constraint; c, blank entries mean data are not available or zero; d, standardised average, calculated by using Equation 10 in the main text; e, FEQ plus FB; f, EQ plus FEQ; g, CB plus GB plus FB

Table 14 Optimal portfolio composition[a] at 9% real return level under the PPR scenario[b], EMEs

EMEs	STDEV	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Argentina[c]	3.6	0.678	0.156	0.006		0.003			0.083	0.020
Brazil										
Chile	7.7		0.221	0.081		0.000			0.000	0.697
China	5.0		0.144	0.142					0.063	0.651
Hong Kong	15.8		0.209	0.301		0.000			0.031	0.459
Indonesia	10.9	0.062		0.000		0.854			0.135	0.002
India	6.4		0.318	0.030		0.189			0.014	0.448
Israle	6.1		0.557	0.000		0.000			0.041	0.402
Korea	3.9	0.536	0.282	0.019		0.146			0.017	0.000
Mexico										
Malaysia	22.1		0.032	0.157		0.000			0.635	0.176
Pakistan	5.4		0.000	0.017		0.424			0.002	0.558
Peru	5.5	0.894		0.041					0.065	0.000
Philippine	6.5	0.000	0.692	0.000		0.000			0.141	0.167
Singapore	24.1		0.000	0.000		0.000		0.553	0.158	0.290
Thailand	10.6		0.483	0.071		0.050			0.182	0.214
S. Africa	12.6		0.230	0.249		0.028			0.000	0.493
Average	9.8	0.434	0.256	0.074		0.130		0.553	0.104	0.305
Standardised average[d]	5.3	0.234	0.138	0.040		0.070		0.298	0.056	0.164
Combined foreign assets[e]:	0.221									
Combined equities[f]:	0.096									
Combined bonds[g]:	0.536									

Source: own calculations, based on Equation 3; key see Table 1; a, optimal weights reported here are the average between a set of estimates, i.e. estimates calculated by using different sub-samples (see main text for details); b, refers to the policy without any foreign investment constraint; c, blank entries mean data are not available or zero; d, standardised average, calculated by using Equation 10 in the main text; e, FEQ plus FB; f, EQ plus FEQ; g, CB plus GB plus FB

Table 15 Optimal portfolio composition[a] at 5% real return level under the PPR scenario[b], OECD

OECD	STDEV	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Australia	6.5	0.010	0.000	0.085		0.485		0.199	0.049	0.171
Austria	9.2		0.648	0.164		0.166		0.000	0.022	0.000
Belgium[c]	6.8		0.259	0.206		0.362		0.143	0.030	0.000
Canada	3.2	0.090	0.000	0.041		0.551		0.311	0.008	0.000
Switzerland	11.7	0.098	0.000	0.461		0.349		0.091	0.000	0.000
Germany	4.7	0.000	0.372	0.056		0.282		0.291	0.000	0.000
Denmark										
Spain	1.9	0.957	0.015	0.012		0.003		0.004	0.000	0.009
Finland	6.4		0.074	0.098		0.711			0.003	0.113
France	1.1	0.919	0.000	0.002		0.038		0.006	0.017	0.019
UK	8.8	0.000	0.405	0.063		0.096		0.079	0.043	0.315
Greece	6.2		0.570	0.000		0.234			0.000	0.197
Ireland	9.0		0.000	0.003		0.381		0.091	0.000	0.526
Italy	1.3	0.904	0.018	0.000		0.000		0.014	0.013	0.051
Japan	8.8	0.048	0.577	0.017		0.058		0.215	0.085	0.000
Luxembourg	2.4		0.000	0.058		0.931			0.011	0.000
Netherlands	5.3	0.022	0.253	0.159		0.130		0.433	0.002	0.000
Norway	7.0		0.000	0.001		0.641		0.085	0.088	0.185
New Zealand	7.8		0.000	0.000		0.613		0.000	0.149	0.238
Portugal	7.6		0.087	0.019		0.407		0.065	0.003	0.419
Sweden	7.7	0.000	0.003	0.130		0.621		0.013	0.057	0.175
USA	7.9	0.219	0.000	0.323		0.048		0.243	0.014	0.154
Average	6.3	0.272	0.156	0.090		0.338		0.127	0.028	0.122
Standardised average[d]	5.3	0.240	0.138	0.080		0.298		0.112	0.025	0.108
Combined foreign assets[e]:	0.133									
Combined equities[f]:	0.105									
Combined bonds[g]:	0.485									

Source: own calculations, based on Equation 3; key see Table 1; a, optimal weights reported here are the average between a set of estimates, i.e. estimates calculated by using different sub-samples (see main text for details); b, refers to the policy without any foreign investment constraint; c, blank entries mean data are not available or zero; d, standardised average, calculated by using Equation 10 in the main text; e, FEQ plus FB; f, EQ plus FEQ; g, CB plus GB plus FB

Table 16 Optimal portfolio composition[a] at 7% real return level under the PPR scenario[b], OECD

OECD	STDEV	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Australia	10.4	0.023	0.014	0.126		0.093		0.328	0.121	0.295
Austria	9.2		0.166	0.256		0.000		0.000	0.578	0.000
Belgium[c]	15.4		0.127	0.551		0.021		0.130	0.171	0.000
Canada	5.1	0.170	0.005	0.044		0.139		0.605	0.038	0.000
Switzerland	16.8	0.141	0.000	0.670		0.113		0.075	0.000	0.000
Germany	6.9	0.000	0.369	0.103		0.009		0.505	0.014	0.000
Denmark	4.7	0.006	0.000	0.007		0.764		0.205	0.000	0.018
Spain	4.7	0.722	0.000	0.046		0.000		0.094	0.059	0.079
Finland	10.5		0.219	0.209		0.367			0.023	0.181
France	7.2	0.674	0.000	0.086		0.000		0.000	0.240	0.000
UK	11.7	0.000	0.196	0.134		0.000		0.104	0.110	0.456
Greece	7.0		0.701	0.002		0.000			0.007	0.290
Ireland	11.6		0.000	0.024		0.190		0.126	0.001	0.660
Italy	6.6	0.568	0.000	0.000		0.000		0.011	0.156	0.265
Japan	8.8	0.048	0.577	0.017		0.058		0.215	0.085	0.000
Luxembourg	11.1		0.000	0.303		0.595			0.102	0.000
Netherlands	9.4	0.056	0.077	0.391		0.000		0.475	0.000	0.000
Norway	11.2		0.000	0.002		0.379		0.153	0.164	0.303
New Zealand	12.0		0.000	0.000		0.320		0.000	0.287	0.393
Portugal	9.4		0.106	0.035		0.275		0.041	0.009	0.534
Sweden	12.1	0.000	0.009	0.246		0.331		0.021	0.076	0.317
USA	13.3	0.028	0.000	0.554		0.000		0.215	0.197	0.006
Average	9.8	0.187	0.117	0.173		0.166		0.174	0.111	0.173
Standardised average[d]	8.9	0.170	0.106	0.157		0.151		0.158	0.101	0.157
Combined foreign assets[e]:			0.258							

Combined equities[f]:			0.258						
Combined bonds[g]:			0.433						

Source: own calculations, based on Equation 3; key see Table 1; a, optimal weights reported here are the average between a set of estimates, i.e. estimates calculated by using different sub-samples (see main text for details); b, refers to the policy without any foreign investment constraint; c, blank entries mean data are not available or zero; d, standardised average, calculated by using Equation 10 in the main text; e, FEQ plus FB; f, EQ plus FEQ; g, CB plus GB plus FB

Table 17 Optimal portfolio composition[a] at 9% real return level under the PPR scenario[b], OECD

OECD	STDEV	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Australia	16.0	0.000	0.000	0.135		0.000		0.232	0.406	0.226
Austria										
Belgium[c]	20.0		0.015	0.520		0.000		0.098	0.367	0.000
Canada	11.6	0.001	0.000	0.006		0.008		0.547	0.438	0.000
Switzerland										
Germany	9.5	0.000	0.088	0.070		0.000		0.840	0.002	0.000
Denmark	6.2	0.009	0.000	0.027		0.516		0.426	0.000	0.022
Spain	10.7	0.358	0.000	0.088		0.000		0.229	0.153	0.172
Finland	15.3		0.227	0.337		0.156			0.044	0.236
France	19.1	0.179	0.000	0.186		0.000		0.000	0.635	0.000
UK	16.0	0.000	0.000	0.229		0.000		0.121	0.274	0.377
Greece	9.0		0.478	0.020		0.000			0.069	0.433
Ireland	14.4		0.000	0.041		0.015		0.171	0.003	0.769
Italy	12.8	0.208	0.000	0.000		0.000		0.014	0.299	0.479
Japan	17.1	0.154	0.040	0.208		0.000		0.546	0.052	0.000
Luxembourg	20.4		0.000	0.548		0.259			0.192	0.000
Netherlands	15.9	0.054	0.000	0.696		0.000		0.249	0.000	0.000
Norway	15.7		0.000	0.003		0.124		0.221	0.241	0.411
New Zealand	16.8		0.000	0.000		0.049		0.000	0.452	0.500
Portugal	11.3		0.124	0.050		0.144		0.018	0.019	0.645
Sweden	16.7	0.000	0.000	0.373		0.076		0.028	0.105	0.419
USA		0.000	0.000	0.135		0.000		0.232	0.406	0.226
Average	14.5	0.088	0.051	0.186		0.071		0.234	0.198	0.247

Standardised average[d]	13.5	0.082	0.048	0.173		0.066		0.218	0.184	0.230
Combined foreign assets[e]:			0.414							
Combined equities[f]:			0.357							
Combined bonds[g]:			0.359							

Source: own calculations, based on Equation 3; key see Table 1; a, optimal weights reported here are the average between a set of estimates, i.e. estimates calculated by using different sub-samples (see main text for details); b, refers to the policy without any foreign investment constraint; c, blank entries mean data are not available or zero; d, standardised average, calculated by using Equation 10 in the main text; e, FEQ plus FB; f, EQ plus FEQ; g, CB plus GB plus FB

Table 18 Statistical summary of standard deviation by portfolio return, OECD countries and EMEs

	OECD			EMEs			
	5%	**7%**	**9%**		**5%**	**7%**	**9%**
Australia	5.0	9.9	16.0	Argentina			3.6
Austria	9.2	9.2		Brazil			
Belgium				Chile	4.9	6.3	7.7
Canada	2.5	4.4	11.6	China	2.6	3.4	5.0
Switzerland	10.4	16.2		Hong Kong	7.8	11.3	15.8
Germany	2.7	6.8	9.5	Indonesia	4.0	6.9	10.9
Denmark		3.5	5.4	India	3.5	4.7	6.4
Spain	1.9	4.7	10.7	Israel	3.4	4.1	6.1
Finland	6.4	10.5	15.3	Korea			3.9
France	1.1	7.2	19.1	Mexico			
UK	6.6	11.0	16.0	Malaysia	8.9	15.1	22.1
Greece	6.2	7.0	9.0	Pakistan	3.5	4.3	5.4
Ireland	9.0	11.6	14.4	Peru		3.4	5.5
Italy	1.3	6.6	12.8	Philippine	0.9	1.9	6.5
Japan	5.1	12.8	17.1	Singapore	7.9	14.9	24.1
Luxembourg	2.4	11.1	20.4	Thailand	4.8	7.4	10.6
Netherlands	3.3	8.3	15.9	S. Africa	9.8	11.2	12.6
Norway	7.0	11.2	15.7	**AVERAGE**	**5.2**	**7.3**	**9.8**
New Zealand	2.8	5.7	14.2	**Std AV**	**3.9**	**4.3**	**5.3**
Portugal	7.6	9.4	11.3				
Sweden	4.1	9.6	15.6				
USA	3.9	13.5					
AVERAGE	**4.9**	**9.1**	**13.9**				
Std AV	**3.5**	**7.3**	**12.2**				

Source: Tables 12 through 17

Table 19A Statistical summary of optimal portfolio composition, based on the basic model and four variants, OECD

		Return level	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Basic model	**Without BL & MO**	**5%**	**0.240**	**0.138**	**0.080**		**0.298**		**0.112**	**0.025**	**0.108**
		7%	**0.170**	**0.106**	**0.157**		**0.151**		**0.158**	**0.101**	**0.157**
		9%	**0.082**	**0.048**	**0.173**		**0.066**		**0.218**	**0.184**	**0.230**
Four variants	With BL & MO	5%	0.199	0.037	0.038	0.230	0.069	0.349	0.030	0.008	0.040
		7%	0.128	0.027	0.124	0.360	0.025	0.112	0.074	0.080	0.070
		9%	0.084	0.009	0.143	0.227	0.014	0.039	0.182	0.179	0.122
	Without BL only	5%	0.186	0.058	0.050		0.131	0.456	0.039	0.012	0.068
		7%	0.168	0.063	0.125		0.071	0.256	0.113	0.084	0.120
		9%	0.076	0.047	0.149		0.034	0.121	0.209	0.173	0.189
	Without MO only	5%	0.186	0.062	0.046	0.400	0.168		0.043	0.017	0.078
		7%	0.119	0.051	0.107	0.377	0.072		0.077	0.085	0.111
		9%	0.050	0.040	0.126	0.227	0.032		0.193	0.163	0.170
	Without PR only	5%	0.180	0.037	0.046	0.253	0.068	0.360		0.013	0.042
		7%	0.119	0.034	0.142	0.355	0.023	0.149		0.105	0.072
		9%	0.080	0.011	0.231	0.186	0.015	0.068		0.282	0.126

Source: the author’s own calculations.

Table 19B Statistical summary of optimal portfolio composition, based on the basic model and four variants, EMEs

		Return level	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
Basic model	**Without BL & MO**	**5%**	**0.100**	**0.232**	**0.040**		**0.301**		**0.136**	**0.008**	**0.184**
		7%	**0.193**	**0.177**	**0.039**		**0.151**		**0.227**	**0.028**	**0.185**
		9%	**0.234**	**0.138**	**0.040**		**0.070**		**0.298**	**0.056**	**0.164**
Four variants	With BL & MO	5%	0.000	0.088	0.024	0.528	0.215		0.053	0.004	0.088
		7%	0.000	0.088	0.024	0.528	0.215		0.053	0.004	0.088
		9%	0.235	0.060	0.042	0.290	0.036		0.166	0.044	0.126
	Without BL only	5%									
		7%									
		9%									
	Without MO only	5%									
		7%									
		9%									
	Without PR only	5%	0.000	0.093	0.026	0.549	0.226			0.013	0.093
		7%	0.295	0.087	0.033	0.370	0.087			0.038	0.090
		9%	0.320	0.060	0.048	0.308	0.039			0.079	0.146

Source: the author's own calculations.

Table 20 Statistical summary of aggregate asset allocation by group and portfolio return, based on the basic model and four variants, OECD countries and EMEs

			OECD				EMEs			
			STDEV	Foreign	Equities	Bonds	STDEV	Foreign	Equities	Bonds
Four variants	With BL & MO	5%	2.9	0.048	0.046	0.277	2.4	0.092	0.028	0.177
		7%	6.5	0.150	0.204	0.225	2.4	0.089	0.040	0.398
		9%	11.6	0.301	0.322	0.215	4.6	0.171	0.086	0.422
	Without BL only	5%	3.5	0.080	0.062	0.312				
		7%	7.3	0.204	0.209	0.351				
		9%	12.2	0.363	0.323	0.312				
	Without MO only	5%	3.8	0.094	0.062	0.327				
		7%	6.7	0.197	0.192	0.281				
		9%	11.5	0.333	0.289	0.260				
	Without PR only	5%	3.2	0.055	0.059	0.259	2.7	0.106	0.039	0.186
		7%	7.4	0.177	0.247	0.226	3.3	0.127	0.071	0.472
		9%	14.7	0.408	0.513	0.217	5.3	0.225	0.127	0.526
Basic model	Without BL & MO	5%	5.5	0.133	0.105	0.485	3.9	0.191	0.048	0.516
		7%	8.9	0.258	0.258	0.433	4.3	0.214	0.067	0.556
		9%	13.5	0.414	0.357	0.359	5.3	0.221	0.096	0.536

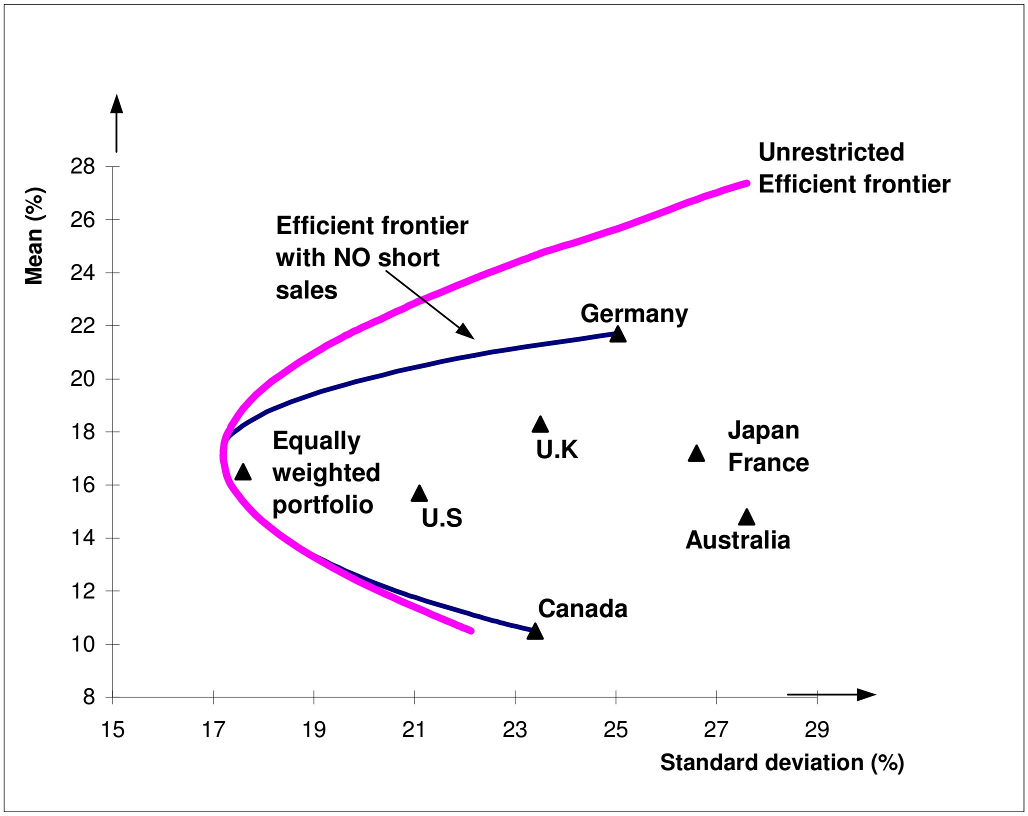
Source: the author's own calculations.

Table 21 A comparison between pension fund portfolios and optimal portfolios in selected OECD countries, 2003/2004

			Actual portfolio						
Country/Year		Portfolio return[a]	Domestic Bonds	Domestic equities	Short-term assets	Property	Foreign equities	Foreign bonds	Others
AUS	2003	10.1%	0.080	0.452	0.145	0.057	0.197	0.000	0.070
CAN	2003	10.1%	0.313	0.264	0.024	0.067	0.293	0.005	0.035
JPN	2004	5.0%	0.260	0.290	0.110	0.010	0.160	0.110	0.060
CHE	2003	9.7%	0.340	0.130	0.080	0.160	0.140	0.100	0.050
GBR	2003	8.3%	0.182	0.359	0.033	0.054	0.182	0.042	0.150
USA	2004	5.9%	0.330	0.470	0.010	0.020	0.130	0.010	0.030
			Optimal portfolio						
Country/Year		Portfolio return[b]	Domestic bonds	Domestic equities	Short-term assets	Property	Foreign equities	Foreign bonds	Others[c]
AUS	2003	9%	0.000	0.135	0.000	0.232	0.406	0.226	0.000
CAN	2003	9%	0.001	0.006	0.008	0.547	0.438	0.000	0.000
JPN	2004	5%	0.625	0.017	0.058	0.215	0.085	0.000	0.000
CHE	2003	9%	0.141	0.670	0.113	0.075	0.000	0.000	0.000
GBR	2003	9%	0.000	0.229	0.000	0.121	0.274	0.377	0.000
USA	2004	5%	0.219	0.323	0.048	0.243	0.014	0.154	0.000

Source: a, portfolio returns for JPN are from www.nikko-fi.co.jp (Nikko Financial Intelligence), and for GBR are from Clark and Hu (2005a); returns for AUS, CAN, CHE, and USA are calculated by using asset returns and portfolio composition data by the author. Data of asset returns are from a number of sources, see Table 1; As to portfolio composition, data source for AUS is www.rba.gov.au (Reserve Bank of Australia), for CAN is www.piacweb.org (Pension Investment Association of Canada), for JPN, CHE and USA is UBS Pension Fund Indicators (2005) (occupational pension schemes), for GBR is National Financial Statistics, while for USA is www.federalreserve.gov (Federal Reserve); b, portfolio returns under the optimal portfolio are selected to be closest to the returns in corresponding actual portfolios; c, by our definition in Section 5.3, allocation to "others" is zero.

Figure 1. Efficient frontiers with seven countries



Source: Bodie et al (2003)

Appendix 1 Optimal portfolio composition (%) under the basic model and the PPR scenario[a], Singapore

	Sub-sample period[b]	SD	CB[c]	GB	EQ	BL	MP	MO	PR	FEQ	FB
5%[d]	~2000	7.4		0.500	0.000		0.000		0.163	0.000	0.337
	~2001	8.8		0.283	0.000		0.000		0.201	0.000	0.516
	~2002	8.1		0.308	0.000		0.000		0.183	0.000	0.509
	~2003	7.7		0.296	0.000		0.000		0.178	0.000	0.526
	~2004	7.7		0.256	0.000		0.000		0.181	0.000	0.563
	Mean	**7.9**		**0.329**	**0.000**		**0.000**		**0.181**	**0.000**	**0.490**
	SD	**0.6**		**0.098**	**0.000**		**0.000**		**0.013**	**0.000**	**0.088**
7%	~2000	11.9		0.025	0.000		0.000		0.295	0.000	0.681
	~2001	15.8		0.000	0.000		0.000		0.376	0.052	0.572
	~2002	17.0		0.000	0.000		0.000		0.461	0.000	0.539
	~2003	14.6		0.000	0.000		0.000		0.404	0.000	0.596
	~2004	15.2		0.000	0.000		0.000		0.379	0.080	0.541
	Mean	**14.9**		**0.005**	**0.000**		**0.000**		**0.383**	**0.027**	**0.586**
	SD	**1.9**		**0.011**	**0.000**		**0.000**		**0.060**	**0.038**	**0.058**
9%	~2000	17.3		0.000	0.000		0.000		0.456	0.014	0.530
	~2001	24.3		0.000	0.000		0.000		0.441	0.302	0.257
	~2002	29.4		0.000	0.000		0.000		0.784	0.000	0.216
	~2003	24.5		0.000	0.000		0.000		0.605	0.116	0.280
	~2004	25.2		0.000	0.000		0.000		0.478	0.356	0.166
	Mean	**24.1**		**0.000**	**0.000**		**0.000**		**0.553**	**0.158**	**0.290**
	SD	**4.3**		**0.000**	**0.000**		**0.000**		**0.145**	**0.164**	**0.141**

Source: own calculations, based on Equation 3; key see Table 1; a, refers to the policy without any foreign investment constraint; b, datasets with different sub-sample periods ending at 2000 until 2004; c, blank entries mean data are not available or zero; d, in real term after inflation

Appendix 2 Optimal portfolio composition (%) under the basic model and the PPR scenario[a], UK

	Sub-sample period[b]	SD	CB	GB	EQ	BL	MP	MO	PR	FEQ	FB
5%[c]	~1995	9.1	0.000	0.252	0.095		0.000		0.260	0.024	0.370
	~1996	9.2	0.000	0.368	0.071		0.094		0.105	0.031	0.331
	~1997	9.0	0.000	0.344	0.070		0.161		0.070	0.031	0.323
	~1998	9.1	0.000	0.430	0.064		0.099		0.048	0.052	0.308
	~1999	8.9	0.000	0.374	0.071		0.148		0.052	0.064	0.292
	~2000	8.6	0.000	0.361	0.069		0.172		0.052	0.053	0.293
	~2001	8.7	0.000	0.416	0.059		0.117		0.051	0.051	0.307
	~2002	8.7	0.000	0.502	0.044		0.043		0.046	0.039	0.326
	~2003	8.5	0.000	0.481	0.044		0.073		0.052	0.041	0.309
	~2004	8.5	0.000	0.517	0.043		0.048		0.053	0.047	0.293
	Mean	**8.8**	**0.000**	**0.405**	**0.063**		**0.096**		**0.079**	**0.043**	**0.315**
	SD	**0.3**	**0.000**	**0.082**	**0.016**		**0.056**		**0.066**	**0.012**	**0.024**
7%	~1995	12.4	0.000	0.000	0.184		0.000		0.209	0.130	0.477
	~1996	11.7	0.000	0.166	0.135		0.000		0.152	0.083	0.463
	~1997	11.3	0.000	0.285	0.104		0.000		0.111	0.073	0.427
	~1998	11.9	0.000	0.238	0.137		0.000		0.072	0.127	0.426
	~1999	11.5	0.000	0.283	0.118		0.000		0.077	0.137	0.384
	~2000	11.1	0.000	0.302	0.106		0.000		0.083	0.115	0.394
	~2001	11.5	0.000	0.228	0.123		0.000		0.083	0.118	0.448
	~2002	12.3	0.000	0.097	0.157		0.000		0.077	0.101	0.568
	~2003	11.7	0.000	0.183	0.129		0.000		0.087	0.101	0.499
	~2004	11.9	0.000	0.173	0.144		0.000		0.090	0.115	0.478
	Mean	**11.7**	**0.000**	**0.196**	**0.134**		**0.000**		**0.104**	**0.110**	**0.456**
	SD	**0.4**	**0.000**	**0.094**	**0.024**		**0.000**		**0.044**	**0.020**	**0.054**
9%	~1995	17.2	0.000	0.000	0.250		0.000		0.012	0.318	0.420
	~1996	15.6	0.000	0.000	0.231		0.000		0.184	0.273	0.312
	~1997	14.2	0.000	0.000	0.188		0.000		0.161	0.143	0.508

	~1998	15.7	0.000	0.000	0.242		0.000		0.094	0.277	0.387
	~1999	14.9	0.000	0.000	0.211		0.000		0.103	0.242	0.444
	~2000	14.3	0.000	0.000	0.195		0.000		0.120	0.204	0.481
	~2001	15.6	0.000	0.000	0.217		0.000		0.126	0.279	0.377
	~2002	19.0	0.000	0.000	0.286		0.000		0.125	0.415	0.175
	~2003	16.7	0.000	0.000	0.220		0.000		0.142	0.287	0.351
	~2004	17.1	0.000	0.000	0.244		0.000		0.143	0.303	0.311
	Mean	**16.0**	**0.000**	**0.000**	**0.229**		**0.000**		**0.121**	**0.274**	**0.377**
	SD	**1.5**	**0.000**	**0.000**	**0.029**		**0.000**		**0.047**	**0.071**	**0.097**

Source: own calculations, based on Equation 3; key see Table 1; a, refers to the policy without any foreign investment constraint; b, datasets with different sub-sample periods ending at 2000 until 2004; c, in real term after inflation