

Home Bias Makes Sense for U.S. Pension Plans

An asset/liability model of pension plan portfolio allocation.

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Over the past 30 years, much attention has been paid to understanding the contribution of international securities to a mixed-asset portfolio. Foremost has been the idea that international securities offer diversification benefits because of their low correlation with other U.S. asset classes. Many authors have concluded that international securities offer diversification benefits to U.S. pension plans, and those allocations should be increased from their current levels.

The idea of diversifying a portfolio using international securities is hardly new. Levy and Sarnat [1970] empirically demonstrate that portfolio risk could be reduced with the addition of international securities. Since international securities have low correlations with U.S. assets, they can help lower portfolio risk. Clarke and Tullis [1999] and Michaud et al. [1996] estimate that international equities should represent between 20% and 30% of a portfolio's equity allocation; Lewis [1999] estimates an allocation of almost 40%.

Actual allocations to international stocks fall below these findings, averaging around 12% for most of the late 1990s and the early 2000s for large defined-benefit plans. Why are actual allocations to international equities so much lower?

The research so far follows three general themes: First, diversification costs exceed the gains. The costs of information gathering, differing tax codes and regulations, and capital restrictions and controls make international securities look less desirable than domestic securities.

Second, there are empirical problems in correctly measuring the risk of international securities. Many believe that the true risk of international securities is higher than that measured by the standard deviation of historical returns, such as in French and Poterba [1991].

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The last reason we have a home bias is that several U.S. pensions limit the holding of international securities. Pension sponsors typically establish investment guidelines. Government-sponsored pension plans have tended to place severe or total restrictions on the holding of international securities. In the 1990s, some of these restrictions were generally loosened.

The question becomes more interesting when we consider the institutional changes we have seen in the last few years with regard to pension plans and international securities. Many countries have greatly reduced or eliminated controls on capital movement into and out of their countries. At the same time, pension plan boards have been expanding the universe of possible investments for their plans, with particular focus on international securities. Pension managers should now be free to investigate international equities as a potential new investment class.

I want to determine if there is a home bias for U.S. pension plans. The main methodology examines international stock allocations using an asset/liability model. When managers try to maximize the portfolio surplus, allocations to international equities are lower than predicted by typical mean-variance models. Thus there is really no home bias in investment.

TYPICAL MEAN-VARIANCE MODEL

In the typical mean-variance model of portfolio allocation without short-selling and riskless borrowing or lending, the pension manager's objective is to minimize the risk of the portfolio, subject to a given level of return and the constraints that the asset weights are all non-negative and sum to one. By varying the return between the minimum-variance portfolio return and the maximum-variance portfolio return, the manager can trace out the efficient frontier.

In this analysis, the pension manager can choose from four broad categories of asset returns: U.S. common stocks, long-term and intermediate-term U.S. government bonds, and international equity securities. The annual U.S. stock returns are computed from the large-company index as reported in Ibbotson Associates' *SBBI 2003 Yearbook*, which represents the total return on the S&P 500 index. Both bond series returns are for U.S. government bonds reported in *SBBI 2003*. The long-term bond index has average maturities of 20 years, while the intermediate index has average maturities of 5 years.

For the international equities, the primary source is Morgan Stanley Capital International (MSCI). MSCI

compiles several indexes on international securities. I use the EAFE Index, which measures the performance of an index of equities in developed countries outside North America. The EAFE data series is available monthly starting in January 1970.*

One important aspect of the indexes created by MSCI is that they are calculated on a *free* basis, meaning that they take into account only the portion of equities available for purchase by international investors in public equity markets. This step helps to eliminate the concern with capital controls in different countries since only the stock available for foreign investment is included in the MSCI indexes.

Exhibit 1 reports the means and standard deviations for each asset class for the time periods 1988-2001 and 1970-2001. Exhibit 2 shows the asset correlation matrix. Here, notice the relatively low correlation of international equities with the other assets. As expected, these low correlations lead to higher allocations.

The results of a standard mean-variance portfolio allocation model are reported in Exhibit 3 for asset data over 1988-2001. The minimum-variance portfolio, Portfolio I, consists of about 87% intermediate bonds and 13% in international equities. As we move up the efficient fron-

EXHIBIT 1

Asset Returns

Panel A. Annual Asset Returns 1988-2001

Asset	Mean Return (%)	Standard Deviation
U.S. Stocks	15.51	15.90
Long-Term Government Bonds	10.55	11.06
Intermediate Government Bonds	8.13	6.02
International Developed Stock Markets (EAFE)	6.45	17.56

Panel B. Annual Asset Returns 1970-2001

Asset	Mean Return (%)	Standard Deviation
U.S. Stocks	13.30	16.40
Long-Term Government Bonds	9.75	11.76
Intermediate Government Bonds	8.96	6.65
International Developed Stock Markets (EAFE)	13.11	22.05

EXHIBIT 2

Return Correlations

Panel A. Correlation of Asset Returns 1988-2001

Asset	Stocks	Long-Term Government Bonds	Intermediate Government Bonds	International Developed Stocks
Stocks	1.00			
Long-Term Government Bonds	0.36	1.00		
Intermediate Government Bonds	0.27	0.93	1.00	
International Developed Stocks	0.59	0.04	-0.11	1.00

Panel B. Correlation of Asset Returns 1970-2001

Asset	Stocks	Long-Term Government Bonds	Intermediate Government Bonds	International Developed Stocks
U.S. Stocks	1.00			
Long-Term Government Bonds	0.37	1.00		
Intermediate Government Bonds	0.28	0.92	1.00	
International Developed Stocks	0.55	0.14	0.01	1.00

tier, the allocation to international equities declines to zero as the allocation to U.S. stocks increases to 100% in Portfolio VII.

In Exhibit 4, the model is estimated using asset data from 1970 through 2001. International equities are 8% of the minimum-variance portfolio and increase to a maximum of 16.39% as we move up the efficient frontier.

Although these percentages are below the high predicted allocations for international securities in other research, they are still higher than actual pension plan asset allocations. Pension managers likely allocate funds based on more than mean-variance considerations. For example, the minimum-variance portfolio also includes very high allocations to bonds, yet few managers would choose such a portfolio—most pension plans operate at higher levels of risk. In addition, managers use their own judgment and past experience to place limits on the portfolio concentrations of certain asset classes.

ASSET/LIABILITY MODEL

A new body of literature concerning pension plan allocation developed in the 1990s. These asset/liability or surplus return models of portfolio diversification take into account not only asset returns and variances but also changes in pension liabilities and their covariance with asset returns.

Research beginning with Leibowitz [1987], Sharpe [1990], and Leibowitz, Kogelman, and Bader [1994] suggests that pension managers are concerned with maximizing their risk-adjusted surplus value (assets minus liabilities). In such an optimization model, asset allocations can differ greatly from that in the standard mean-variance framework. Peskin [1997] concludes that corporations can limit the costs and risks of their pension plans if they follow such a model.

Chun, Ciochetti, and Shilling [2000] extend the model first formulated by Sharpe [1990] and apply it to pension plan asset allocation decisions involving real estate. They find that predicted portfolio allocations to real estate are much lower with an asset/liability model than with the typical asset mean-variance model.

In these models, the pension manager worries about the surplus value or the difference between plan assets and liabilities, and

EXHIBIT 3

Optimal Asset Allocations in Mean-Variance Framework Asset Returns 1988-2001

Portfolios			Asset Allocations (%)			
	Portfolio Return (%)	Portfolio Standard Deviation (%)	U.S. Stocks	Long-term Bonds	Intermediate Bonds	International Stocks
I	7.91	5.51	0.00	0.00	87.05	12.95
II	8.50	5.72	6.89	0.00	84.97	8.14
III	10.00	6.81	25.35	0.00	74.65	0.00
IV	11.50	8.74	45.03	1.96	53.01	0.00
V	13.00	11.04	56.89	27.80	15.31	0.00
VI	14.50	13.64	79.65	20.35	0.00	0.00
VII	15.51	15.90	100.00	0.00	0.00	0.00

EXHIBIT 4

Optimal Asset Allocations in Mean-Variance Framework Asset Returns 1970-2001

Portfolios			Asset Allocations (%)			
	Portfolio Return (%)	Portfolio Standard Deviation (%)	U.S. Stocks	Long-term Bonds	Intermediate Bonds	International Stocks
I	9.29	6.39	0.00	0.00	91.97	8.03
II	10.00	6.95	14.04	0.00	75.67	10.32
III	10.80	8.53	30.92	0.00	57.15	11.93
IV	11.50	10.39	45.69	0.00	40.96	13.35
V	12.30	12.82	62.57	0.00	22.46	14.97
VI	13.00	15.08	76.96	2.08	4.58	16.39
VII	13.30	16.40	100.00	0.00	0.00	0.00

thus seeks to maximize the risk-adjusted surplus return. Typical mean-variance models try to combine assets that are negatively (or less positively) correlated with each other. Such a combination greatly reduces the risk of the portfolio.

In an asset/liability model, assets with returns that are highly correlated with the changes in pension liabilities are added to the portfolio to help reduce the risk of the surplus value. You can think of the pension liabilities as an asset that the corporation has shorted. In this case, pension liabilities represent firm indebtedness held by employees. The model now searches for assets that are highly correlated with the pension liabilities. Shorting one of two positively correlated assets is equivalent to combining two assets that are negatively correlated.

To implement such a model, the first step is to measure changes in pension liabilities. These data, available from the Business Information file of Compustat, include pension assets, number of employees, and most important, the pension plan's projected benefit obligation (PBO). PBO represents the actuarial present value of all benefits earned by employees to that date plus the projected benefits attributable to future salary increases as determined by the plan's benefit formula.

By 1987, firms were required by FAS No. 87 to report PBO annually. I follow the methodology in Chun, Ciochetti, and Shilling [2000] and Craft [2001] to construct a panel of defined-benefit pension plans using only firms reporting PBO over the entire time period. The annual percent change in PBO is calculated for each

pension plan and standardized by the number of employees. This results in a panel of 684 U.S. firms with complete data in Compustat for the entire time period.

The mean annual rate of change in pension liabilities from 1988 to 2001 was 11.56% with a standard deviation of 7.27. The correlations between liabilities and the asset classes were: U.S. stocks 0.29, long-term bonds 0.78, intermediate bonds 0.86, and international stocks -0.03. The two bond assets have the highest correlation with changing liabilities, followed by U.S. stocks. The correlation with international equities is very low, however, a fact that will greatly affect the final results.

The next step is to estimate the level to which pension plans were overfunded or underfunded over the time period. The funding ratio is usually defined as pension plan assets divided by present value of pension plan liabilities. A funding ratio higher than 1 means that the pension is overfunded, and a ratio lower than 1 shows that a pension is underfunded. With data on changes in pension liabilities and funding ratios along with estimates of the correlations between liabilities and different asset classes, we can estimate an asset/liability model of portfolio allocation.

For the sake of exposition, the typical mean-variance model of asset allocation can be formulated so that the pension manager seeks to minimize the risk of the portfolio, subject to a given level of return. If no short-selling or riskless borrowing or lending is allowed, the optimization problem becomes:

$$\text{Minimize } \sum_{i=1}^N w_{A,i}^2 \sigma_{A,i}^2 + \sum_{i=1}^N \sum_{j=1}^N w_{A,i} w_{A,j} \sigma_{ij} \quad (1)$$

subject to:

$$\sum_{i=1}^N w_{A,i} R_i = \overline{R_p} \quad (2)$$

$$\sum_{i=1}^N w_{A,i} = 1 \quad (3)$$

$$w_{A,i} \geq 0 \quad (4)$$

where $w_{A,i}$ is the portfolio weight of each asset i , $\sigma_{A,i}$ is the standard deviation of each asset, σ_{ij} is the covariance between assets i and j , and R_i is the return on each asset. The manager minimizes the standard deviation of the

portfolio [Equation (1)], subject to a given level of return [Equation (2)], where the asset weights sum to 1 and each is non-negative [Equations (3) and (4)].

The asset/liability model is set up in a similar way. As in the model in Chun, Ciochetti, and Shilling [2000], the pension plan manager seeks to minimize the variance of the surplus subject to a given level of change (i.e., return) in the pension surplus. Therefore, the optimization problem becomes:

$$\text{Minimize } \sum_{i=1}^N w_{A,i}^2 \sigma_{A,i}^2 + w_L^2 \sigma_L^2 + \sum_{i=1}^N \sum_{\substack{j=1 \\ j \neq i}}^N w_{A,i} w_{A,j} \sigma_{ij} + \sum_{i=1}^N w_{A,i} w_L \sigma_{iL} \quad (5)$$

subject to

$$\sum_{i=1}^N \left(\frac{w_{A,i}}{s} \right) R_i - \left(\frac{w_L}{s} \right) R_L = \overline{R_{SP}} \quad (6)$$

$$\sum_{i=1}^N w_{A,i} = 1 \quad (7)$$

$$w_{A,i} \geq 0 \quad (8)$$

$$R_{SP} \geq 0 \quad (9)$$

To be consistent with the asset portfolio weights, w_L is defined as the ratio of liabilities to assets (the reciprocal of the funding ratio), R_L is the return or change in liabilities, σ_L is the standard deviation of pension liabilities, and σ_{iL} is the covariance between asset i and pension liabilities. For the surplus return, the asset and liability returns are weighted by s , the ratio of the surplus to assets. The surplus return on the portfolio, R_{SP} , is constrained to be at least zero, and no short-selling or riskless borrowing or lending is allowed.

Solving this problem for a typical pension plan with a funding ratio of 1 (i.e., a w_L of 1) and return data over 1988-2001 results in the efficient frontier outlined in Exhibit 5. The allocation to international equities is 0% at all levels of risk, quite different from the result for the mean-variance model in Exhibit 3.

The main reason for the difference is the low correlation between changes in

liabilities and international returns. Given the greater correlation between liabilities and U.S. stock and bond returns, those assets are weighted more in the portfolio because they reduce the risk of the surplus return.

Because the returns on international equities were particularly low during 1988-2001, in Exhibit 6 I run the asset/liability model using asset risk and return data from 1970 through 2001 but liability data from 1988 through 2001. International equities represent only 3% of the min-

EXHIBIT 5

Optimal Asset Allocations in Asset/Liability Framework Fully Funded Pension Plan Returns 1988-2001

	Portfolios		Asset Allocations (%)			
	Surplus Return (%)	Surplus Standard Deviation (%)	U.S. Stocks	Long-term Bonds	Intermediate Bonds	International Stocks
I	0.00	6.66	28.78	54.13	17.09	0.00
II	0.50	7.37	32.74	62.74	4.52	0.00
III	1.00	8.16	40.61	59.39	0.00	0.00
IV	1.50	9.14	50.68	49.32	0.00	0.00
V	2.00	10.27	60.75	39.25	0.00	0.00
VI	3.00	12.83	80.90	19.10	0.00	0.00
VII	3.94	15.47	100.00	0.00	0.00	0.00

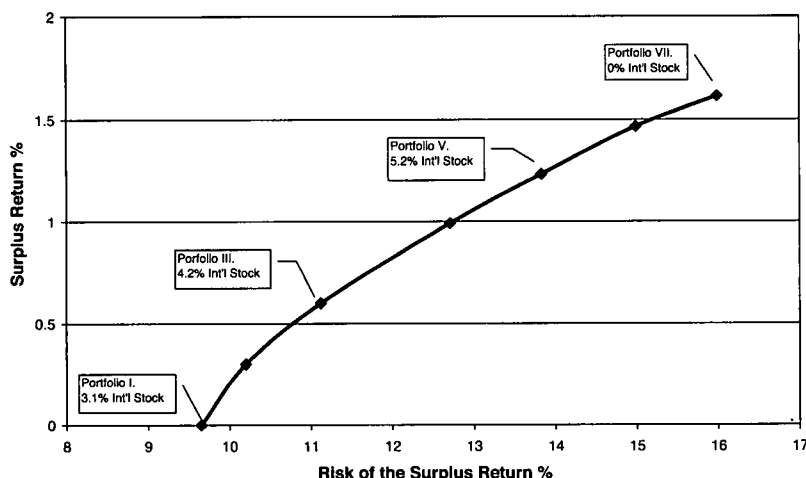
EXHIBIT 6

Optimal Asset Allocations in Asset/Liability Framework Fully Funded Pension Plan Returns 1970-2001

	Portfolios		Asset Allocations (%)			
	Surplus Return (%)	Surplus Standard Deviation (%)	U.S. Stocks	Long-term Bonds	Intermediate Bonds	International Stocks
I	0.00	9.75	50.15	37.44	9.33	3.08
II	0.30	10.67	55.97	40.36	0.00	3.67
III	0.60	11.65	63.93	31.90	0.00	4.18
IV	0.90	12.71	71.89	23.43	0.00	4.68
V	1.20	13.83	79.85	14.97	0.00	5.19
VI	1.50	14.99	87.81	6.50	0.00	5.69
VII	1.74	15.99	100.00	0.00	0.00	0.00

EXHIBIT 7

Surplus Efficient Frontier Fully Funded Pension Plan Returns 1970-2001



imum-variance portfolio now, and increase to a maximum of 5.69% over the efficient frontier.

Exhibit 7 graphs the surplus efficient frontier. Once again, the results predict a much lower allocation to international stocks than with a typical mean-variance model.

How sensitive are the portfolio allocations to the pension's funding ratio? We might expect an overfunded pension plan to enjoy the luxury of avoiding risk to meet its pension obligations, which in this case means holding fewer international equities. An underfunded pension plan, on the other hand, might be forced to take more risks in order to cover shortfalls in the portfolio.

To test this hypothesis, I recalculate the asset/liability model for a pension plan that is overfunded or underfunded by 5%. For the overfunded pension plan (i.e., $w_L = 0.95$), allocations to international equities decline from their levels in the fully funded portfolio (2.41% instead of 3.19% for the fully funded plans) and the allocations to intermediate bonds increase in the minimum-variance portfolio. Moving up the efficient frontier, the allocations to international stocks increase slightly from that in the fully funded pension results. The greater impact on overfunded plans comes from allocating more to intermediate bonds than fully funded plans.

As the pension plan becomes underfunded (i.e., $w_L = 1.05$), the portfolio includes more international equities in the minimum-variance portfolio, 3.60% instead of 3.19% for the fully funded. Moving up the efficient frontier, the allocation to international stocks drops slightly

from that in the fully funded results. Underfunded plans allocate more to U.S. stocks at all levels of risk. Overall, the funding level of the pension appears to have only a slight impact on the allocation to international stocks.

CONCLUSION

Typical asset portfolio models conclude that international equities should have a much higher portfolio allocation than what we actually observe. I conclude this does not mean that pension managers have a home bias. What they may really be doing is minimizing the variance of the surplus return of the portfolio. In an asset/liability framework, portfolio allocations are determined not only by asset

returns and variances but also by correlations with the changes in the liabilities of the pension plan. Assets with higher correlations with pension liabilities would receive higher weights.

Over the time periods analyzed, a typical mean-variance model would predict international equity allocations of as much as 16.39%. In an asset/liability framework, however, a fully funded pension would allocate at most only 5.69%, and in many cases 0%. These lower estimated allocations result from the low correlations between international equities and pension liabilities. The level of overfunding or underfunding has only a slight impact on the allocation to international equities.

Of course this is not the only reason international equities might have a low allocation. Other issues include higher transaction costs and management fees. Illiquidity would also be an issue.

My main conclusion is that an asset/liability model predicts much lower allocations to international securities than suggested by the standard mean-variance model. If managers rationally try to minimize the variance of the surplus portfolio, lower allocations to international securities make sense. Thus there is really not an equity home bias for U.S. pension plans.

ENDNOTE

*The countries included in the EAFE index are: Australia, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, the Netherlands, New

Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and the United Kingdom.

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