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Journal of Empirical Finance 8 (2001) 35–54

Journal of EMPIRICAL FINANCE

www.elsevier.com/locate/econbase

What causes home asset bias and how should it be measured?

Debra A. Glassman [a], Leigh A. Riddick [b,*]

[a] *School of Business Administration, University of Washington, Seattle, WA 98195-3200 USA*
[b] *Kogod School of Business, American University, 4400 Massachusetts Avenue NW, Washington, DC 20016-8044 USA*

Abstract

Many explanations of home asset bias involve intuitions that should affect the data inputs used by investors in optimizing portfolios: (1) transaction costs affecting expected returns, (2) perceived riskiness of foreign assets affecting standard deviations, and (3) omitted assets affecting correlations. Only the first area has been examined empirically. We examine the empirical feasibility of the second and third explanations, as well as whether combining explanations can fully account for home asset bias. We find that no single set of adjustments can explain home asset bias by itself. Combining adjustments is promising but the implied correlation structure among asset returns is puzzling. © 2001 Elsevier Science B.V. All rights reserved.

JEL classification: F30, International finance—general; G11, Portfolio choice; G15, International financial markets
Keywords: International portfolio diversification; Home asset bias; Home asset preference; Portfolio choice

1. Introduction

Previous research on international mean-variance portfolio choice consistently predicts that investors should put much more of their wealth into foreign assets than they actually do; i.e., investors appear to engage in a sub-optimal degree of

* Corresponding author. Tel.: +1-202-885-1944; fax: +1-202-885-1946.
E-mail address: riddick@american.edu (L.A. Riddick).

PII: S0927-5398(00)00026-8

international diversification. This preference for domestic over foreign assets is often referred to as home asset bias, and it has been documented for investors in several countries by many authors (including French and Poterba, 1990, 1991; Tesar and Werner, 1992, 1994, 1995; Cooper and Kaplanis, 1994).

Many researchers wishing to explain home asset bias have focused on the inputs to the investor's optimization model, examining such issues as the presence of differential transaction costs between countries, additional sources of risk for foreign investing, or the explicit omission of assets from the investor's opportunity set. We will reference and discuss their work in some detail in following sections, but here we note that the empirical implementation of each of the potential explanations for bias requires directly or indirectly adjusting the inputs to the standard mean-variance model of portfolio choice—the returns, variances, and covariances (correlations) of the assets in the investment list. Only the first category of these explanations has been examined empirically and results show that adjusting returns does not explain the home asset bias.[1]

In this paper we first examine the empirical feasibility of the remaining explanations by determining *how much* each of the statistical inputs would have to be individually altered to explain home asset bias. We find that the input values have to be outside reasonable ranges. We then ask whether there are *combinations* of the explanations that can explain observed bias towards domestic assets without resorting to extreme parameter values. In these cases, the required adjustments to expected returns and standard deviations are reasonable in magnitude, but the implied correlations for the omitted asset do not correspond to any single identifiable asset. In particular, human capital, foreign or domestic bonds, and foreign or domestic real estate do not have the same characteristics as the omitted asset we describe in our exercise. We conclude that completely erasing home asset bias requires a model with multiple omitted assets, as well as transaction costs and risk adjustments.

The reader should not view the analysis as merely a tautological exercise. We are not trying to determine *whether* adjusting model inputs can explain home asset bias; mathematically, many such combinations exist. Rather, we are asking if the necessary adjustments to model inputs are consistent with observable data and/or strong intuitions based on earlier research.

The paper is organized as follows. In Section 2, we briefly describe the standard model we use to measure home asset bias. Section 3 addresses the empirical feasibility of the three individual categories of explanations for the home asset bias: adjustments to expected returns, adjustments to standard deviations and

[1] Errunza et al. (1999) have shown that portfolios of US and foreign assets, all listed in the US, can be used to obtain foreign diversification because they replicate foreign market indices, hedging potential. They do not establish that investors actually use these portfolios, but it is an interesting avenue for further research.

adjustments to correlations resulting from the inclusion of an additional asset. In Section 4, we examine the potential for combinations of parameter adjustments to explain home asset bias. We also discuss what the results suggest about asset categories that should be included in a more complete model. We conclude with a summary section.

2. The international mean–variance model

In the remainder of the paper we focus on the empirical issue of inputs to the optimization problem for the investor. In this section, we briefly discuss the optimization model we will use, since model choice is important to the simulations we report. Adler and Dumas (1983) present the solution to the well-known international mean–variance model in a variety of ways, including decomposing the solution for optimal portfolio weights as follows:

$$\underline{x} = (1/\delta)\mathbf{\Omega}^{-1}\left[E(\underline{r}) - \underline{1}r_{\mathrm{f}}\right] + \left[1-(1/\delta)\right]\mathbf{\Omega}^{-1}\mathbf{\Phi}\underline{\alpha}, \tag{1}$$

where $\underline{x}$ is the $N \times 1$ vector of optimal portfolio shares; δ is the coefficient of relative risk aversion (CRRA); $[E(\underline{r}) - \underline{1}r_{\mathrm{f}}]$ is the vector of expected nominal excess asset returns (measured relative to the nominal risk-free rate r_{f}); $\mathbf{\Omega}$ is the variance–covariance matrix of nominal returns; $\mathbf{\Phi}$ is the matrix of covariances between nominal asset returns and rates of inflation of national goods prices; and $\underline{\alpha}$ is a vector of the investor's expenditure shares on goods from each country.

Note that this model does not require homogeneity of real return expectations to hold for all investors. There are certain special cases in which the homogeneity of expectations does hold—e.g., when purchasing power parity (PPP) holds, or when investors optimize in nominal rather than real terms. Such cases yield a single index asset pricing model—known as the International Capital Asset Pricing Model (ICAPM). However, it is clear that the necessary conditions for the ICAPM are unrealistic. In addition, Glassman and Riddick (1996) illustrate that relying on the ICAPM can double estimates of the size of home asset bias. For these reasons, we use the more general model of Eq. (1) in this paper.

3. Statistical inputs to the optimization model: returns, variances and covariances

3.1. Returns issues: transaction costs and other adjustments to returns

It is standard practice for researchers to use historical returns as the measure of expected returns in portfolio optimization. However, there are several reasons why investors are likely to adjust those historical returns before optimizing. For example, the existence of transaction costs is documented in the literature on international market segmentation (see, e.g., French and Poterba, 1990; Glassman and Riddick, 1994; Stulz, 1995; Solnik, 1996). The many additional costs of foreign investment are estimated to total 1–4% per annum, with some variation across countries (see, e.g., Perold and Sirri, 1994; Solnik, 1996). Subtracting these greater foreign asset costs reduces the expected return on foreign assets relative to domestic ones and, *ceteris paribus*, makes home assets more attractive.

Another issue related to returns is whether domestic and foreign investors have the same expectations of returns. Shiller et al. (1991) report survey data indicating that domestic investors tend to be more optimistic about domestic market returns than foreign investors are. Clearly, such optimism about home asset returns would skew portfolios towards domestic assets.

A third approach to adjusting expected returns is to account for estimation risk. In practice, returns cannot be precisely measured, but instead must be estimated by the investor or the researcher. Estimation risk is the term used for this uncertainty, and it exists in addition to the risk created by the randomness of security returns (see, e.g., Bawa et al., 1979; Jorion, 1985; Eun and Resnick, 1987). Several studies have used shrinkage estimators, which make foreign asset returns more like domestic asset returns, thus reducing the relative attractiveness of foreign investment. However, Jorion (1985) and Glassman and Riddick (1994) have found that estimation risk can explain only a small part of the divergence between actual and optimal investment portfolio positions.

Do the costs of foreign investment and other adjustments to expected returns together account for home asset bias? French and Poterba (1990, 1991) addressed this question with the method of implied returns. Given data on actual portfolio shares, $\underline{x}^*$, the implied returns are the set of expected returns that make the international portfolio model fit exactly. They are computed by solving the first-order conditions in Eq. (1) for expected real relative returns:

$$E\left[\underline{R} - \underline{1}R_{\mathrm{f}}\right] = \delta \Sigma \underline{x}^*, \tag{2}$$

where R, R_{f} and E are the returns and covariances in real terms.

The difference between these implied returns and the historical returns can be interpreted as a composite measure of all categories of adjustments to returns. The work of French and Poterba (1991) and later studies by Tesar and Werner (1992), Glassman and Riddick (1994), Cooper and Kaplanis (1994) and Baxter and Jermann (1997) all conclude that implied returns differ from historical returns by amounts far greater than reasonable estimates of returns-adjusting factors.[2,3]

[2] This result appears in the 1993 working paper version of the Baxter and Jermann paper.

[3] Tesar and Werner (1995) provide a different kind of evidence that transaction costs do not explain the patterns of international investment when they report that turnover is higher for foreign securities than for domestic ones. This is exactly the opposite of what would be expected in the presence of higher transaction costs associated with foreign investment.

Table 1
National equity market returns used to compute of optimal international portfolios (sample period: 1985:1–1990:12)

	Canada	France	Germany	Japan	UK	US
Monthly mean returns and standard deviations						
Mean	0.0104	0.0246	0.0224	0.0213	0.0209	0.0137
Std. dev.	0.0517	0.0771	0.0801	0.0822	0.0697	0.0512
Correlation matrix						
Canada	1.0	0.43	0.30	0.24	0.64	0.81
France		1.0	0.71	0.47	0.53	0.49
Germany			1.0	0.31	0.48	0.37
Japan				1.0	0.41	0.23
UK					1.0	0.61
US						1.0

Notes: all returns are in US dollar terms and include dividends. They are computed from end-of-month data. Source: Morgan Stanley Capital International indices, from Datastream.

Because we will combine returns adjustments with other input adjustments later in the paper, we start by computing implied returns for a sample of six equity markets (Canada, France, Germany, Japan, UK and the US) for the 1985–1990 period. We use historical data on stock market returns provided by Morgan Stanley. The estimation is done in real terms, with a risk-free asset included.[4] Nominal values are deflated by the US Consumer Price Index (CPI). The historical means, standard deviations and correlations for these markets are given in Table 1. The data on US investors' actual portfolio shares are from French and Poterba (1991), supplemented by data from the Federal Reserve Annual Report on holdings of the risk-free asset, which is defined as the sum of cash, demand deposits and time deposits.

The implied returns and their deviations from the historical value of relative returns for CRRA $= 3$ are presented in Fig. 1.[5] As one would expect from the literature, we observe large deviations for most countries, clearly exceeding any reasonable measure of transaction costs or investor optimism or other adjustment to returns. For example, to explain the deviations, transaction costs for France, Germany, Japan and the UK must be in excess of 1% per month (14–19% per year)—nearly as large as returns themselves. This result demonstrates that adjusting returns alone is insufficient to account for home asset bias.

[4] We used the 30-day US T-bill rate provided in the CRSP database, which averaged 0.0051 per month over our sample period.

[5] Most authors suggest CRRA values between 2 and 4. We found similar results for CRRA values from 1 to 5. They are available upon request.

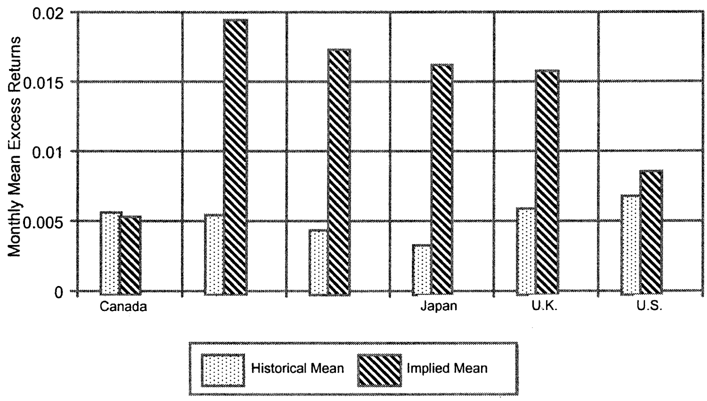

Fig. 1. Historical vs. implied mean returns, CRRA = 3.

3.2. *Variance issues: adjustments to perceived risk*

More recently, researchers have focused on the role of asset variances in explaining home asset bias (e.g., Gehrig, 1993; Coval, 1996; Glassman, 1998; Coval and Moskowitz, 1999). The intuition behind adjusting variances is simple: if the perceived risk of foreign assets is increased, then, *ceteris paribus*, foreign assets become less desirable, thus generating a home asset bias.

Why should the perceived risk of foreign assets be adjusted upwards? One explanation is that less (and lower quality) information is available about foreign assets. Barry and Brown (1984, 1985) present this as another form of estimation risk. In the presence of “differential information,” risk-averse investors prefer the high information assets because they perceive them as less risky. Additional evidence on the potential importance of informational asymmetries is provided by Kang and Stulz (1994), who examine foreign equity ownership in Japan. They find that foreign investors in Japan do not hold the Japanese market portfolio, but instead show a preference for large, well-known manufacturing firms. This could be explained if foreign investors have less information about domestic assets than do domestic investors, with the informational discrepancy being greater for small firms. However, they show that a model with size-based informational asymmetries alone cannot yield asset allocations consistent with the observed portfolios for Japanese investors.

To provide empirical evidence on the importance of variance adjustments in explaining home asset bias, we ask: how much would variances have to be adjusted to account for the observed home asset bias? The answer is provided by

Table 2
Historical standard deviations of returns vs. implied standard deviations and implied scale factors

CRRA	Canada	France	Germany	Japan	UK	US
Implied monthly standard deviations						
1	0.0735	0.3810	0.4380	0.4650	0.2651	0.0982
2	0.0520	0.2694	0.3097	0.3288	0.1875	0.0694
3	0.0424	0.2200	0.2529	0.2685	0.1531	0.0567
4	0.0368	0.1905	0.2190	0.2325	0.1326	0.0491
5	0.0329	0.1704	0.1959	0.2079	0.1186	0.0439
Implied scale factors (implied / historical)						
1	1.41	4.92	5.45	5.63	3.80	1.91
2	1.00	3.48	3.85	3.98	2.68	1.35
3	0.82	2.84	3.15	3.25	2.19	1.10
4	0.71	2.46	2.73	2.82	1.90	0.95
5	0.63	2.20	2.44	2.52	1.70	0.85

computing implied standard deviations using a variation on the method of implied returns.[6] Define the variance–covariance matrix of asset returns as:

$$\boldsymbol{\Sigma} = \boldsymbol{\Delta} \mathbf{P} \boldsymbol{\Delta} \tag{3}$$

where $\boldsymbol{\Delta}$ is a matrix with the vector of standard deviations on the diagonal and zeros elsewhere and $\mathbf{P}$ is the correlation matrix for the asset returns. To find the standard deviations, we set $\underline{x} = \underline{x}^*$ and $E[\underline{R} - \underline{1}R_f]$ from Eq. (2) and $\mathbf{P}$ to their historical values. The first-order conditions from portfolio optimization can be solved for the vector on the diagonal of $\boldsymbol{\Delta}$, yielding the implied standard deviations.

Table 2 presents the implied standard deviations from this exercise for CRRA values from 1 to 5. We also report the implied scale factors—ratios of implied to historical standard deviations—as a convenient measure for comparisons. Fig. 2 presents the comparison between implied and historical standard deviations for CRRA = 3.

To interpret our results, we need some prior notion of what constitutes reasonable values for scale factors. The literature does not provide much intuition on this point, but a simple calculation generates some insight. Suppose that investors do not rely entirely on historical sample data to assess the variance of foreign asset returns. Instead they take a linear combination of a sample variance and a variance from another source. One possible justification for this behavior is the "peso problem" of Krasker (1980), which illustrates a case when investors believe that there is a small probability of a dramatic event affecting returns. US investors might believe that there is a small probability of a large depreciation of a foreign currency which would sharply decrease the US dollar value of their

[6] This approach is intuitively similar to that in Frankel (1982) and Engel et al. (1993).

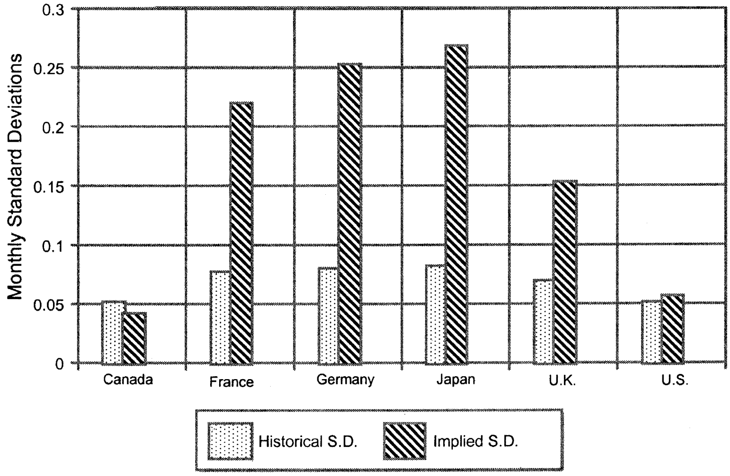

Fig. 2. Historical vs. implied standard deviations, CRRA = 3.

foreign equity returns. When the historical sample period lacks such an event, the historical variance will be too small and investors will average it with a larger variance estimate.

We illustrate the impact of such an adjustment as a linear combination of historical and extreme variances: $\sigma^2_{\text{perceived}} = (1-\alpha)(\sigma^2_{\text{historical}}) + \alpha(\sigma^2_{\text{extreme}})$ where α is the chosen weight. In this case $\sigma^2_{\text{historical}} < \sigma^2_{\text{extreme}}$ and α represents the small probability of the catastrophic event. We computed values for $\sigma^2_{\text{perceived}}$ for α values ranging from 0.01 to 0.10 and for σ_{extreme} values ranging from 0.10 to 0.80. The value of $\sigma_{\text{historical}}$ is set at 0.08, roughly the average of the (non-North American) standard deviations in Table 1. A selection of standard deviations from the combined distribution is given in Table 3, with scale factors, (ratio to $\sigma_{\text{historical}} = 0.08$), in parentheses. Looking at the scale factors, we see that most of

Table 3
Perceived risk values

σ_{extreme}	α Values:		
	0.01	0.05	0.10
0.10	0.0802 (1.02)	0.0811 (1.02)	0.0822 (1.03)
0.20	0.0821 (1.03)	0.0899 (1.12)	0.0988 (1.24)
0.40	0.0891 (1.11)	0.1187 (1.48)	0.1475 (1.84)
0.60	0.0997 (1.25)	0.1552 (1.94)	0.2044 (1.56)
0.80	0.1129 (1.41)	0.1951 (2.44)	0.2641 (3.30)

the entries are below 2. In order to generate an implied standard deviation more than twice as big as the historical standard deviation, α has to be greater than 0.05 and the standard deviation from the extreme distribution has to be at least 0.80, i.e. 10 times higher than the historical standard deviation. This is beyond the range of currency depreciation or stock market crashes that are likely. We conclude from this exercise that scale factors above 2.0 are unreasonably big (and even those above 1.5 may be unlikely).

In Table 2, the reader will note that all but one country's standard deviations have to be scaled up 2–5 times their historical levels to explain observed investment.[7] If the intuition of our simple example holds, these increases are not reasonable. We conclude that the variance adjustment is insufficient to explain home asset bias.

3.3. Covariance issues: the choice of assets to be included in the optimization problem

A third issue is that of choosing the assets to include in estimating optimal portfolios. The extent of the error introduced by an omitted asset is primarily a function of whether or not it provides a significant additional source of diversification, as captured in correlation measures.

Studies of international portfolio diversification inevitably omit assets. In fact, the majority of empirical work has looked at only international equity holdings. A few papers have examined portfolios diversified to include international bonds as well as stocks (e.g., Tesar and Werner, 1992; Black, 1993). The degree of home asset bias in stock investments is not particularly affected by the inclusion of bonds. Instead, we see home preference in both categories.

A number of recent papers have asked whether including human capital in the asset menu generates home asset bias. Intuitively, if investors have exogenously fixed human capital holdings whose returns vary with shocks to labor income, they can use equities to hedge the human capital risk. The size of human capital holdings and the size and sign of the correlation with equity returns are crucial to the analysis. Brainard and Tobin (1992) reason that foreign equities are less correlated with domestic human capital than are domestic equities, and hence are preferred hedges for human capital. This makes home asset bias worse. Baxter and Jermann (1997) argue that human capital is a large portion of wealth (60%) and assume there is perfect correlation between human capital returns and domestic

[7] The exception is Canada, where the implied standard deviations are sometimes below the historical standard deviations. As Tesar and Werner (1992) report, US investors seem to over-invest in Canada relative to the possible diversification benefits. This may be explained by various institutional factors that make it more attractive for US investors to invest in Canada than in other foreign countries.

equity returns. Given these assumptions, investors' optimal portfolios have short positions in domestic equity, generating an even more extreme puzzle. Bottazzi et al. (1996) find evidence of negative correlations between human capital and asset returns, generating a preference for domestic assets. They conclude that including human capital may account for as much as 30–35 percentage points of the home asset bias.

Obviously, the sign and magnitude of the correlations between various measures of human capital and equity returns remains an unresolved empirical question. Rather than deal directly with that issue, we again extend the methodology of implied parameters to ask a related question: if we add an asset to the model, is there a realistic set of implied correlations between that asset's returns and domestic and foreign equity returns that explains observed portfolios?

Implied correlations can be computed from the first-order conditions for portfolio optimization, much as implied returns and implied standard deviations were, but we must add another (seventh) asset to the investment menu. We do not wish to limit ourselves to just one type of asset, so we will simply refer to it as the "omitted asset." However, as in the literature on human capital, we assume that the weight on the omitted asset is exogenously fixed. We consider three values for the omitted asset weight: 0.6, 0.4 and 0.2.[8] Using the notation established above, the objective function for the portfolio optimization including the seventh asset can be written as:

$$\max\left[\left(\underline{R}' - \underline{1}' R_{\mathrm{f}}\right)\left(R_7 - R_{\mathrm{f}}\right)\right]\begin{bmatrix}\underline{x}\\ x_7\end{bmatrix} - \left(\frac{1}{2}\right)\delta\left[\underline{x}'\, x_7\right]\begin{bmatrix}\Sigma & \underline{\sigma}\\ \underline{\sigma} & \sigma_7\end{bmatrix}\begin{bmatrix}\underline{x}\\ x_7\end{bmatrix} \tag{4}$$

where R_7 is the omitted asset's real return, x_7 is its portfolio weight, $\underline{\sigma}$ is the vector of covariances between the return on the omitted asset and the return on each of the included risky assets, and σ_7 is the standard deviation of the omitted asset return. Setting the seventh asset weight x_7 to one of our assumed fixed values and the risky asset weights $\underline{x}$ to their actual values $\underline{x}^*$, we can use historical values for returns and their covariances to solve for $\underline{\sigma}$:

$$\underline{\sigma} = \left(\underline{R} - \underline{1}R_{\mathrm{f}}\right)\left[1/\left(\delta x_7^*\right)\right] - \Sigma\underline{x}^*\left(1/x_7^*\right). \tag{5}$$

The implied correlations with the six equity returns are then given by

$$\rho_{i,7} = \sigma_{i,7}/\left[\sigma_i \sigma_7\right], \qquad i = 1,\ldots,6. \tag{6}$$

Note that this requires the assumption of a value for σ_7. While the risky asset standard deviations have values around 0.05 (see Table 1), we found that we had to assume a value of $\sigma_7 = 0.33$ in order to satisfy the requirement of having correlation coefficients no greater than 1 in absolute value. We address the implications of this assumption below.

[8] These choices cover the range of values likely to be relevant for human capital or other omitted asset classes, and are sufficient for our illustrative example.

Table 4
Implied correlations of equity returns with omitted asset returns

CRRA	Canada	France	Germany	Japan	UK	US
Omitted asset weight = 0.20						
1	*	*	*	*	*	*
2	0.34	*	*	*	*	0.73
3	0.08	0.98	0.87	0.83	0.80	0.31
4	−0.05	0.67	0.60	0.58	0.51	0.10
5	−0.13	0.48	0.43	0.43	0.34	−0.03
Omitted asset weight = 0.40						
1	0.61	*	*	*	*	*
2	0.22	0.84	0.73	0.68	0.73	0.43
3	0.09	0.53	0.46	0.44	0.44	0.22
4	0.03	0.37	0.33	0.31	0.30	0.12
5	−0.01	0.27	0.24	0.24	0.21	0.05
Omitted asset weight = 0.60						
1	0.44	*	*	0.96	*	0.75
2	0.18	0.59	0.51	0.47	0.51	0.33
3	0.10	0.37	0.33	0.30	0.32	0.19
4	0.06	0.27	0.24	0.22	0.23	0.12
5	0.03	0.21	0.18	0.17	0.17	0.08

Note: entries marked with an "*" indicate that a solution between ±1 did not exist.

Table 4 presents the implied correlations for the three values of omitted asset weights and a range of CRRA values. Note that, in a few instances, a correlation coefficient between −1 and 1 could not be found. A higher value for σ_7 would have been necessary. Those instances are marked in Table 4 with an "*." Fig. 3 presents the set of results for the case of CRRA = 3 shown in Table 4. The first thing we observe about Table 4 is the predominance of positive correlations. Although Baxter and Jermann (1997) associate high positive correlation with negative domestic asset weights, we find that positive holdings of the domestic equity can be consistent with a positive correlation between omitted asset returns and domestic equity returns. We attribute this to the richer diversification structure in our more general model.

Another observation in Table 4 is that several of the correlations with foreign equities are as large or larger than the US equity correlation.[9] This is not what we would expect. If the omitted asset is something like human capital, then the presumption in the literature is that it is more highly correlated with domestic equity than with foreign equity. The unreasonable magnitudes of the implied

[9] The large correlation coefficients with foreign assets in Table 4 reflect the relatively high risk-adjusted returns on foreign assets. Since actual portfolios contain very small holdings of foreign assets, the foreign equities must be highly correlated with the omitted asset to make the model fit.

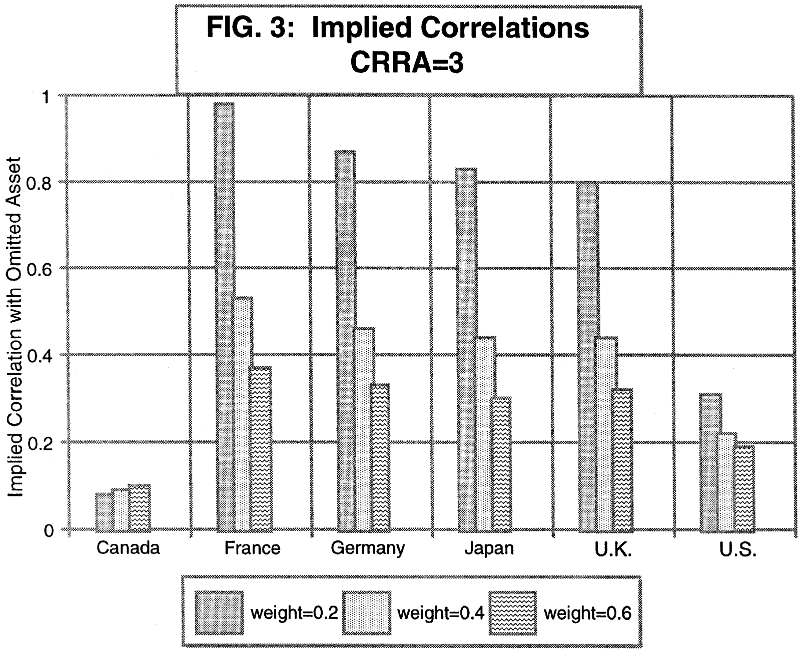

Fig. 3. Implied correlations, CRRA = 3.

correlations in Table 4 suggest that adding an "omitted" asset is not, by itself, sufficient to explain actual investment behavior.

4. Combining explanations of home asset bias

4.1. Implied standard deviations and implied correlations with transaction costs

Since there is agreement in the literature that foreign equities are subject to greater "transaction costs" than are domestic ones, we now re-compute the implied standard deviations and implied correlations for our data after adjusting expected returns for transaction costs.[10] Our goal is to demonstrate the potential explanatory power of combining explanations for home asset bias, rather than to determine exact values for the model parameters. Therefore, we choose parameter adjustments that are easy to implement but that capture the required intuitions. Specifically, we assume that transaction costs apply only to the non-North American

[10] While we are the first to explore a combination of explanations, we are not the first to suggest this. Kang and Stulz (1994) conjecture that sunk investment costs plus informational asymmetries may explain foreign investment patterns.

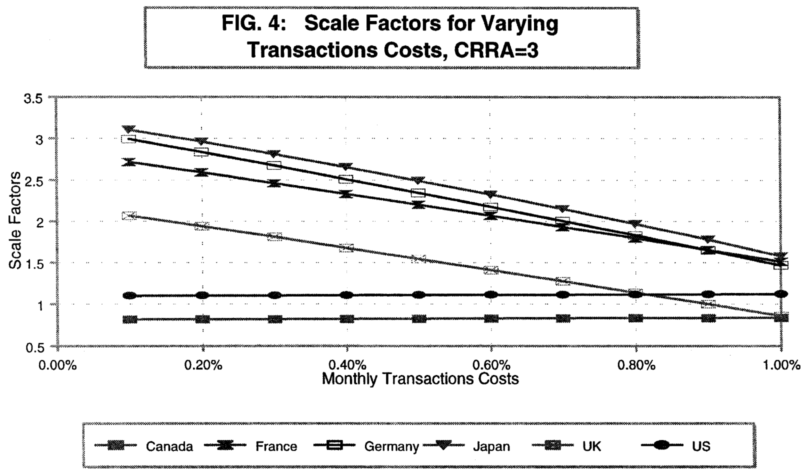

Fig. 4. Scale factors for varying transactions costs, CRRA = 3.

assets (French, German, Japanese and British equities) and that they are the same for each of these markets.[11] When we adjust standard deviations in our second exercise, we assume that the French, German, Japanese and British standard deviations are scaled upwards by equal amounts.

As discussed above, the literature suggests that transaction costs are in the range of 1–4% per annum. We considered a wide of values, but report a sample for brevity: from 0.1% to 0.9% per month (roughly 1.2–10.8% per annum). The implied standard deviations and scale factors corresponding to the varying transaction costs are reported in Fig. 4 and Table 5 for CRRA = 3. As expected, Fig. 4 shows a monotonic trade-off between the increase in expected returns and the decrease in implied scale factors for the non-North American assets, as risk and return offset one another. However, transaction costs must increase to 10.8% per annum for implied scale factors to fall below 2 for France, Germany and Japan; only the UK factor drops more quickly.

Using the same adjustments for transaction costs, we repeat the exercise for implied correlations.[12] We again assume there is an omitted asset whose portfolio weight is either 0.2, 0.4 or 0.6 and whose (monthly) standard deviation is 0.33. In this exercise, no adjustment is made to the standard deviations. While including transaction costs lowers the average implied correlation between the omitted asset and the equities, we again find a pattern that does not correspond to our prior: correlations still tend to be higher for France, Germany, Japan and the UK than for

[11] Canadian returns are unadjusted since Canadian investments are low-cost for US investors.

[12] Results are available upon request.

Table 5
Implied vs. historical standard deviations for varying levels of transactions costs (CRRA = 3)

Monthly transactions costs	Canada	France	Germany	Japan	UK	US
Implied monthly standard deviations:						
0.001	0.0426	0.2103	0.2403	0.2566	0.1443	0.0568
0.003	0.0428	0.1907	0.2147	0.2320	0.1263	0.0570
0.005	0.0430	0.1705	0.1883	0.2057	0.1080	0.0572
0.007	0.0433	0.1497	0.1610	0.1775	0.0892	0.0574
0.009	0.0435	0.1283	0.1327	0.1469	0.0699	0.0577
Implied scale factors (implied / historical):						
0.001	0.8178	2.7143	2.9912	3.1078	2.0659	1.1023
0.003	0.8220	2.4607	2.6725	2.8091	1.8093	1.1063
0.005	0.8265	2.2002	2.3439	2.4911	1.5468	1.1106
0.007	0.8312	1.9319	2.0042	2.1496	1.2776	1.1150
0.009	0.8363	1.6551	1.6521	1.7791	1.0011	1.1197

the US. Combining adjustments to returns with the addition of an asset cannot fully explain home asset bias.

4.2. Implied correlations when adjusting both expected returns and standard deviations

For our final exercise, we compute implied correlations, given adjustments to both expected returns and standard deviations. We consider the same range of transaction cost adjustments as in the previous sub-section (0.1–0.9% per month) and, in addition, increase the French, German, Japanese and British standard deviations by a factor of 1.75. Table 6 reports a complete set of implied correlations for all levels of transaction costs, and Fig. 5 presents the implied correlations for the representative case where monthly transaction costs are 0.3%. All calculations are done for CRRA = 3. Results for other CRRA values (not reported) are similar.

Table 6 and Fig. 5 show that the combined adjustments yield higher implied correlations with US equities than with foreign equities. This is especially true as we increase both the weight of the omitted asset and the transaction costs. However, the pattern of implied correlations is not entirely satisfactory, because the correlation with US equity is only slightly higher than with foreign equities. For example, the implied correlation with US equity for an omitted asset weight of 0.40 and transaction costs of 0.3% is 0.22, while the implied correlations with French, German and Japanese equities are 0.19, 0.17 and 0.16, respectively. Nonetheless, we conclude that much of the observed preference for home assets

Table 6
Implied correlations of equity with omitted assets given varying transactions costs and standard deviation of non-North American assets scaled by 1.75; CRRA = 3

Monthly transactions costs	Canada	France	Germany	Japan	UK	US
Omitted asset weight = 0.20:						
0.001	0.07	0.38	0.35	0.35	0.25	0.30
0.003	0.07	0.31	0.28	0.28	0.17	0.30
0.005	0.07	0.24	0.21	0.21	0.09	0.30
0.007	0.07	0.16	0.14	0.14	0.00	0.30
0.009	0.07	0.09	0.07	0.07	−0.08	0.30
Omitted asset weight = 0.40:						
0.001	0.09	0.23	0.21	0.20	0.17	0.22
0.003	0.09	0.19	0.17	0.16	0.13	0.22
0.005	0.09	0.16	0.13	0.13	0.09	0.22
0.007	0.09	0.12	0.10	0.09	0.05	0.22
0.009	0.09	0.08	0.06	0.06	0.00	0.22
Omitted asset weight = 0.60:						
0.001	0.10	0.18	0.16	0.15	0.14	0.19
0.003	0.10	0.15	0.13	0.12	0.12	0.19
0.005	0.10	0.13	0.11	0.10	0.09	0.19
0.007	0.10	0.10	0.08	0.08	0.06	0.19
0.009	0.10	0.08	0.06	0.05	0.03	0.19

can be explained by jointly including transaction costs, scaling up the perceived volatility of foreign assets and accounting for an omitted asset.

4.3. What is the mystery "omitted" asset?

The exercises described above provide some clues to the nature of the omitted asset. We do not think the omitted asset fits the profile of human capital. First, the

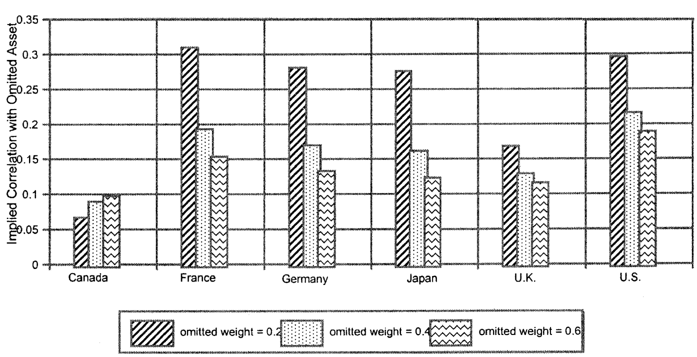

Fig. 5. Implied correlations, CRRA = 3, return and standard deviation adjusted.

high idiosyncratic risk that we have to assume (standard deviation of 0.33) is greater than that usually assumed for human capital and greater than the standard deviations for equity returns (0.05–0.08).[13] Second, the correlation patterns are not sensible. The standard view is that US investors' human capital is much more highly correlated with US equities than with foreign ones. However, if our omitted asset has a portfolio weight of 0.4 or 0.2, then its returns are sometimes more highly correlated with foreign equities than with domestic ones. When our omitted asset has a weight of 0.6 in investors' portfolios—a value close to that in Baxter and Jermann (1997)—then the returns on this asset are almost as highly correlated with non-North American equities as with US equities.

If not human capital, then what are possible candidates for the omitted asset? We can think of no other good candidates for a non-traded asset. We briefly consider four classes of traded assets: domestic bonds, foreign bonds, domestic real estate and foreign real estate.[14]

While we might believe that US investors hold a large amount of their wealth in domestic corporate bonds, these bonds will clearly not exhibit the high-risk patterns that we observe, and we would expect a different correlation pattern with US stock aggregates. For example, Elton and Gruber (1995; chapter 4) report correlations between US bonds and equity on the order of 0.30–0.50, depending on the sampling period. We would also expect much lower correlations between US bonds and foreign equities than we observe for our omitted asset.

Foreign bonds should be more highly correlated with foreign equities than with domestic equities, and this is consistent with some of our implied correlations. However, we know the aggregate foreign bond weight for US investors' portfolios is on the order of 4–7%, even when we consider both corporate and government bonds, so the weight for our omitted asset is too high for this category (Pappas, 1997). Finally, Mull and Soenen (1997) report standard deviations for foreign bonds on the order of 0.04–0.17, so they do not meet our 0.33 standard deviation barrier.

Now, consider real estate. US investors can invest in domestic and foreign real estate in two ways, either directly through purchase or indirectly through stock vehicles based on real estate portfolio funds (e.g., REITs). The latter are included in data on domestic and foreign stock positions, and so are not candidates for the omitted asset. Estimates from the US Flow of Funds Statement for direct, domestic real estate holdings as a percent of total US wealth lie in the range of 12–15%. Even if all real estate holdings are for investment rather than consumption, this is lower than the weight for our omitted asset (recall, we consider a range of

[13] Using different data and methodologies, Bottazzi et al. (1996) and Baxter and Jermann (1997) both compute annualized standard deviations for US human capital that range from 0.02 to 0.06, which are lower than the standard deviations for financial asset returns.

[14] One could also consider precious metals or artwork, but—as Ibbotson et al. (1985) document—these have such a low weight in the aggregate portfolio that we omit them for simplicity.

0.2–0.6). We do not have an estimate of levels of US foreign direct investment in real estate available, but we know that foreign real estate is some 36% of total world wealth (Ibbotson et al., 1985). However, we find it difficult to believe that US investors directly own more than a fraction of this, making the portfolio weight too low to fit our profile.

Now, consider the risk measures for foreign and domestic real estate value. Ibbotson et al. (1985), report a correlation of US real estate with the NYSE of 0.05, while its correlation with European equities is 0.16. The magnitude of the foreign correlation is close to our estimates, but the size of the correlation with the US asset is too small. Similarly, a recent assessment of the risk of domestic, direct real estate investment over our sample period by Kallberg et al. (1996) shows a range of standard deviation of 0.06–0.14, well below our omitted asset standard deviation of 0.33. Foreign real estate standard deviations have been estimated by Newell and Webb (1996) to be in the range of 0.06–0.20, lending support to our general notion that foreign investments are inherently riskier for US investors, but the range of values still lies well below our 0.33.

5. Conclusions and suggestions for future research

In this paper, we examine the measurement of and explanations for home asset bias, the documented tendency of investors to "over-invest" in home assets, even in the face of evidence that their risk-return portfolio profile can be improved by less domestic investment. Home asset bias is measured by comparing actual portfolio weights to optimal weights, so a natural question to ask is whether we have the right model and data inputs to generate the optimal weights for the comparison. Previous work has documented that a general model with PPP deviations must be used to allow for all diversification possibilities. However, earlier work also documents that home asset bias persists, even when such a model is used.

The remaining explanations of home asset bias can be categorized as leading to adjustments in the statistical inputs to the portfolio optimization model: (1) adjustments to expected returns to reflect transaction costs and other market-segmenting factors, (2) adjustments to standard deviations to reflect the additional perceived riskiness of foreign assets, and (3) adjustments to correlations by including a previously omitted asset in the investment menu. These explanations of home asset bias are all based on compelling intuitions, but it is an empirical question to determine which, if any, may explain observed behavior. Only the category of adjustments to returns has been examined empirically in prior work, and home asset bias remained.

In this paper, we provide the first evidence on the empirical feasibility of explanations based on adjusting standard deviations or adding an omitted asset. We also are the first to empirically examine whether combining these explanations can fully account for home asset bias. When we consider each explanation individually, we find that the adjustments to statistical inputs are unreasonable in magnitude—either much larger than historical values or inconsistent with the assets involved. However, when we combine adjustments to returns, standard deviations and correlations, we are able to find a combination of parameters whose magnitudes are more reasonable. This conclusion must be qualified because the characteristics of the omitted asset—its return volatility, its weight in the portfolio and its pattern of implied correlations with equity returns—do not correspond to any single asset we can imagine. In particular, we can rule out human capital, domestic or foreign bonds and domestic or foreign real estate as being the omitted asset.

We conclude that the failure to find a single (unidentified) omitted asset that accounts for the home asset bias means that we should consider multiple omitted assets. However, adding multiple assets means that many more correlations will be involved so that we cannot anticipate what the effects on home asset bias will be. We cannot uniquely solve for implied correlations in our framework when more than one asset is omitted, so we do not explore this possibility here. We believe this is an important avenue for future research.

Acknowledgements

This research was made possible, in part, by faculty development grants to Prof. Riddick from American University and by the support she received from the University of Maryland during a sabbatical visit. The authors also wish to thank Richard Baillie and two anonymous referees for helpful comments. The usual caveat applies.

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