Explaining domestic bias in investing: A new approach

by

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Abstract

The concept of domestic bias in investing has been widely discussed and analysed in financial literature. Many papers have striven to provide an explanation for the bias demonstrated by investors to foreign equities by under investing in equities issued by non-domestic firms. In this paper, I deviate from the assumption about standard investor preferences and demonstrate that this phenomenon is actually consistent with the manner in which some investors analyze information about foreign equities. I show that domestic bias is a puzzle only if we require all the investors in the economy to have standard preferences. I prove that by introducing investors in the economy that analyse information about foreign equities differently than they analyse information on foreign equities, this puzzle is easily solved.[1]

I Introduction

Globalization is a buzzword that is used with much fervour in the media and the financial world. We read and hear everyday about jobs being outsourced to China and India due to lower production costs. Almost all of the reports allude to the phenomenon of the world becoming a global village. Experts widely opine that economic developments in one country have important ramifications for other countries. In such an intertwined state of global economy, it would be reasonable for us to expect investors to hold assets in different economies. The precise financial reason can be traced from elementary portfolio management theory: just as holding stocks of only one corporation is generally hailed to be speculation rather than investment, the case for investing in the assets of a particular country should not be any different. Just as astute investors diversify away unsystematic risk by investing in assets less than perfectly correlated, we should expect them to diversify away unsystematic domestic risk by holding securities issued from firms of different countries. This argument is just a natural extension of portfolio theory of

[1] I wish to thank Dr. Marie Louise Viero for her support and guidance without which this paper could not have been completed. All errors are mine.

investing in corporations to investing in countries. As long as markets of different countries are less than perfectly correlated, which historical data suggests is the case, we should expect investors to gain from this opportunity.

However, surveys conducted by various financial researchers reveal something puzzling: investors tend to greatly over invest in home securities and under invest in foreign securities. This enigma remains true for naive as well as professional investors. Even though investors have a plethora of investment opportunities available in the global market, they are choosing to invest primarily in domestic market and relinquishing the potential diversification gains. This observation has been made for all of the economies examined for this purpose.

The objective of this paper is to closely examine this issue and provide an explanation why this may be happening. The paper is organized as follows: first I provide an in-depth discussion of the relevant literature on this issue, then I examine the various possible explanations given in the literature, then I reproduce a theoretical model from the paper of a different author and finally I utilize this model to provide an explanation for this phenomenon.

II Literature review

Coval and Moskowitz (1999) discuss the issue of home bias and state that U.S. equity traders allocate nearly 94 percent of their funds to domestic securities, even though the U.S. equity market comprises less than 48 percent of the global equity market. This phenomenon, dubbed the “home bias puzzle,” exists in other countries as well, where investors appear to invest only in their home country, virtually ignoring foreign opportunities. Karen Lewis (1999) discusses the nature of "equity home bias" as noted in finance models. To demonstrate this concept, she plots the mean and standard deviations of annualized monthly returns from January 1970 to December 1996 for an artificial mutual fund of the US stock market as measured by the S&P 500, and a non-US international fund measured in dollars called the "Europe, Australia, and Far East" or EAFE fund. EAFE index is often used as a non-US world stock market index, a convention that she follows in her paper. Moving along the curve from 100 percent US stocks to 100 percent foreign stocks (figure 1 below), the line plots the mean returns and standard deviations from holding an increasing proportion of foreign stocks. This is a simplified version of the so-called "efficient frontier" which solves for the portfolio with the minimum standard deviation for a given return, and therefore does not constrain the foreign stock composition. Nevertheless, the basic conclusions are similar to those with an "efficient frontier." In particular, the mean of the S&P 500 is lower than a portfolio with the same standard deviation where the portfolio includes some foreign stocks. Thus, if investors prefer higher returns to lower returns, point C is clearly preferable to 100 percent US stocks. In fact, as long as investors like higher returns and lower variance, the minimum variance portfolio at B must be preferable to the US portfolio alone.

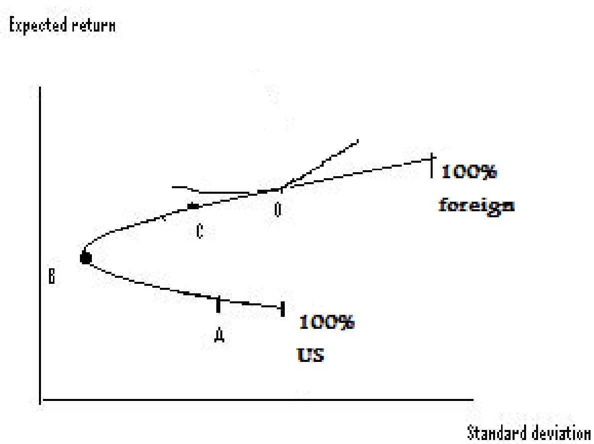

Figure 1

Explicit utility functions pick out the optimal points along the frontier. An investor with indifference curve U_0 will optimally choose point O. Thus, the relatively low risk aversion as assumed by this utility function compared to point C implies an even higher proportion of foreign stocks. Indeed, a portfolio with a 100 percent share in the S&P 500 is dominated by all portfolios with a foreign share of about 39 percent corresponding to the minimum variance point B. Nevertheless, estimates from the literature put the share of US holdings of foreign equities at about 8 percent, which would imply point A. Clearly, this portfolio is suboptimal with any set of standard preferences. Stated in this way, equity home bias is the phenomenon that domestic investors' foreign equity holdings are below point B.

Coval and Moskowitz state that clearly such behavior appears to be grossly inefficient from a diversification standpoint and this phenomenon has led to academics offering a variety of explanations. Initial explanations focused on barriers to international investment such as governmental restrictions on foreign and domestic capital flows, foreign taxes, and high transactions costs. Although many of these obstacles to foreign investment have substantially diminished, the propensity to invest in one's home country remains strong. Thus, other explanations have been put forth, which can be broadly grouped into two categories: explanations associated with the existence of national boundaries perhaps the distinguishing feature of international capital markets, and explanations associated with a preference for geographic proximity. Under the first set of explanations, when capital crosses political and monetary boundaries, it faces exchange rate fluctuation, variation in regulation, culture, and taxation, and sovereign risk, which many home bias explanations focus on as the primary factors discouraging investment abroad.

Fidora, Fratzcher and Thimann (2006) discuss several of the explanations proposed for this phenomenon and in their paper they evaluate real exchange rate as a possible explanation. They state that a steadily growing literature has proposed several partly competing and partly complementary explanations. Their paper takes a global perspective and focuses on the role of real exchange rate volatility as a key determinant of international portfolio allocation and home bias. It analyzes the importance of real exchange rate volatility in explaining cross-country differences in home bias, and in particular as an explanation for differences in home bias across financial asset classes, i.e. between equities and bonds. They use a Markowitz-type international capital asset pricing model (CAPM) which incorporates real exchange rate volatility as stochastic deviations from PPP. Given a mean variance optimization which implies risk aversion of investors, real exchange rate volatility induces a bias towards domestic financial assets because it puts additional risk on holding foreign securities from a domestic (currency) investors' perspective, unless foreign local currency real returns and the real exchange rate are sufficiently negatively correlated. They show that a reduction of the monthly real exchange rate volatility from its sample mean to zero reduces bond home bias by up to 60 percentage points, while it reduces the equity home bias by only 20 percentage points. Although these findings underline the overall importance of real exchange rate volatility as a driver of portfolio home bias, it does not explain much of the equity home bias.

Coval and Moskowitz analyze the homes bias literature by stating that some studies argue that informational differences between foreign and domestic investors are the driving force behind home bias, others claim that the primary cause is investor concern about hedging the output of firms that produce goods not traded internationally. They emphasize that a key point largely overlooked in the debate, is that not all home bias explanations rely on properties unique to the international economy. For instance, the existence of national boundaries may amplify information asymmetries and the concern for hedging non tradable goods, but these frictions arise even in the absence of country borders—that is, when only geographic distance separates an investor from potential investments.

Lewis views the cost to domestic residents of acquiring information about foreign equity markets as an alternative cost of foreign investment. Equity investment in foreign companies that are not cross-listed in domestic markets requires understanding foreign accounting practices and corporate relationships, not to mention the legal environment. Some indirect evidence points to the importance of these informational costs.

Further examination of the notion of familiarity has been conducted by Grinblatt and Keloharju for the investors in Finland. They find that the firm's language, culture, and distance from the investor are three important familiarity attributes that might explain an investor's preference for certain firms. Their paper finds that all three of these attributes contribute to investor preferences for certain stocks. They also show that the preferences tied to these attributes are inversely related to investor sophistication.

Despite the precedent in the home bias literature, the authors have been careful to not to classify the influence of distance, language, and culture as “biases,” which connotes that some form of investor irrationality is behind the influence of these factors. For portfolios that are as poorly diversified as those of most households in Finland, the “biases” that have been identified here have little effect on the risk profile of the investor’s holdings. The damage has been done by poor diversification. However, for an investor who chooses to hold a large number of stocks, concentrating the portfolio in certain stocks because of distance, language, or culture effects may make quite a large difference to the risk profile of his investment holdings. The authors find modest evidence of such effects among institutions and those households with larger numbers of firms among their holdings. However, the existence of such effects at all among the more sophisticated Finnish investors, as well as their lesser influence among the more sophisticated investor groups, leads them to conjecture that investors generally prefer to hold and trade stock in more familiar firms. Consistent with this conjecture, the authors state that the investment regularities exhibited towards familiar firms in Finland probably exist in other countries, even among those with more diversified holdings. From this it would naturally follow that such familiarity related effects could be the major contributor to home bias.

The authors believe that it is possible that any familiarity “bias” could be rational. Investors may acquire useful information about familiar firms from reading company statements in a language they understand, from general or acquired knowledge about local firms, or from the cultural groups they socialize within. Such an information-based theory of the influence of distance, language, and culture would be manifested in more active trading of these familiar firms and would generate superior performance in these firms.

Lewis is of the opinion that information and government restrictions costs can be important for explaining why the portfolios of domestic residents in developing, relatively unrestricted countries may be biased away from holdings of equities in emerging markets. On the other hand, she admits that this argument is more difficult to make for the equities of developed countries that do not face these restrictions. As we have seen, the US demonstrates a strong "home bias" in equity holdings with developed countries such as Germany and the UK, yet these countries do not impose significant restrictions on capital account movements. Moreover, the costs of acquiring information on at least some firms in these countries do not appear large, particularly for institutional investors and for foreign stocks that are traded in the US, so-called ADRs (American Depositary Receipts).

Thus, a Bayesian approach that incorporates estimation risk into the portfolio analysis suggests that difficulties in empirical measurement do not necessarily explain home bias. Indeed, greater uncertainty about foreign returns may induce the investor to pay more attention to the data and allocate more of his wealth to foreign equities.

She examines the alternative explanation for equity home bias that the gains from diversifying abroad are insufficient to warrant the costs involved. However, she states that the gains from international diversification of stock portfolios appear to be large. The gains can be evaluated by examining figure 1. In moving from the position corresponding to 100 percent domestic stocks to the portfolio shares corresponding to point C, the investor will gain an expected 80 basis points per year without sacrificing higher variance. Alternatively, by moving from 100 percent US stocks to point B, the domestic investor will reduce the standard deviation of his portfolio by about 1.5 percentage points and increase his expected return by 50 basis points. Clearly, all portfolio shares represented by points C to 100 percent foreign stocks correspond to gains in terms of higher expected returns. From B to C, these gains arise from lower variability as well.

The decision of what foreign portfolio share the domestic investor should choose depends upon his utility function. Solving for this optimal allocation with different values of relative risk aversion implies gains ranging from 20 percent to near 100 percent of lifetime consumption. Therefore, she concludes that the costs of holding foreign stocks must be extremely large to dissuade an efficient domestic investor from foreign diversification.

On the other hand, if the costs of acquiring and/or holding foreign equities are sufficiently high, then investors may be induced to keep their savings at home. The costs of international diversification include international taxes, informational costs, and other barriers to trade equity.

Warnock examines the possibility whether transaction costs can explain the observed home bias in equity holdings by taking a different approach than Lewis. He begins by an overview of the investigation of researchers and their direct measure of transaction costs faced by institutional investors across many countries.

Warnock concludes the while no direct evidence between transaction costs and home bias exists, there may well be an indirect relationship. Since the NYSE is one of the lower cost exchanges in the world, one way firms from high cost countries can alleviate trading costs in their stocks is by listing on the NYSE. The author is of the opinion that his empirical work gives strong evidence that there is a very important geographical component in international asset flows. International capital markets are not frictionless: they are segmented by informational asymmetries or familiarity effects. These results may have implications for the ‘home bias’ literature. Countries have different information sets, which heavily influence their international transactions.

Lewis analyzes the explanation for the observation of equity home bias that domestic equities provide a better hedge for risks that are specific to the home country. The author describes three types of hedge demands discussed in the literature: first, hedges against domestic inflation; second, hedges against wealth that is not traded in capital markets, such as human capital; and third, hedges with foreign returns implicit in equities of domestic firms that have overseas operations. The author concludes that explanations of home bias based upon the hedge properties of domestic equities do not seem to explain home bias towards domestic assets. In some cases when hedges against domestic country-specific risks are better hedged with foreign stocks, this type of explanation can actually deepen the home bias puzzle.

In conclusion, while different authors have taken different approaches to measuring the extent of home bias prevalent in various economies, a complete explanation still remains elusive. The discussion above shows that the concept of over investing in home securities is far from being a rational choice. While there are costs associated with finding out more information about foreign securities, the benefits far outweigh the costs. As long as the investors have mean variance preferences implying that they treat the information set regarding the possible returns and variances in identical ways, home bias remains an enigma.

III Analysis

All of the above papers assume that there is only one kind of investors in the economy. Easley and O' Hara (forthcoming) discuss the implications of ambiguity aversion for the performance and regulation of markets. In this research paper, we reinterpret and extend the findings of their upcoming paper in the home bias context. They develop a model in which all agents' decision-making may incorporate both risk and ambiguity, and demonstrate that nonparticipation can arise from the rational decision by some traders to avoid ambiguity. In equilibrium, these participation decisions can affect the equilibrium risk premium, and distort the performance of the market when viewed from the perspective of traditional asset pricing models.

In the standard von Neumann-Morgenstern expected utility theory, decision makers have preferences over, and make decisions between, objective distributions. Applications of this theory to asset markets assume that the distributions of payoffs to portfolios of assets are known to investors. This assumption is usually justified with the rational expectations hypothesis. For some assets and some investors this is a reasonable assumption. For others, it is surely not reasonable. Do unsophisticated investors know the distribution of payoffs to even simple portfolios; do U.S. investors know the distribution of payoffs to all foreign stocks; do any investors know the distribution of payoffs to new assets? Even for established assets, investors with common information often disagree about the distribution of payoffs.

The Savage generalization of expected utility theory provides a Bayesian approach to subjective uncertainty about payoff distributions. In this approach, individuals' subjective distributions of payoffs are derived from their preferences over stochastic consumption streams. This allows similarly informed investors to disagree about the predicted distribution of payoffs on portfolios. But it does imply that each investor acts as if he or she has some subjective distribution. In some cases, this seems reasonable; in others, such as with the example of a new asset, it is much less plausible.

In this model, Easley and O'Hara assume a fraction of investors as Savage expected utility maximizers. They assume that these sophisticated investors know the payoff distribution for each asset. This rational expectations assumption for expected utility traders is a strong, but standard, assumption. Allowing them to place a prior on the set of distributions the ambiguity-averse investors deem to be possible would greatly complicate the analysis, but it would not change the results in important ways. The other investors are aware of the set of possible payoff distributions, but they are unable or unwilling to place a prior on this set. These naïve investors are what is now termed in the literature ambiguity-averse.

The authors have two motivations for considering ambiguity-averse investors. First, the expected utility approach yields predictions about individual portfolios that are inconsistent with actual portfolios for many investors. Most important, is the fact that expected utility traders should hold diversified portfolios. They should not be overweighted in stocks that they are familiar with because of geography such as the stocks of local or national firms. They should hold at least small amounts, at least indirectly through funds, of foreign assets whose payoffs are not perfectly correlated with their portfolios.[2] Barberis and Thaler [2003] provide a concise survey of the evidence against expected utility, and they offer alternatives including ambiguity aversion to explain this observed behavior.

Second, there is direct experimental evidence that some individuals do not always act as if they have a prior. The most notable evidence is the Ellsberg Paradox. In a simple version of the Ellsberg experiment an individual is given an opportunity to bet on the draw of a ball from one of two urns. Urn one has 50 red and 50 black balls. Urn two has 100 balls which are some mix of red and black. First, subjects are offered a choice between two gambles: $1 if the ball drawn from urn one is red and nothing if it is black or $1 if the ball drawn from urn two is red and nothing if it is black. Many subjects chose the first gamble. Thus, if they have a prior on urn two the predicted probability of red in urn two is less than 0.5. Next, subjects are offered a choice between two new gambles: $1 if the ball drawn from urn one is black and nothing if it is red or $1 if the ball drawn from urn two is black and nothing if it is red. Many subjects again chose the

[2]Of course, if investors have private information that is not fully reflected in local or national stock prices then they should over-or-under weight these stocks. We find it implausible that information accounts for all of the local bias. Similarly, transaction costs can account for some of the lack of diversification. But, again, the transaction costs connected with mutual fund investments are low enough to make this explanation implausible as well.

first gamble. Thus, if they have a prior on urn two the predicted probability of black in urn two is less than 0.5. This cannot be, so they do not act as if they have only one prior on urn two.

Experiments like Ellsberg's have been repeated many times in many settings. This evidence led Gilboa and Schmeidler [1989] to weaken the Savage axioms in order to produce a decision theory consistent with the behavior observed by Ellsberg.[3] Their approach yields a utility function defined over payoffs as in Savage but rather than a single prior it yields a set of priors. The axioms also imply that the decision maker evaluates any act according to the minimum expected utility it yields.[4]

The Gilboa and Schmeidler model has itself been generalized to allow for the possibility that the decision maker is not so pessimistic as to select the act that maximizes the minimum expected utility. Two recent papers by Ghirardato, Maccheroni and Marinacci (2004) and Klibanoff, Marinacci and Mukerji (2005) provide alternative approaches to separating ambiguity and the decision maker's attitude toward ambiguity. The authors follow the Gilboa and Schmeidler model to illustrate their ideas, but the results could be generalized to allow for less ambiguity aversion, although at considerable loss of tractability. The important aspect of these models for our results about the effect of regulations is that naïve investors facing ambiguity are ambiguity averse, but exactly how ambiguity averse they are is not important for our qualitative results.

The ambiguity-averse naïve investors face a set of payoff distributions and they do not aggregate these distributions to produce a predicted payoff distribution. There are, at least, two other reasonable ways to view the decision problem faced by our naive decision makers. First, they could be thought of as choosing robust portfolios. That is, they could search for portfolios that are robust to their uncertainty about the correct model for payoffs. Hansen and Sargent (2000) follow this approach to evaluating macroeconomic models. Maenhout [2004] and

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[3] They actually begin with Anscombe and Aumann's framework which is a standard alternative to Savage's approach. The axiom that they weaken is the Independence axiom.

[4] In the Ellsberg framework this model implies that the individual acts as if he has a set of priors for urn two which includes a prior in which the probability of red is less than 0.5 and a prior in which the probability of black is less than 0.5. Since he acts as if evaluates each act according to its minimum expected utility, he will never chose urn 2 as in his pessimistic view it will be unlikely to pay off.

Garlappi, Uppal, and Wang [2004] use a similar approach to consider asset pricing issues. Second, they could be thought of as behavioral traders who either have biased beliefs or who do not maximize expected, or minimum expected, utility.

IV The Model

The authors analyze an economy with three assets. There is one risk free asset, money, which has a constant price of 1 and is in zero net supply. There are two risky, financial assets with independent, normally distributed payoffs v^i, $i = 1, 2$.[5] The first asset class, v^1, refers to home securities and v^2 refers to foreign securities.

All investors know that payoffs are independent and normal. The set of possible mean payoffs for asset i is $\{\bar{v}_1^i, ..., \bar{v}_N^i\}$; the set of possible variances is $\{\sigma_1^i, ..., \sigma_N^i\}$. All pairs of mean and variance are possible and $\Theta^i = \{\theta_1^i, ..., \theta_n^i\}$, with $n = N^2$ elements, denotes the set of possible parameters.[6]

There are J investors indexed by $j = 1, ..., J$. All investors have CARA utility for wealth, with the risk aversion parameter set equal to 1:

$$u_j(w) = -\exp(-w). \quad (1)$$

There are two types of investors in the economy, sophisticated investors (S) and naive investors (U). Sophisticated investors constitute a fraction $1-\mu$ of all investors, while naïve investors constitute the remaining fraction. The sophisticated investors are standard expected utility maximizers (EU) with rational expectations about payoff parameters. Let $(\hat{v}^i, \hat{\sigma}^i)$ denote the true

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[5] We consider two risky assets in order to be able to discus relative prices of risky assets. Our results generalize immediately to any number of assets.

6 As will become apparent, only the minimum and maximum mean payoff and maximum the maximum variance affect decisions made by naive traders. So changes to the set that leave these values unchanged have no affect on the market.

mean payoffs and variance for asset i. Since the sophisticated traders have rational expectations, they know $(\hat{v}^i, \hat{\sigma}^i)$.

The naive investors also care about means and variances, but they differ from sophisticated investors in that they do not know the parameters.[7] Instead, they consider each normal distribution of payoffs, $N(\theta^i)$, as a possible payoff distribution. Following Gilboa and Schmeidler's (1989) axiomatic foundation for ambiguity aversion, the authors model these naïve investors as choosing a portfolio to maximize their minimum expected utility over the set of possible distributions. To make the analysis of the equilibrium interaction between S and U traders interesting, it is assumed that naive investors consider as possible mean payoffs above and below $\hat{v}^i$ and variances above and below $\hat{\sigma}^i$. That is, the true parameter values are convex combinations of the extreme values considered possible by the naive traders.

The per capita endowments of assets are $(\bar{x}^1, \bar{x}^2)$. The exact distribution of endowments over investors does not affect their demands for risky assets because of the CARA-Normal structure, so it is not specified.[8] A typical investor's wealth is denoted by w. Where no confusion would occur, the investor index will be dropped. The investor's budget constraint is

$$w = m + p^1 x^1 + p^2 x^2 \quad (2)$$

where m is the quantity of money, p^i is the price of asset i , and x^i is the quantity of risky asset i. Investors are allowed to go long or short in each asset. If the investor chooses portfolio (m, x^1, x^2) his random next period wealth will be

$$\tilde{w} = m + \tilde{v}^1 x^1 + \tilde{v}^2 x^2. \quad (3)$$

[7] These investors can be thought of as inexperienced potential investors who do not have enough experience in financial markets to reliably access payoff distributions. Perhaps they have not yet participated in the asset market, and although they can imagine many possible payoff distributions, they are unable to place a prior on this set of distributions. They know that holding cash is safe, but are just not sure how to think about risky assets.
[8] For ambiguity-averse investors, the most natural interpretation is that they have no endowment of risky assets. But, regardless of their endowments, what they care about is their final asset position. So, in an equilibrium in which ambiguity-averse investors choose not to hold a risky asset, they will trade, if necessary, in order to achieve a zero asset position.

For a sophisticated investor, with CARA utility of wealth and payoff parameters $(\hat{v}^i, \hat{\sigma}^i)$, the expected utility of this random wealth is a strictly increasing transformation of

$$(\hat{v}^1 - p^1)x^1 + (\hat{v}^2 - p^2)x^2 - 1/2\,\hat{\sigma}^1(x^1)^2 - 1/2\,\hat{\sigma}^2(x^2)^2 + w. \quad (4)$$

Calculation shows that the sophisticated investor's demand function for asset i is given by:

$$x_U^{i*}(p^i) = \frac{\hat{v}^i - p^i}{\hat{\sigma}^i}. \qquad (5)$$

A naïve investor evaluates the expected utility of wealth for each parameter vector and chooses the portfolio that maximizes the minimum of these expected utilities. In effect, the naive investor tries to avoid the worst case outcomes, and so chooses a portfolio that explicitly limits exposure to such adverse outcomes. The expected utility of random wealth, given parameters $(\theta^1 = (\overline{v}^1, \sigma^1), \theta^2 = (\overline{v}^2, \sigma^2))$, is a strictly increasing transformation of

$$(\overline{v}^1 - p^1)x^1 + (\overline{v}^2 - p^2)x^2 - 1/2\,\sigma^1(x^1)^2 - 1/2\,\sigma^2(x^2)^2 + w. \qquad (6)$$

Thus, the naive investor's decision problem can be written as

$$\underset{(x^1,x^2)}{Max}\ \underset{(\theta^1,\theta^2)}{Min} \left((\overline{v}^1 - p^1)x^1 + (\overline{v}^2 - p^2)x^2 - 1/2\,\sigma^1(x^1)^2 - 1/2\,\sigma^2(x^2)^2 + w \right) \ (7)$$

Examining the minimization problem reveals that for any portfolio the minimum occurs at the maximum possible variance for each asset. Denote these variances by $\sigma^i_{\max}$. Consequently, what matters to the naive investor is not the "expected" variance, but rather the largest variance. Whether the minimum occurs at the maximum or minimum mean payoff depends on whether the investor is long or short in the asset. The minimum occurs at minimum mean payoff for asset i if the investor is long in asset i and at maximum mean payoff for asset i if the investor is short in asset i. Denote these mean payoffs by $\overline{v}^i_{\min}$ and $\overline{v}^i_{\max}$, respectively. Calculation shows that the naive investor's demand function for asset i is

$$x_A^{i*}(p^i) = \begin{bmatrix} \frac{\overline{v}^i_{\min} - p^i}{\sigma^i_{\max}} \;\; if \;\; \overline{v}^i_{\min} > p^i \\ 0 \;\; if \;\; \overline{v}^i_{\min} \le p^i \le \overline{v}^i_{\max} \\ \frac{\overline{v}^i_{\max} - p^i}{\sigma^i_{\max}} \;\; if \;\; \overline{v}^i_{\max} < p^i \end{bmatrix}. \qquad (8)$$

There are several properties of this demand function that will be important for the analysis. First, note that if the price of asset i is above the minimum possible mean payoff and below the maximum possible mean payoff, then the naive investor will not participate in the market for asset i.[9] This occurs because a naive investor is heavily influenced by the worst possible state, and what is worst depends on the investor's asset position. If the investor holds a positive quantity of the asset, he evaluates it using the lowest possible mean payoff, $\overline{v}^i_{\min}$, and the highest possible variance, $\sigma^i_{\max}$. If the investor goes short, the worst possible mean switches to $\overline{v}^i_{\max}$ and the worst variance stays at $\sigma^i_{\max}$.[10] So unless the price of the asset is above $\overline{v}^i_{\max}$ or below $\overline{v}^i_{\min}$, a naive investor will not participate in the asset market.

Second, note that the naive investor's decision about whether to hold the asset is independent of the set of variances he believes to be possible. All that matters for the participation decision is the price, the minimum mean payoff, and the maximum mean payoff. If the naive investor decides to hold the asset, then variance matters, just as it does for the sophisticated investor. But only the maximum possible variance affects the quantity to be held. The other variances the naive investor believes to be possible do not affect his decision about whether to participate or his decision about how much to hold if he chooses to participate.

Third, note that the naive investor's demand function is continuous in price but that it has kinks at $\overline{v}^i_{\min}$ and $\overline{v}^i_{\max}$. In particular, for any price between $\overline{v}^i_{\min}$ and $\overline{v}^i_{\max}$ the naive investor does not hold the asset. This contrasts with sophisticated investors who hold a non-zero position in any

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[9] Here by not participating we mean that his final asset position will be zero. This interpretation is most natural if ambiguity-averse investors do not initially hold the risky asset.

[10] We will show that in fact the equilibrium price cannot be above the maximum mean payoff. So, in equilibrium, naïve investors never go short.

asset as long as its price is not equal to its mean payoff.[11] Note that the sophisticated investor always holds a larger amount (in absolute value) of the risky asset than does the naïve investor. This is because for any given parameters these investors evaluate the tradeoff between mean and variance equivalently. They both avoid risk and require compensation in expected payoff in order to hold risk. But the naive investor also avoids ambiguity in the distribution of payoffs, and so as long as the set of possible means and variances is non-degenerate he further reduces the size of his position in the risky asset.

In equilibrium, the per capita demand for asset i must equal its per capita supply. Equating the demands from equations (5) and (8) to this supply then yields

$$\mu x_U^{i*}(p^i) + (1-\mu) x_A^{i*}(p^i) = \overline{x}^i \,. \quad (9)$$

Depending on the parameters of the economy, there are two possible types of solutions to this equation.

First, if at a price between $\overline{v}^i_{\min}$ and $\overline{v}^i_{\max}$ the sophisticated investors are willing to hold the entire supply of the asset, then in equilibrium the naive investors will not participate in the market. If only sophisticated investors participate in the market the market clearing price must be

$$\hat{p}^i = \hat{v}^i - \tfrac{\hat{\sigma}^i \overline{x}^i}{1-\mu} \quad (10)$$

Thus, $\hat{p}^i$ will be the market clearing price for asset i if $\overline{v}^i_{\max} \geq \hat{p}^i \geq \overline{v}^i_{\min}$. Note that $\overline{v}^i_{\max} \geq \hat{p}^i$ as $\overline{v}^i_{\max} \geq \hat{v}^i \geq \hat{p}^i$, so the binding condition is $\hat{p}^i \geq \overline{v}^i_{\min}$.

Second, it is possible that both types of investors participate in the market for asset i. If it is conjectured that both types of investors participate, then the market clearing price must be

$$p^{i*} = \frac{\mu \hat{\sigma}^i \overline{v}^i_{\min} + (1-\mu)\sigma^i_{\max}\hat{v}^i - \overline{x}^i \sigma^i_{\max}\hat{\sigma}^i}{\mu \hat{\sigma}^i + (1-\mu)\sigma^i_{\max}} \,. \qquad (11)$$

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[11] More generally, if asset payoffs are correlated sophisticated investors also holds assets in order to diversify their portfolios.

This can be an equilibrium price only if ambiguity-averse investors are willing to participate, i.e. only if $p^{i*} < \overline{v}^i_{\min}$. Calculation shows that this constraint is met if and only if $\hat{p}^i < \overline{v}^i_{\min}$. In order to insure that the price is sensible (greater than zero) even if there are only naive investors in the market, it is assumed that $\overline{v}^i_{\min} - \overline{x}^i \sigma^i_{\max} > 0$.

As the binding condition for a non-participation equilibrium is $\hat{p}^i \geq \overline{v}^i_{\min}$, one and only one of these equilibria will prevail for any economy. Thus, there is a unique equilibrium. This equilibrium is either one in which ambiguity averse investors do not participate, a Non-Participating Equilibrium, or one in which they do participate, a Participating Equilibrium. These results are summarized in the proposition below.

Proposition: There is a unique equilibrium in the market for asset i. It is one of two types:

Non-Participating: If $\hat{p}^i = \hat{v}^i - \frac{\hat{\sigma}^i \overline{x}^i}{1-\mu} \geq \overline{v}^i_{\min}$ then in the equilibrium $x^{i*}_A = 0$, $x^{i*}_U = \frac{\overline{x}^i}{1-\mu}$ and $\hat{p}^i$ is the market clearing price.

Participating: If $\hat{p}^i = \hat{v}^i - \frac{\hat{\sigma}^i \overline{x}^i}{1-\mu} < \overline{v}^i_{\min}$ then in the equilibrium both $x^{i*}_A > 0$ and $x^{i*}_U > 0$, and p^{i*} is the market clearing price.

V Application of the above results

Using the results of Easley and O'Hara, I assume that there are two types of investors in an economy. Type 1 investors have mean-variance preferences as assumed in all of the papers discussed in the literature review. These investors are EU maximizers and treat the information sets about home and foreign securities in identical ways. Type 2 investors are the ambiguity averse investors. I assume that the stock market returns for home and foreign securities are normally distributed with means and variances given in the worksheet below. There is a set of distributions for the foreign asset but a unique distribution for the home asset.

I do a simulation in the worksheet (table 2) to compute the asset demands for different scenarios i.e. for different sets of returns and variances for home and foreign securities. I simulate 9 different cases with different values sets of possible returns and variances for the home and foreign asset. The proportion of AA investors (μ) and EU investors (1- μ) in the economy is held to be constant at 0.4 and 0.6 respectively for all mixed economy scenarios in the 9 cases. This means that whenever I price an asset in a 'mixed' economy for any of the 9 cases, μ = 0.4 and 1- μ = 0.6. When I price an asset for these 9 cases when there are only EU investors, μ = 1.0. In case 1, the minimum possible mean payoff on the foreign asset is 10%, the mean payoff on the foreign asset is 15% and the maximum possible mean payoff on the foreign asset is 20%. The minimum possible variance of foreign asset is 5%, the expected possible variance of foreign asset is 10% and the maximum possible variance of the foreign asset is 15%. The expected mean payoff on the home asset is 6% and the expected possible variance of the home asset is 4%. I use (11) to compute the price of the home and foreign assets for the case when there is a mix of EU and AA investors in the economy and also when there are only EU investors in the economy. As can be seen, the price of the foreign asset is always less in the case of a mixed economy as compared to the case when there are only EU investors in the economy. The intuitive understanding is that while EU investors treat the information set of foreign assets in the same way as the information set for the domestic assets, the AA investors treat information set of a domestic asset in a more favourable light. Thus, the greater the proportion of AA investors in the economy, the lower will be the price for the foreign asset in a mixed economy. Clearly, the mix of the economy has no repercussions for the domestic assets as both types of investors treat domestic information sets in identical ways. Continuing with case 1, I compute the demand of EU investors using (5) above. Demand by domestic investors is derived from (8) above. The expected return on the portfolio of both investors is computed using a weighted average of their asset holdings in the portfolio. The expected variance is less than the weighted average of the variance of assets because of diversification (as the foreign and domestic asset returns were assumed to be independent, the correlation coefficient is 0 thereby implying diversification benefits).

The asset demand by type 2 investors for foreign securities is always less than the demand by type 1 investors. This result is to be expected from (5) and (8) above. We also do ordinary least squares regression (table 3) for three scenarios with expected return as the dependent variable and the expected variance as the independent variable. The first scenario incorporates the case for EU investors in an economy where there is a mix of both EU and AA investors. The second regression incorporates the case for AA investors in the same economy. The third case is when there are only EU investors in the economy. As the regression shows, the AA investors have a lower return to variance ratio than the EU investors' portfolio. Since type 2 investors have portfolios that have a smaller fraction invested in foreign securities, it seems plausible that it would be optimal for this kind of investors to display "home bias". The higher the proportion of such investors in the economy, the more starkly would the phenomenon of home bias appear. Since all the papers assumed that the population consists only of type 1 investors, home bias would come across as a puzzle. As table 2 (the formula sheet for the worksheet can be found in the appendix) shows, we would expect type 1 investors to have significantly more investments in foreign securities. But if the economy consists of both type 1 and type 2 investors, the economy would have lower investment in foreign securities and we should expect to see "home bias".

Key to notation used in excel simulation

Table 1

v f min: Minimum possible mean payoff on the foreign asset
v f hat: Expected mean payoff on the foreign asset
v f max: Maximum possible mean payoff on the foreign asset
v h hat: Expected mean payoff on the home asset
sigma f min: Minimum possible variance of foreign asset
sigma f hat: Expected possible variance of foreign asset
sigma f max: Maximum possible variance of foreign asset

sigma h hat: Expected possible variance of home asset price f mix: price of foreign asset when the economy has both EU and AA investors price h mix: price of home asset when the economy has both EU and AA investors price f only EU: price of foreign asset when the economy has only EU investors price h only EU: price of home asset when the economy has only EU investors demand EU f: per capita demand by EU investors for foreign asset demand EU h: per capita demand by EU investors for home asset demand AA f: per capita demand by AA investors for foreign asset demand AA h: per capita demand by AA investors for home asset ER for EU: return expected by EU investors on their portfolio EV for EU: variance expected by EU investors on their portfolio ER for AA: return expected by AA investors on their portfolio EV for AA: variance expected by AA investors on their portfolio

Table 2

Excel simulation

AA	EU									
μ	1-μ									
0.4	0.6									
		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9

	V f min	10	6	15	10	10	6	6	15	15
	V f hat	15	8	25	15	15	8	8	25	25
	V f max	20	10	35	20	20	10	10	35	35
	sigma f min	5	3	10	5	5	3	3	10	10
	sigma f hat	10	5	20	10	10	5	5	20	20
	sigma f max	15	7	30	15	15	7	7	30	30
	V h hat	6	3	20	3	20	6	20	6	3
	sigma h hat	4	2	10	2	10	4	10	4	2
	price f mix	7.69231	3.4032	12.692	7.692	7.69231	3.4032	3.4032	12.692	12.692
	price h mix	3.6	2	14	2	14	3.6	14	3.6	1.8
	price f only EU	10	4.5	17	10	10	4.5	4.5	17	17
	price h only EU	3.6	2	14	2	14	3.6	14	3.6	1.8
mix	demand EU f	0.73077	0.9194	0.6154	0.731	0.73077	0.9194	0.9194	0.6154	0.6154
	demand EU h	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6
	demand AA f	0.15385	0.371	0.0769	0.154	0.15385	0.371	0.371	0.0769	0.0769
	demand AA h	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6
	total demand									
	foreign	0.5	0.7	0.4	0.5	0.5	0.7	0.7	0.4	0.4
	home	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6
	total supply									
	x f (foreign)	0.5	0.7	0.4	0.5	0.5	0.7	0.7	0.4	0.4
	x h (home)	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6
	ER for EU	10.9422	6.2386	22.532	10.13	17.2543	7.2102	12.739	15.62	14.139
	EV for EU	3.82859	2.3459	7.5645	3.855	5.04828	2.4545	3.3902	6.1022	5.6148
	ER for AA	6.81633	4.2778	19.432	4.647	17.9592	6	14.651	7.0227	4.3636
	EV for AA	3.15868	1.929	8.2438	2	6.9596	2.5492	4.8403	3.53	1.9587
EU only	demand EU f	0.5	0.7	0.4	0.5	0.5	0.7	0.7	0.4	0.4
	demand EU h	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6

	ER for EU	10.0909	5.9167	22	9	17.7273	7.0769	13.538	13.6	11.8
	EV for EU	3.2562	2.0486	6.8	3	5.04132	2.3018	3.5799	4.64	3.92

Table 3

Regression results

		Regressand		Regressor		return to variance ratio				
		Expected		Expected						
		Return		Variance						
	Mixed case									
	EU	10.9422		3.8286		2.74172				
		6.23864		2.3459						
		22.5316		7.5645						
		10.125		3.8555						
		17.2543		5.0483						
		7.21019		2.4545						
		12.7389		3.3902						
		15.6203		6.1022						
		14.1392		5.6148						
	AA	6.81633		3.1587		2.58786				
		4.27778		1.929						
		19.4318		8.2438						
		4.64706		2						
		17.9592		6.9596						
		6		2.5492						
		14.6512		4.8403						
		7.02273		3.53						
		4.36364		1.9587						
	EU only	10.0909		3.2562		3.38878				
		5.91667		2.0486						
		22		6.8						
		9		3						

		17.7273		5.0413						
		7.07692		2.3018						
		13.5385		3.5799						
		13.6		4.64						
		11.8		3.92						

VI Conclusion

This paper examined the phenomenon of home bias which comes across as a puzzle under the assumption that all investors have mean variance preferences. Although various explanations have been put forward by researchers, none has been successful to provide a comprehensive answer to this puzzle. However, if we are willing to make the assumption that there are some ambiguity averse investors in the economy then their over investing in home securities is actually consistent with their preferences. The higher the proportion of these investors in the economy, the higher will be the investment in home securities at the expense of foreign securities. The observed phenomenon is actually not a puzzle at all in the presence of ambiguity averse investors.

VII Appendix

Formula sheet for table 2

	B	C	D	E	F	G	H	I	J	K	L
1	AA	EU									
2	μ	1-μ									
3	0.4	=1-B3									
4											
5			Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
6											
7		r f min	10	6	15	10	10	6	6	15	15
8		r f hat	15	8	25	15	15	8	8	25	25
9		r f max	20	10	35	20	20	10	10	35	35
10											
11		sigma f min	5	3	10	5	5	3	3	10	10
12		sigma f hat	10	5	20	10	10	5	5	20	20
13		sigma f max	15	7	30	15	15	7	7	30	30
14											
15		r h hat	6	3	20	3	20	6	20	6	3
1											

6											
17		sigma h hat	4	2	10	2	10	4	10	4	2
18											
19		price f mix	=($B$3*D12*D7+$C$3*D13*D8-D35*D13*D12)/($B$3*D12+$C$3*D13)	=($B$3*E12*E7+$C$3*E13*E8-E35*E13*E12)/($B$3*E12+$C$3*E13)	=($B$3*F12*F7+$C$3*F13*F8-F35*F13*F12)/($B$3*F12+$C$3*F13)	=($B$3*G12*G7+$C$3*G13*G8-G35*G13*G12)/($B$3*G12+$C$3*G13)	=($B$3*H12*H7+$C$3*H13*H8-H35*H13*H12)/($B$3*H12+$C$3*H13)	=($B$3*I12*I7+$C$3*I13*I8-I35*I13*I12)/($B$3*I12+$C$3*I13)	=($B$3*J12*J7+$C$3*J13*J8-J35*J13*J12)/($B$3*J12+$C$3*J13)	=($B$3*K12*K7+$C$3*K13*K8-K35*K13*K12)/($B$3*K12+$C$3*K13)	=($B$3*L12*L7+$C$3*L13*L8-L35*L13*L12)/($B$3*L12+$C$3*L13)
20		price h mix	=D15-(D17*D36)	=E15-(E17*E36)	=F15-(F17*F36)	=G15-(G17*G36)	=H15-(H17*H36)	=I15-(I17*I36)	=J15-(J17*J36)	=K15-(K17*K36)	=L15-(L17*L36)
21		price f only EU	=D8-D12*D35	=E8-E12*E35	=F8-F12*F35	=G8-G12*G35	=H8-H12*H35	=I8-I12*I35	=J8-J12*J35	=K8-K12*K35	=L8-L12*L35
22		price h only EU	=D15-D17*D36	=E15-E17*E36	=F15-F17*F36	=G15-G17*G36	=H15-H17*H36	=I15-I17*I36	=J15-J17*J36	=K15-K17*K36	=L15-L17*L36
23											
24	mix	demand EU f	=(D8-D19)/D12	=(E8-E19)/E12	=(F8-F19)/F12	=(G8-G19)/G12	=(H8-H19)/H12	=(I8-I19)/I12	=(J8-J19)/J12	=(K8-K19)/K12	=(L8-L19)/L12
25		demand EU h	=(D15-D20)/D17	=(E15-E20)/E17	=(F15-F20)/F17	=(G15-G20)/G17	=(H15-H20)/H17	=(I15-I20)/I17	=(J15-J20)/J17	=(K15-K20)/K17	=(L15-L20)/L17
26		demand AA f	=(D7-D19)/D13	=(E7-E19)/E13	=(F7-F19)/F13	=(G7-G19)/G13	=(H7-H19)/H13	=(I7-I19)/I13	=(J7-J19)/J13	=(K7-K19)/K13	=(L7-L19)/L13
2		demand AA	=(D15-	=(E15-	=(F15-	=(G15-	=(H15-	=(I15-	=(J15-	=(K15-	=(L15-

7		h	D20)/D17	E20)/E17	F20)/F17	G20)/G17	H20)/H17	I20)/I17	J20)/J17	K20)/K17	L20)/L17
28											
29		total demand									
30		Foreign	=D24*$C$3+D26*$B$3	=E24*$C$3+E26*$B$3	=F24*$C$3+F26*$B$3	=G24*$C$3+G26*$B$3	=H24*$C$3+H26*$B$3	=I24*$C$3+I26*$B$3	=J24*$C$3+J26*$B$3	=K24*$C$3+K26*$B$3	=L24*$C$3+L26*$B$3
31		home	=D25*$C$3+D27*$B$3	=E25*$C$3+E27*$B$3	=F25*$C$3+F27*$B$3	=G25*$C$3+G27*$B$3	=H25*$C$3+H27*$B$3	=I25*$C$3+I27*$B$3	=J25*$C$3+J27*$B$3	=K25*$C$3+K27*$B$3	=L25*$C$3+L27*$B$3
32											
33		total supply									
34											
35		x f (foreign)	0.5	0.7	0.4	0.5	0.5	0.7	0.7	0.4	0.4
36		x h (home)	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.6
37											
38		ER for EU	=(D24*D8+D25*D15)/(D24+D25)	=(E24*E8+E25*E15)/(E24+E25)	=(F24*F8+F25*F15)/(F24+F25)	=(G24*G8+G25*G15)/(G24+G25)	=(H24*H8+H25*H15)/(H24+H25)	=(I24*I8+I25*I15)/(I24+I25)	=(J24*J8+J25*J15)/(J24+J25)	=(K24*K8+K25*K15)/(K24+K25)	=(L24*L8+L25*L15)/(L24+L25)
3		EV for	=(D24/(D2	=(E24/(E2	=(F24/(F2	=(G24/(G2	=(H24/(H2	=(I24/(I2	=(J24/(J2	=(K24/(K2	=(L24/(L2

9		EU	4+D25))^2*D12+(D25/(D24+D25))^2*D17	4+E25))^2*E12+(E25/(E24+E25))^2*E17	4+F25))^2*F12+(F25/(F24+F25))^2*F17	4+G25))^2*G12+(G25/(G24+G25))^2*G17	4+H25))^2*H12+(H25/(H24+H25))^2*H17	4+I25))^2*I12+(I25/(I24+I25))^2*I17	4+J25))^2*J12+(J25/(J24+J25))^2*J17	4+K25))^2*K12+(K25/(K24+K25))^2*K17	4+L25))^2*L12+(L25/(L24+L25))^2*L17
40											
41		ER for AA	=(D26*D7+D27*D15)/(D26+D27)	=(E26*E7+E27*E15)/(E26+E27)	=(F26*F7+F27*F15)/(F26+F27)	=(G26*G7+G27*G15)/(G26+G27)	=(H26*H7+H27*H15)/(H26+H27)	=(I26*I7+I27*I15)/(I26+I27)	=(J26*J7+J27*J15)/(J26+J27)	=(K26*K7+K27*K15)/(K26+K27)	=(L26*L7+L27*L15)/(L26+L27)
42		EV for AA	=(D26/(D26+D27))^2*D13+(D27/(D26+D27))^2*D17	=(E26/(E26+E27))^2*E13+(E27/(E26+E27))^2*E17	=(F26/(F26+F27))^2*F13+(F27/(F26+F27))^2*F17	=(G26/(G26+G27))^2*G13+(G27/(G26+G27))^2*G17	=(H26/(H26+H27))^2*H13+(H27/(H26+H27))^2*H17	=(I26/(I26+I27))^2*I13+(I27/(I26+I27))^2*I17	=(J26/(J26+J27))^2*J13+(J27/(J26+J27))^2*J17	=(K26/(K26+K27))^2*K13+(K27/(K26+K27))^2*K17	=(L26/(L26+L27))^2*L13+(L27/(L26+L27))^2*L17
43											
44	EU only	demand EU f	=(D8-D21)/D12	=(E8-E21)/E12	=(F8-F21)/F12	=(G8-G21)/G12	=(H8-H21)/H12	=(I8-I21)/I12	=(J8-J21)/J12	=(K8-K21)/K12	=(L8-L21)/L12
45		demand EU h	=(D15-D22)/D17	=(E15-E22)/E17	=(F15-F22)/F17	=(G15-G22)/G17	=(H15-H22)/H17	=(I15-I22)/I17	=(J15-J22)/J17	=(K15-K22)/K17	=(L15-L22)/L17
46											
47		ER for EU	=(D44*D8+D45*D15)/(D44+D45)	=(E44*E8+E45*E15)/(E44+E45)	=(F44*F8+F45*F15)/(F44+F45)	=(G44*G8+G45*G15)/(G44+G45)	=(H44*H8+H45*H15)/(H44+H45)	=(I44*I8+I45*I15)/(I44+I45)	=(J44*J8+J45*J15)/(J44+J45)	=(K44*K8+K45*K15)/(K44+K45)	=(L44*L8+L45*L15)/(L44+L45)
48		EV for EU	=(D44/(D44+D45))^2*D12+(D45/(D44+D45))^2*D17	=(E44/(E44+E45))^2*E12+(E45/(E44+E45))^2*E17	=(F44/(F44+F45))^2*F12+(F45/(F44+F45))^2*F17	=(G44/(G44+G45))^2*G12+(G45/(G44+G45))^2*G17	=(H44/(H44+H45))^2*H12+(H45/(H44+H45))^2*H17	=(I44/(I44+I45))^2*I12+(I45/(I44+I45))^2*I17	=(J44/(J44+J45))^2*J12+(J45/(J44+J45))^2*J17	=(K44/(K44+K45))^2*K12+(K45/(K44+K45))^2*K17	=(L44/(L44+L45))^2*L12+(L45/(L44+L45))^2*L17
4											

9											
50											
51			Regressand		Regressor		return to variance ratio				
52											
53			Expected		Expected						
54			Return		Variance						
55		Mixed case									
56		EU	=D38		=D39		=SLOPE(D56:D64,F56:F64)				
57			=E38		=E39						
58			=F38		=F39						
59			=G38		=G39						
60			=H38		=H39						
61			=I38		=I39						
62			=J38		=J39						
63			=K38		=K39						
6			=L38		=L39						

4											
65											
66											
67		AA	=D41		=D42		=SLOPE(D67:D75,F67:F75)				
68			=E41		=E42						
69			=F41		=F42						
70			=G41		=G42						
71			=H41		=H42						
72			=I41		=I42						
73			=J41		=J42						
74			=K41		=K42						
75			=L41		=L42						
76											
77		EU only	=D47		=D48		=SLOPE(D77:D85,F77:F85)				
78			=E47		=E48						

79			=F47		=F48						
80			=G47		=G48						
81			=H47		=H48						
82			=I47		=I48						
83			=J47		=J48						
84			=K47		=K48						
85			=L47		=L48						
86											

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