University of Toronto
Department of Economics

Working Paper 393

Asymmetric Information, Portfolio Managers, and Home Bias

By Wioletta Dziuda and Jordi Mondria

February 12, 2010

Asymmetric Information, Portfolio Managers, and Home Bias*

Wioletta Dziuda
Kellogg School of Management

Jordi Mondria
University of Toronto

February 2010

Abstract

We propose a model of delegated asset management in which individual investors are more informed about the domestic market than the foreign market and face uncertainty about quality of portfolio managers. The model shows that asymmetric information of individual investors results in home bias even if professional fund managers are equally well informed about all markets. Additionally, the model generates predictions about the size and the quality of mutual funds that are consistent with empirical studies: there are fewer mutual funds investing domestically, but their quality and market value are higher.

*Wioletta Dziuda, Kellogg School of Management, Northwestern University, email: wdziuda@kellogg.northwestern.edu; Jordi Mondria, Department of Economics, University of Toronto, email: jordi.mondria@utoronto.ca. We are grateful to Markus Brunnermeier, Matthew Doyle, Juan Carlos Hatchondo, Christian Hellwig, Van Thi Tuong Nguyen, Jonathan Vogel, Mirko Wiederholt, Vivian Yue for very useful conversations, and to seminar and conference participants at AFA 2010, CEA 2009, CEPR Meetings on Global Interdependence 2009, Cowles Foundation Summer Conference 2009, MFA 2009, NASMES 2009 and Saskatchewan for useful comments.

1 Introduction

Nowadays a large share of international investments is executed by portfolio managers in financial institutions.[1] However, most models of international finance rely on individual investors. We propose a model of delegated asset management that can explain empirical regularities observed in international markets: the presence of home bias, the lower proportion of mutual funds investing domestically, and the higher quality and market value of domestic mutual funds.

The model builds on Berk and Green (2004)[2] and relies on two observations. First, individual investors seem to have more precise information about local markets (e.g., Ivkovich and Weisbenner, 2005; Malloy, 2005; Bae, Stulz, and Tan, 2008). The professional portfolio managers, however, are likely to have access to similar information about all markets. Second, there seems to be heterogeneity in the ability of portfolio managers to generate abnormal returns (e.g., Chevalier and Ellison, 1999; Gottesman and Morey, 2006).

We study a two-period economy in which individual investors delegate their investment decisions to mutual fund managers. Each manager invests in the assets of one market only; the choice of the market is made at the beginning of the game and is irreversible. Managers differ in their ability to generate abnormal returns, and prior to their choice of the market, all participants observe signals about the ability of each manager. Individual investors observe the fundamentals in the domestic market, but not in the foreign market. After the first period, the returns generated by each manager are observed, and investors reallocate their capital across managers.

First, the model predicts home bias: investors channel most of their capital to managers who invest domestically.[3] The reason for this is that investors have a local monitoring advantage: when assessing the ability of the managers investing domestically, investors compare

[1] At the end of 2007, mutual funds, pension funds, and other financial intermediaries had discretionary control over almost two-thirds of the US equity market.

[2] The model is also closely related to theories of delegation of portfolio management decisions such as Kothari and Warner (2001), Lynch and Musto (2003), Basak, Pavlova, and Shapiro (2007), Cuoco and Kaniel (2007), Mamaysky, Spiegel, and Zhang (2007), Wei (2007), Dang, Wu, and Zechner (2008), Garcia and Vanden (2009) and Glode (2009).

[3] The home bias puzzle was raised by French and Poterba (1991) and Tesar and Werner (1995). They showed that, at the beginning of the '90s, the fraction of stock market wealth invested domestically was around 90% for the U.S. and Japan, and around 80% for the U.K. Ahearne, Griever and Warnock (2004) updated the home bias numbers for the U.S. and found no dramatic change. The share of domestic equity in the US portfolio in the year 2000 is around 88%, while its share in the world portfolio is 50%.

their performance with the performance of the domestic economy, but when assessing the ability of the managers investing in the foreign market, they are able to compare only the performance across managers. As a result, investors learn faster about the ability of managers who invest domestically, which allows them to reallocate their capital in the domestic market more efficiently. This in turn leads investors to channel more capital to the domestic market, thereby generating home bias. If the prior signals about the quality of the managers do not favor any manager, the expectation of this home bias attracts more managers to the domestic market in the first place. This allows investors to better diversify their domestic investment, which amplifies the equity home bias even further.

The idea that asymmetric information can explain the equity home bias puzzle is not new (see Gehrig, 1993; Brennan and Cao, 1997; Zhou, 1998; Barron and Ni, 2008; Hatchondo, 2008; and Van Nieuwerburgh and Veldkamp, 2009).[4] Because individual agents watch domestic television, listen to domestic radio, and read domestic newspapers, domestic investments carry less risk when these agents invest on their own. However, many argue that the information-based explanations of home bias have not taken into account the existence of institutionally managed funds. Institutionally managed funds overcome information barriers about foreign markets by allocating significant resources to information processing. Our model shows that even if portfolio managers are equally informed about all markets, the uncertainty about their ability provides a channel through which the asymmetric information faced by individual investors generates home bias. It thus restores the validity of the information-based explanation of home bias.

The second finding of this paper is that (i) managers who are expected to be more skilled invest domestically; as a result, (ii) investors obtain on average higher returns on the capital invested in domestic assets. The reason for this is that, since investors are better able to assess the ability of managers who invest domestically, they are more responsive to the

[4]Following Sercu and Vanpee (2008), there are four more types of explanations for the equity home bias puzzle: the lack of perfect financial integration (see Black, 1974; Stulz, 1981; Martin and Rey, 2004, although Bonser-Neal et al., 1990; Hardouvelis, Porta, and Wizman, 1994; Claessens and Rhee, 1994; and Errunza and Losq, 1985 show evidence disputing this explanation), investors hedging domestic risks (see Cooper and Kaplanis, 1994; Baxter and Jermann, 1997; Engel and Matsumoto, 2008; Heathcote and Perri, 2007; Coeurdacier and Gourinchas, 2008; Coeurdacier, Martin and Kollmann, 2009), corporate governance, transparency, and political risk (see Dahlquist et al., 2003; Ahearne, Griever, and Warnock, 2004; Gelos and Wei, 2005; Kraay et al., 2005; Kho, Stulz and Warnock, 2009), behavioral-based stories of equity home bias (see Huberman, 2001; Barber and Odean, 2001, 2002; Solnik, 2008; Morse and Shive, 2009; and Karlsson and Norden, 2007).

expected quality of these managers. That is, the domestic market rewards ability more. As a result, managers who consider themselves to be more skilled invest domestically. This induces investors to channel even more funds to the domestic market, leading in turn to the market value of mutual funds investing in the domestic market being higher than the market value of funds investing in foreign markets.

This finding is consistent with the extensive empirical evidence showing that foreign investors have a lower stock-picking ability than domestic investors. Shukla and van Inwegen (1995) show that U.K. money managers underperform American money managers when choosing U.S. stocks. Kang and Stulz (1997) show that foreign investors in Japan hold a portfolio biased toward large companies and firms with low leverage. Hau (2001) finds that domestic traders in the German stock market outperform foreign traders. Choe, Kho, and Stulz (2005) show that domestic investors in Korea buy at lower prices and sell at higher prices than foreign investors. Dvorak (2005) provides evidence that foreign investors have a lower stock-picking ability than domestic investors in Indonesia. Bae, Stulz, and Tan (2008) provide evidence that domestic analysts make more precise earning forecasts than do foreign analysts. Our finding also seems to be consistent with empirical observations within the U.S. market. Coval and Moskowitz (2001) provide evidence that fund managers who display a stronger local bias achieve higher risk-adjusted returns. Grote and Umber (2006) also show that the most successful mergers and acquisitions deals are the ones that display a stronger local bias. These findings are usually interpreted as suggesting that managers have a local information advantage. However, our model suggests that these regularities may also be due to the fact that the more skilled managers choose to invest locally.

Finally, if the signals about managers' ability imply large heterogeneity among the managers, the fact that the quality of the managers investing in the domestic market is expected to be high makes it unprofitable for average quality managers to compete with them in the same market. As a result, those managers prefer to invest in foreign assets, which may result in a smaller fraction of mutual funds investing domestically.

If there are fewer managers investing in domestic assets, the ability of individual investors to diversify the manager specific risk is lower for the domestic investment. As a result, the individual investors have an incentive to channel more capital to the foreign market, which counteracts the effect of the higher ability of managers investing domestically. The final effect on the home bias depends on the parameters of the model.

Using the findings of Chan, Covrig, and Ng (2005) and Hau and Rey (2008), we calibrate our model to have 46% of the fund managers in the domestic market and the rest in the foreign market. The calibrated model implies that, on average, individual investors allocate from 52% to 76% of their funds to domestic fund managers and the rest to foreign fund managers. Our calibrated model also implies that domestic managers generate excess returns between 36 and 60 basis points higher than foreign managers. Although our model underestimates the empirical home bias, it nevertheless comes very close, given its stylized nature. The findings of the calibration are consistent with Chan, Covrig, and Ng (2005) and Hau and Rey (2008), which report three stylized facts about mutual funds' investment style in the most developed financial markets: (1) On average, the number of international funds is larger than the number of domestic funds. (2) On average, the market value of international funds is smaller than the market value of domestic funds. (3) There is equity home bias at the fund level.

We check the robustness of our results by numerically simulating the model for different parameters. For a range of reasonable parameters we observe home bias with a smaller number of managers investing domestically. We also show that home bias increases with the unobserved heterogeneity of the managers.

Overall, this paper suggests that asymmetric information at the individual level combined with uncertainty about the ability of portfolio managers plays an important role in the delegated management industry in international markets. In particular, the paper provides arguments in favor of the information-based explanation of home bias.

2 The Model

We study a two-period economy with two countries: domestic (D) and foreign (F).

There is a continuum of managers of measure one, and each manager either invests in the assets of the domestic market, invests in the assets of the foreign market, or stays out of both. There is a fixed cost F_M for entry to market M, where $M \in \{D, F\}$. Each manager can enter only one market, and the entry decision is irreversible. For simplicity, managers investing in the domestic market are called domestic managers, and managers investing in the foreign market are called foreign managers, but the reader should keep in mind that all managers serve domestic investors. Let μ be the mass of managers who decide to invest in any of the markets, and let n denote the fraction of operating managers who choose the domestic market. A manager j investing in market M has the ability to generate excess returns with respect to a passive benchmark, and we denote them by R_{tj}^{M}.

Excess returns depend on the ability of the manager to acquire and process information about the likely prospects of individual assets. Some of this information is available to all sophisticated players in a given market, can be disseminated via media or word-of-mouth, and is likely to be understood ex post by everybody in a given market. Let v_{Mt}, called *fundamentals,* measure how on average one could outperform the benchmark in country M using only country M's assets if one had access only to this type of information. However, some of the relevant information is more difficult or costly to gather and understand, and might be available only to managers of mutual funds. Moreover, a highly trained manager might be better at interpreting this information. Let α_j, called *ability,* denote this additional knowledge and the asset-picking ability that a given manager brings to the table. And finally, let ε_{tj} be an error term, which is normally distributed and independent over time and across managers, $\varepsilon_{tj} \sim N\left(0, \sigma_{\varepsilon}^{2}\right)$. We assume that $R_{tj}^{M} = \alpha_j + v_{Mt} + \varepsilon_{tj}$.

The following assumption is one of the two main building blocks of our model.

Assumption A The ability of each manager α_j is independent of the market she invests in, is constant over time, and is independent of other managers' abilities.

Managers are paid a fixed fee f per unit of capital they manage, and there is no cost of active management. Managers maximize the present discounted profit, which is equivalent to maximizing the present discounted value of received capital.

There is a continuum of investors of measure one. Investors have a unit of capital to invest in both markets and mean-variance preferences with a coefficient of absolute risk aversion γ.

Investors invest only through mutual funds. Each investor draws a fixed number of funds T from the pool of all operating mutual funds, and each of these funds is drawn from the domestic market with probability n. Hence, the number of funds investing domestically that are observed by an investor, which we denote by N, is a random variable with the binomial distribution:

$$\Pr\left(N|n\right) = \binom{T}{N} n^{N} \left(1-n\right)^{T-N}.$$

The set of observed mutual funds is constant for both periods.[5]

We assume that the ability of each manager consists of a publicly observed signal y_j and an unknown, random factor η_j; that is, $\alpha_j = y_j + \eta_j$, where $\eta_j \sim N\left(0, \sigma_\eta^2\right)$, and η_j and η_i are independent for $i \neq j$. The managers observe the signals before they choose in which market to invest, while the investors observe only the signals of the T mutual funds that they have access to.

The following assumption is the second important building block of our model.

Assumption B Investors observe domestic fundamentals, but do not observe foreign fundamentals.

The first period is divided into three stages. First, managers decide simultaneously whether to enter, and if they decide to enter, into which market. Then, each investor draws T mutual funds and chooses how to allocate the capital across those funds. Finally, returns are realized. In the second period, investors observe the realized returns of the mutual funds in which they invested, $R_1^D \equiv \left\{R_{1j}^D\right\}_{j=1}^N$ and $R_1^F \equiv \left\{R_{1j}^F\right\}_{j=1}^{T-N}$, and the realization of domestic fundamentals v_{D1}. They update their belief about each manager's ability and reallocate their assets accordingly, incurring no switching costs.

Before we move to solving the model, let us discuss some of the assumptions. As in Chevalier and Ellison (1999), we interpret the ability α_j as inherent stock-picking ability, direct benefits from a better education, and differences in the value of the social networks that different schools provide. The signal y_j can be interpreted as the publicly available information, such as curriculum vitae of the fund manager, for example. Chevalier and Ellison (1999) showed that managers who attended higher-SAT undergraduate institutions have systematically higher risk-adjusted excess returns. In their paper, they also cite a 1994 study by Morningstar, Inc., which discovered that "over the previous five years diversified mutual funds managed by "Ivy League" graduates had achieved raw returns that were 40 basis points per year higher than those of funds managed by non-Ivy League graduates." (reported in *Business Week*, July 4, 1994, p. 6).

[5] For reasons of tractability, we assume that there is a continuum of managers, and each investor draws only a finite sample. Alternatively, we could assume that there is a discrete number of managers who are observed by all investors; but when analyzing the entry decision, we would have to deal with each manager taking into account the fact that her entry affects the number of managers in each market. This effect is uninteresting and analytically cumbersome.

Assumption B reflects the observation that domestic investors get their information from domestic media and talk to other individuals who might have expertise in domestic assets. For example, they may learn about the performance of other investment vehicles, such as hedge funds. Therefore, they can reasonably estimate which abnormal returns they should expect from mutual funds. They have much less information, however, about the foreign market.

The assumption that managers can invest in only one market is clearly a simplification, but it can be justified on many grounds. First, it might be disadvantageous for a manager to invest in many markets because there might be returns to scale in information processing as suggested in Van Nieuwerburgh and Veldkamp (2009).[6] Another theoretical support for the existence of funds with narrow mandates is provided by He and Xiong (2008) in a model of delegated asset management in multiple markets with agency frictions. And finally, empirical evidence provided by Hau and Rey (2008) shows that the distribution of the markets in which mutual funds invest is bimodal. The distribution has a peak for completely home-biased funds and a peak for funds investing only in foreign markets.

2.1 Portfolio choice

In this section, we study the portfolio choice of investors in each period, after the entry decision has been made and after each investor draws the funds she observes. Let $x_{jt}^{D}(N)$ be the amount of capital invested with the domestic manager j at time t by an investor who observes N domestic and $T-N$ foreign managers, with manager j among them. Analogously, let $x_{jt}^{F}(N)$ denote the fraction of the capital that foreign manager j receives from an investor who observes N domestic and $T-N$ foreign managers, with manager j among them. In what follows, we omit the arguments when confusion should not be an issue.

The investment satisfies $\sum_{j=1}^{N} x_{jt}^{D} + \sum_{j=1}^{T-N} x_{jt}^{F} = 1$ since each investor has one unit of capital. In the rest of the paper, the superscripts denote to which market a given variable refers. In particular, when we want to stress that we are referring to a manager in a particular market, we denote the signal about manager j in market M by y_j^M.

[6] This assumption could be theoretically rationalized with a model similar to the one proposed by Van Niuewerburgh and Veldkamp (2009). Their model shows that there are increasing returns to scale to information processing when investors have both a portfolio choice and an information processing choice.

2.1.1 The first period

Given the signal structure, in the first period the ability of manager α_j is normally distributed with expectation and variance given by y_j and σ_η^2, respectively. Pick an investor and let $y^D = \frac{1}{N}\sum_{j=1}^N y_j^D$ and $y^F = \frac{1}{T-N}\sum_{j=1}^{T-N} y_j^F$ be the average expected ability of the domestic and foreign mutual funds observed by this investor. This investor chooses the allocation of funds $\left\{x_{j1}^D\right\}_{j=1}^N$ and $\left\{x_{j1}^F\right\}_{j=1}^{T-N}$ to solve

$$\begin{aligned}
&\max_{\left\{x_{j1}^D\right\}_{j=1}^N;\left\{x_{j1}^F\right\}_{j=1}^{T-N}} \sum_{j=1}^N \left(\bar{\nu} + y_j^D - f\right) x_{j1}^D + \sum_{j=1}^{T-N} \left(\bar{\nu} + y_j^F - f\right) x_{j1}^F + \\
&-\frac{1}{2}\gamma \left(\left(\sum_{j=1}^N x_{j1}^D \right)^2 \sigma_v^2 + \sum_{j=1}^N \left(x_{j1}^D\right)^2 \left(\sigma_\eta^2 + \sigma_\varepsilon^2\right) \right) + \\
&-\frac{1}{2}\gamma \left(\left(\sum_{j=1}^{T-N} x_{j1}^F \right)^2 \sigma_v^2 + \sum_{j=1}^{T-N} \left(x_{j1}^F\right)^2 \left(\sigma_\eta^2 + \sigma_\varepsilon^2\right) \right),
\end{aligned}$$

subject to $\sum_{j=1}^N x_{j1}^D + \sum_{j=1}^{T-N} x_{j1}^F = 1$. Let $q_{Dt}(N)$ and $q_{Ft}(N)$ denote the amount of capital this investor allocates to each market at time t. Solving the optimization problem above, we obtain that the amount of capital the investor allocates to a domestic fund j with signal y_j^D in the first period is

$$x_{j1}^D(N) = \frac{q_{D1}(N)}{N} + \frac{y_j^D - y^D}{\gamma\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)} \text{ if } N > 0, \text{ and } x_{j1}^D(0) = 0, \tag{1}$$

while the amount of capital the investor allocates to a foreign fund j with signal y_j^F is

$$x_{j1}^F(N) = \frac{q_{F1}(N)}{T-N} + \frac{y_j^F - y^F}{\gamma\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)} \text{ if } N < T, \text{ and } x_{j1}^F(T) = 0. \tag{2}$$

Also,

$$q_{D1}(N) = \sum_{j=1}^N x_{j1}^D(N) = \frac{\gamma\left(\sigma_v^2 + \frac{1}{T-N}\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right) + y^D - y^F}{\gamma\left(2\sigma_v^2 + \left(\frac{1}{T-N} + \frac{1}{N}\right)\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right)}, \tag{3}$$

$$q_{F1}(N) = \sum_{j=1}^{T-N} x_{j1}^F(N) = \frac{\gamma\left(\sigma_v^2 + \frac{1}{N}\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right) - y^D + y^F}{\gamma\left(2\sigma_v^2 + \left(\frac{1}{T-N} + \frac{1}{N}\right)\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right)}. \tag{4}$$

The amount of capital that the investor allocates to each market in the first period depends on the number of mutual funds she observes and the expected average quality of managers in each market. All else being equal, the market in which the investor observes more funds allows her to better diversify the fund's specific risk, and therefore attracts more capital. Also, all else being equal, the market with a higher expected average quality of managers provides the investor with higher expected excess returns, and therefore attracts more capital.

Equations (1) and (2) imply that a given fund manager receives more capital if she invests in a market in which few other mutual funds are observed, and if her quality is above average in this market.

2.1.2 The second period

In the second period, investors update their beliefs about each manager's ability. Let ϕ_{j1}^M be the belief that an investor holds after the first period about the quality of manager j who invests in the assets of market M. In the domestic market, besides observing the signals about abilities $\left\{y_j^D\right\}_{j=1}^N$, investors observe the realized returns of the managers they invested with $\left\{R_{j1}^D\right\}_{j=1}^N$, and the domestic fundamental v_{D1}. Investors update their beliefs about domestic fund managers in the following way:

$$\phi_{j1}^D\left(y_j^D, R_{j1}^D, v_{D1}\right) \equiv E\left[\alpha_j \mid \left\{y_j^D\right\}_{j=1}^N, R_{11}^D, ..., R_{N1}^D, v_1^D\right] = E\left[\alpha_j \mid y_j^D, R_{j1}^D, v_{D1}\right]; \tag{5}$$

$$\sigma_{\alpha D}^2 \equiv Var\left(\alpha_i \mid y_j^D, R_{j1}^D, v_{D1}\right) = \sigma_\varepsilon^2 \frac{\sigma_\eta^2}{\sigma_\varepsilon^2 + \sigma_\eta^2}. \tag{6}$$

In the foreign market, investors observe signals about abilities $\left\{y_j^F\right\}_{j=1}^{T-N}$ and the realized returns of the managers they invested with $\left\{R_{j1}^F\right\}_{j=1}^{T-N}$, but they do not observe the foreign fundamentals v_{F1}. Investors update their beliefs about foreign fund managers in the following way:

$$\phi_{j1}^F\left(\left\{y_j^F\right\}_{j=1}^{T-N}, R_1^F\right) \equiv E\left[\alpha_j \mid \left\{y_j^F\right\}_{j=1}^{T-N}, R_{11}^F, ..., R_{(T-N)1}^F\right]; \tag{7}$$

$$
\begin{aligned}
\sigma^2_{\alpha F} &\equiv Var\left(\alpha_j \mid \left\{y^F_j\right\}^L_{j=1}, R^F_{11}, ..., R^F_{(T-N)1}\right) = \\
&= \frac{\sigma^2_\eta}{\sigma^2_\varepsilon + \sigma^2_\eta} \frac{\sigma^4_\varepsilon + \sigma^2_\eta\left(\sigma^2_v + \sigma^2_\varepsilon\right) + (T-N)\,\sigma^2_v\sigma^2_\varepsilon}{\sigma^2_\varepsilon + \sigma^2_\eta + (T-N)\,\sigma^2_v}.
\end{aligned} \tag{8}
$$

Equations (6) and (8) are at the heart of the results of this paper. In the domestic market, investors observe domestic fundamentals, and the realizations of other managers' returns do not carry additional information about the ability of particular managers. Investors can isolate the impact of fundamentals from the impact of ability and idiosyncratic noise. In the foreign market, on the other hand, investors do not observe fundamentals, and they estimate the ability of each manager by comparing her performance to the performance of other managers investing in this market. As a result, for a given N, the uncertainty that an investor faces after the first period about the ability of the foreign managers is higher: $\sigma^2_{\alpha F} > \sigma^2_{\alpha D}$.

After updating their beliefs, investors choose their allocation of capital between the domestic and the foreign funds $\left\{x^D_{j2}\right\}^N_{j=1}$ and $\left\{x^F_{j2}\right\}^{T-N}_{j=1}$ that solve

$$
\begin{aligned}
&\max_{\left\{x^D_{j2}\right\}^N_{j=1};\left\{x^F_{j1}\right\}^{T-N}_{j=1}} \sum_{j=1}^{N}\left(\bar{\nu} + \phi^D_{j1} - f\right) x^D_{j2} + \sum_{j=1}^{T-N}\left(\bar{\nu} + \phi^F_{j1} - f\right) x^F_{j2} + \\
&-\frac{1}{2}\gamma\left(\left(\sum_{j=1}^{N} x^D_{j2}\right)^2 \sigma^2_v + \sum_{j=1}^{N}\left(x^D_{j2}\right)^2\left(\sigma^2_{\alpha D} + \sigma^2_\varepsilon\right)\right) + \\
&-\frac{1}{2}\gamma\left(\left(\sum_{j=1}^{T-N} x^F_{j2}\right)^2 \sigma^2_v + \sum_{j=1}^{T-N}\left(x^F_{j2}\right)^2\left(\sigma^2_{\alpha F} + \sigma^2_\varepsilon\right)\right),
\end{aligned}
$$

subject to $\sum_{j=1}^N x^D_{j2} + \sum_{j=1}^{T-N} x^F_{j2} = 1$. The amount of capital invested in a domestic fund in the second period is

$$
x^D_{j2}(N) = \frac{q_{D2}(N)}{N} + \frac{\phi^D_{j1} - \frac{1}{N}\sum_{i=1}^N \phi^D_{i1}}{\gamma\left(\sigma^2_{\alpha D} + \sigma^2_\varepsilon\right)}, \tag{9}
$$

for $N > 0$ and $x^D_{j2}(0) = 0$, while the allocation of funds in the foreign market is

$$
x^F_{j2}(N) = \frac{q_{F2}(N)}{T-N} + \frac{\phi^F_{j1} - \frac{1}{(T-N)}\sum_{i=1}^{(T-N)} \phi^F_{i1}}{\gamma\left(\sigma^2_{\alpha F} + \sigma^2_\varepsilon\right)}, \tag{10}
$$

for $N < T$ and $x_{j2}^F(T) = 0$. The amount of capital invested in each market is given by

$$q_{D2}(N) = \frac{\gamma\left(\sigma_v^2 + \frac{1}{(T-N)}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)\right) + \left(\frac{1}{N}\sum_{i=1}^{N}\phi_{i1}^D - \frac{1}{(T-N)}\sum_{i=1}^{(T-N)}\phi_{i1}^F\right)}{\gamma\left(2\sigma_v^2 + \frac{1}{(T-N)}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right)}, \tag{11}$$

$$q_{F2}(N) = \frac{\gamma\left(\sigma_v^2 + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right) - \left(\frac{1}{N}\sum_{i=1}^{N}\phi_{i1}^D - \frac{1}{(T-N)}\sum_{i=1}^{(T-N)}\phi_{i1}^F\right)}{\gamma\left(2\sigma_v^2 + \frac{1}{(T-N)}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right)}. \tag{12}$$

Equations (11) and (12) show that if markets are equally diversified, that is, if $N = T - N$, and the average expected ability in both markets after the first period is the same, $\frac{1}{N}\sum_{j=1}^{N}\phi_{j1}^D = \frac{1}{(T-N)}\sum_{j=1}^{(T-N)}\phi_{j1}^F$, then $q_{D2} > q_{F2}$. That is, an investor who observes $N = T-N$, channels more capital into the domestic market, thus generating home bias. The reason for this is that the investor's estimate of domestic managers' ability is more precise, and the investor can better allocate her capital across mutual funds. Hence, from the perspective of the investors, the domestic market is less risky. However, the equilibrium home bias depends on the average expected ability in both markets and the realization of N, which in turn depends on the entry decision of the managers. We analyze this problem in the next section.

2.2 Market entry

In the initial stage, fund managers decide simultaneously whether to invest in the domestic market, in the foreign market, or to stay out. Conditional on operating, they choose the market in which they expect to attract more capital.

Let us first calculate the ex ante expected amount of capital invested in a domestic and a foreign fund in each period by an investor who observes N domestic and $T - N$ foreign funds. For the first period, the amount of capital invested in a domestic fund with signal y_j by an investor who observes N domestic and $T - N$ foreign funds is given by (1), while the amount of capital invested in a foreign fund j with signal y_j is given by (2). For the second period, a fund manager with signal y_j expects that investors' belief about her ability will be independent of which market she invests in, namely:

$$E\left[\phi_{j1}^D\left(y_j, R_{j1}^D, v_1^D\right)\right] = E\left[\phi_{j1}^F\left(\left\{y_j^F\right\}_{j=1}^{T-N}, R_1^F\right)\right] = y_j.$$

The ex-ante expected amount of capital invested in a fund with signal y_j in the second period by an investor who observes N domestic and $T-N$ foreign funds is obtained using equations (9) and (10), and is equal to:

$$E\left[x_{j2}^{D}|N\right]=\frac{\gamma\left(\sigma_{v}^{2}+\frac{1}{T-N}\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)\right)+\left(y^{D}-y^{F}\right)}{N\gamma\left(2\sigma_{v}^{2}+\frac{1}{T-N}\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)+\frac{1}{N}\left(\sigma_{\alpha D}^{2}+\sigma_{\varepsilon}^{2}\right)\right)}+\frac{\left(y_{j}-y^{D}\right)}{\gamma\left(\sigma_{\alpha D}^{2}+\sigma_{\varepsilon}^{2}\right)}\text{ if }N>0,\quad(13)$$

if the manager is in the domestic market, and

$$E\left[x_{j2}^{F}|N\right]=\frac{\gamma\left(\sigma_{v}^{2}+\frac{1}{N}\left(\sigma_{\alpha D}^{2}+\sigma_{\varepsilon}^{2}\right)\right)-\left(y^{D}-y^{F}\right)}{(T-N)\gamma\left(2\sigma_{v}^{2}+\frac{1}{T-N}\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)+\frac{1}{N}\left(\sigma_{\alpha D}^{2}+\sigma_{\varepsilon}^{2}\right)\right)}+\frac{\left(y_{j}-y^{F}\right)}{\gamma\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)}\text{ if }N<T,\tag{14}$$

if the manager is in the foreign market. Again, $E\left[x_{j2}^{D}|0\right]=0$ and $E\left[x_{j2}^{F}|T\right]=0$.

Next, let us construct the expected excess payoff of a fund if it enters the domestic market. If n is the fraction of all managers investing domestically, and $\Pr(N|n)$ is the fraction of investors who observe N domestic funds, then there are $\Pr(N|n)\,N$ observations of this kind. This implies that the number of consumers who observe N domestic funds per domestic fund is $\Pr(N|n)\,\frac{N}{\mu n}$. Analogously, the number of consumers who observe $T-N$ foreign funds per foreign fund is $\Pr(N|n)\,\frac{T-N}{\mu(1-n)}$. Hence, in period t, a manager with signal y_j expects the following excess profit from investing domestically:

$$\Delta_{t}\left(y_{j}\right)\equiv\frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\left(\frac{N}{n}E\left[x_{jt}^{D}|N\right]-\frac{T-N}{1-n}E\left[x_{jt}^{F}|N\right]\right).\tag{15}$$

In equilibrium, conditional on operating, a manager with y_j invests domestically if and only if the expected excess profit from this is equal to the difference in the entry costs:

$$\left(\Delta_{1}\left(y_{j}\right)+\delta\Delta_{2}\left(y_{j}\right)\right)f=F_{D}-F_{F}.\tag{16}$$

2.3 Homogeneous fund managers

To develop the intuition for what forces are at work in this model, we start by solving the model with ex-ante homogeneous fund managers, that is, $y_j=\bar{\alpha}$ for any fund manager j. Hence, in this section $y^D=y^F=y_j=\bar{\alpha}$.

2.3.1 Benchmark case

We first analyze a benchmark case in which investors can observe foreign fundamentals as well. In such a setting it is equally easy for investors to estimate the ability of all managers; hence, $\sigma^2_{\alpha F} = \sigma^2_{\alpha D}$. The allocation in the first period is described by equations (1) and (2), and the allocation in the second period is described by equations (9), (10), (11), and (12), but with $\sigma^2_{\alpha D}$ in place of $\sigma^2_{\alpha F}$.

It is straightforward to prove the following lemma (all proofs are in the appendix).

Lemma 1 *In the benchmark case, when the cost of entry into both markets is the same, $F_D = F_F$, the equilibrium fraction of managers investing in each market is $\frac{1}{2}$, and the expected amount of capital in each market is the same.*

2.3.2 Asymmetric case

Let n_a and n_b be the equilibrium fraction of managers investing in the domestic market in the model with asymmetric information and in the benchmark case, respectively. Denote the total expected amount of capital invested in the domestic market at time t in the two models by Q^a_{Dt} and Q^b_{Dt}, respectively.

Definition *The home bias in period t is $HB_t = Q^a_{Dt} - Q^b_{Dt}$.*

Proposition (1) states that in equilibrium, there are more mutual funds in the domestic market.

Proposition 1 *In equilibrium, if $F_D \leq F_F$, then $n_a > \frac{1}{2}$, and there is home bias in both periods.*

Home bias results from two effects: a direct one and an indirect one. First, in the second period investors have more precise information about domestic managers' ability. Hence, they can distribute their investments better in the domestic market than in the foreign market. This leads them to channel more capital to the domestic market even if the number of mutual funds in each market is the same. Second, due to this initial home bias, the managers expect to obtain more capital in the domestic market, which prompts more managers to enter the domestic market. This has a multiplier effect: diversifying the fund-specific risk becomes easier in the domestic market, and this attracts more capital. Home bias thus becomes even more severe.

2.4 Heterogeneous fund managers

In this section, we analyze the full model in which managers are not ex-ante identical. We begin with the following proposition.

Proposition 2 *In any equilibrium, if $F_D \leq F_N$, then the average quality of managers is higher in the domestic market , $y^D \geq y^F$. Also, exactly one of the following holds:*

a) there exists a threshold ability $\bar{y}$, such that all $y_j \geq \bar{y}$ enter the domestic market, and the best managers among those with $y_j < \bar{y}$ enter the foreign market;

b) all managers are indifferent between the markets and there are fewer managers in the domestic market.

Moreover, either there is home bias in both periods, or $n < \frac{1}{2}$, or both.

Heuristically, investors evaluate the quality of domestic managers more accurately than the quality of the foreign managers. Hence, in the second period they respond more to the new information about the quality of the managers in the domestic market, reallocating their capital to the better managers. This means that quality is rewarded more in the domestic market, and therefore, in equilibrium better managers invest domestically. As a result domestic investment brings higher returns, and hence attracts more capital. This is the direct effect. However, there is also an indirect effect. A medium-quality manager, who would enter the domestic market if the managers were homogeneous, now finds it unprofitable to compete in that market with high-quality managers. As a result, medium-quality managers invest in foreign assets, and in equilibrium there may be fewer managers investing domestically.

The direct effect increases home bias. The indirect effect decreases it, as investors cannot diversify the manager specific risks very well in the domestic market. Therefore, whenever $n > \frac{1}{2}$, there is home bias, but if n is small enough, the indirect effect may dominate. The equilibrium outcome depends on the parameters of the model, and we analyze this numerically in the next section. However, as is apparent in the proof of Proposition (2), there exists an

$\bar{n} < \frac{1}{2}$, such that for all $n > \bar{n}$, there is always home bias. Hence, it is possible to find parameters that allow us to match all stylized facts.

To understand the intuition behind Proposition (2) better, let us have a look at how entry incentives vary with the expected quality y_j. Let $\sigma^2_{\alpha Mt}$ be the uncertainty about the quality of a manager in period t in market M. The amount of capital attracted by a manager with quality y_j when she enters market M is (this notation allows us to express equations (1), (2), (13) and (14) in one; $\neg M$ denotes the other market):

$$\begin{aligned}
& \frac{1}{\mu}\sum_{N=0}^{T}\Pr(N|n)\,\frac{N}{n}E\left[x^M_{j2}|N\right] \qquad (17)\\
= \; & \frac{1}{\mu}\sum_{N=0}^{T}\Pr(N|n)\,\frac{N}{n}\frac{\gamma\left((T-N)\,\sigma^2_v + \left(\sigma^2_{\alpha(\neg M)t} + \sigma^2_\varepsilon\right)\right) + (T-N)\left(y^M - y^{\neg M}\right)}{\gamma\left(2N(T-N)\,\sigma^2_v + N\left(\sigma^2_{\alpha Ft} + \sigma^2_\varepsilon\right) + (T-N)\left(\sigma^2_{\alpha Dt} + \sigma^2_\varepsilon\right)\right)}\\
& + \frac{1}{\mu}\sum_{N=0}^{T}\Pr(N|n)\,\frac{N}{n}\frac{\left(y_j - y^M\right)}{\gamma\left(\sigma^2_{\alpha Mt} + \sigma^2_\varepsilon\right)}.
\end{aligned}$$

An increase in manager j's expected quality y_j has two effects: a direct and an indirect one. The direct effect increases the difference between the quality of this manager and the average quality in her market $\left(y_j - y^M\right)$. The magnitude of this effect depends on how effective a given market is in rewarding quality. If $\sigma^2_{\alpha Mt}$ is the same in both markets, as it is in the first period, then the direct effect of the increase in y_j is the same for both markets. In the second period, the domestic market is better at rewarding quality, $\sigma^2_{\alpha Dt} < \sigma^2_{\alpha Ft}$. With other things being equal, better managers therefore have higher incentives to enter the domestic market.

However, there is also the indirect effect: the average quality of funds that investors of fund j observe, y^M, depends on y_j. Increasing y_j increases y^M, which has two effects. First, the market attracts more funds overall because the average quality is better (the first term in equation (17)); and second, the difference $\left(y_j - y^M\right)$ decreases (the second term in equation (17)). Given that the first effect is shared by all mutual funds observed in market M, and the second effect is specific to fund j, the second effect dominates. Therefore, high-quality managers prefer the foreign market only if many managers invest in that market. But if only few low-quality managers invest domestically, all managers would prefer to invest domestically; hence, this cannot be an equilibrium.

Let us now discuss the implications of Proposition (2). In their empirical paper, Hau and Rey (2008) show that the distribution of mutual funds is bimodal: most of the mutual funds invest overwhelmingly either in domestic assets or in foreign assets. Given that we constrain managers to invest in one market only, we are unable to provide any insight on this finding. However, we can shed some light on their curious observation that more mutual funds invest mainly in foreign assets; however, these funds are smaller on average than those investing domestically.

Proposition (2) says that funds investing domestically are better; hence, they attract more capital than those investing in foreign assets. Moreover, it is possible that fewer funds are investing domestically. Whether this is the case depends on the distribution of the signals about quality, and we investigate this issue in the next section.

One could point out an alternative and simpler explanation for why fewer mutual funds invest domestically. That is, it could be argued that due to returns to specialization, funds invest in just one foreign market or in only a subgroup of foreign markets; and since there are many foreign markets and only one domestic market, we observe fewer mutual funds investing domestically. We find this explanation plausible, but not completely satisfactory. The level of specialization of funds investing in domestic assets seems to be higher than the level of specialization of funds investing in foreign assets; although a curious observation by itself, this would suggest that the number of domestic and foreign mutual funds could in principle be the same. Our model provides a more nuanced explanation of this observation.

In the next section, we show that for reasonable parameters the model can account for the stylized facts about the delegated management industry at the international level. We also show how the equilibrium outcome varies with the parameters of the model.

3 Numerical Analysis

In the following numerical analysis, we investigate whether our model is able to account quantitatively for three salient features of the data on fund managers at the international level, as reported by Chan, Covrig, and Ng (2005) and Hau and Rey (2008). These features are: (1) On average, the number of international funds is larger than the number of domestic funds. (2) On average, the market value of international funds is smaller than the market value of domestic funds. (3) There is equity home bias at the fund level.

We use parameter values calibrated by Dang, Wu, and Zechner (2008) to match empirically observed values using the CRSP survivor-bias-free U.S. mutual fund database (1961 to 2002).[7] The management fee f set by the fund manager is calibrated to be 1% in order to match the average annual expense ratio, including 12b-1 fees, by fund managers. The volatility of the tracking error, $\sigma_\nu + \sigma_\varepsilon$, is set to 10%. As in Van Nieuwerburgh and Veldkamp (2009), we consider a 10% initial information advantage, which implies that the standard deviation of fundamentals, σ_ν, is set to 1% and the standard deviation of the idiosyncratic risk, σ_ε, is set to 9%. Dang, Wu, and Zechner (2008) calibrate the variance of the ability of a fund manager to be 0.04, among other parameters, for their model to match reasonable levels of fund size, portfolio risk, fund flow dynamics, and expected manager tenure. Hence, we set the standard deviation of the ability of a fund manager, σ_η, at 20%. As Wei (2007) notes, according to the ICI's Mutual Fund Fact Book, a typical household in the real world holds four mutual funds on average. Hence, we set $T = 4$. The coefficient of risk aversion is $\gamma = 1$ and the discount factor is $\delta = 0.99$. For the numerical exercise, we assume that $F_F = (1 + g) F_D$ and we will do comparative statics on the parameter g. The parameters for domestic fixed costs, F_D, and the mass of operating managers, μ, are always multiplied with each other. Berk and Green (2004) calibrated the value of the ratio of the size of a new fund over the minimum fund size to be 4.7. When we set $F_D = 2.8\%$, then μF_D is 0.42% and the value of the ratio of the size of an average fund over the minimum fund size is 4.7. The numerical results are independent of the average ability of the fund managers and the mean of the fundamentals in the economy, $\bar{\nu}$; hence, there is no need to take a stand on the debate over the relative performance of fund managers with respect to passive benchmarks.

Figure 1 shows the results of the numerical exercise for the model with homogeneous managers. Panel A shows the equilibrium fraction of managers investing in the domestic market in the model with homogeneous managers and asymmetric information, n_a. According to Proposition 1, if $g = 0$, then $n_a > \frac{1}{2}$, and the numerical example implies $n_a = 63.1\%$. As g increases, the fraction of managers in the domestic market in equilibrium also increases. According to Panels B and C, if $g = 0$, on average, the total expected amounts of capital

[7] A proper calibration would be desirable, but this model is too stylized for a calibration. Because there are no conventional parameter values for this type of model, we gain credibility by taking parameters frequently used in the literature.

invested in the domestic market in the first and second periods are $Q^a_{D1} = 63.1\%$ and $Q^a_{D2} = 63.1\%$, respectively. These panels also show that the higher g is, the higher the amount of capital invested in the domestic market is. In particular, for $g = 1.5\%$, the amount of capital invested in the domestic market in both periods is 87.3%.

For the model with heterogeneous managers, we analyze two examples. We assume there is a continuum of managers distributed uniformly on $[0, 1]$ and the publicly observed signal for manager j is $y_j = q + \frac{1}{2}e - ej$, with $e > 0$. With this formulation, the expected quality of potential managers is constant and equal to q:

$$y_{avg} = \int_0^1 \left(q + \frac{1}{2}e - ej\right) dj = q,$$

and the best manager is the one with $j = 0$. If μ managers enter the markets, then the operating managers are $j \in [0, \mu]$. We choose $q = 0.04$.

Using the same parameters as for the model with homogeneous managers, we consider two numerical examples: with $e = 0.08$, and with $e = 0.02$, respectively. In these examples, we assume that managers outperform the passive benchmark, but, as we mentioned above, we obtain exactly the same results if we require that y_j follow a uniform distribution where managers perform below the benchmark.

Figure 2 shows the results of the example with $e = 0.08$, as a function of g. Panel A plots the fraction of operating managers who invest domestically in equilibrium. The flat region of the figure where $n_a = 0.34$ corresponds to the equilibrium where managers are indifferent between investing in the domestic and foreign markets. The region of the figure with a positive slope corresponds to the threshold equilibrium where better managers enter the domestic market. For small g, as g increases, the fraction of managers investing domestically stays the same, but those managers are of better quality. As g increases further, only the best managers are in the domestic markets; and therefore, an additional increase in the cost of entry to the foreign market will increase the number of managers investing domestically.

Panels C and D show that if $g = 0$, then the total expected amount of capital invested in the domestic market in the first and second periods are $Q^a_{D1} = 40.6\%$ and $Q^a_{D2} = 54.9\%$, respectively. The level of domestic investment is low because $n_a < \frac{1}{2}$, which implies that the foreign market is more diversified than the domestic market. As a result, in the first period more capital flows to the foreign market. However, in the second period the uncertainty about the quality of the domestic managers is lower, and this effect dominates resulting in home bias. Panels C and D also plot the total expected amount of capital invested in the domestic market in the first and second periods, respectively, for the case in which investors can observe foreign fundamentals as well and the fraction of managers investing domestically is given by Panel A. In our model, the total amount of funds invested in the domestic market is between 6 and 20 percentage points higher than the amount implied by this benchmark model.

Figure 3 shows the results of the example with $e = 0.02$, as a function of g. Panels C and D show that if $g = 0$, then the total expected amounts of capital invested in the domestic market in the first and second periods are $Q^a_{D1} = 45\%$ and $Q^a_{D2} = 56\%$, respectively. Again, in our model the total amount of funds invested in the domestic market is between 6 and 20 percentage points higher than the amount implied by this benchmark model.

According to Chan, Covrig, and Ng (2005) and Hau and Rey (2008), the fraction of domestic funds is 46% on average. For our model to generate the fraction of domestic funds implied by the data $n_a = 46\%$, we need $g = 1.5\%$ in the first example and $g = 0.2\%$ in the second. Panels C and D show that for those g, the total expected amounts of capital invested in the domestic market in the first and second periods are $Q^a_{D1} = 55.6\%$ and $Q^a_{D2} = 76.2\%$, respectively, in the first example; for the second example, the corresponding figures are $Q^a_{D1} = 52\%$ and $Q^a_{D2} = 62\%$, respectively. Hence, the market value of international funds is smaller than the market value of domestic funds and there is equity home bias at the fund level. Panel B shows that for any g, the average ability in the domestic market, y^D, is between 36 and 60 basis points higher than the average ability in the foreign market, y^F. Therefore, for a small difference in fixed costs, the model accounts for three salient features of the data about fund managers at the international level: (1) lower number of international funds, (2) lower market value of international funds, and (3) equity home bias at the fund level.

We check the robustness of our results by numerically simulating the model for different parameters. Figures 4 to 7 show, respectively, that we observe home bias in the second period when (i) the ex-ante heterogeneity of managers is not too large, (ii) unobserved heterogeneity is big, (iii) uncertainty about the fundamentals is not too large, and (iv) the idiosyncratic shocks to managers' returns are not too large.

Figure 4 is drawn for $g = 0$ and shows that home bias decreases with the ex-ante heterogeneity of managers. Although better managers decide to invest domestically, which makes investment in those funds attractive, more managers invest in the foreign market, which enables investors to better diversify their foreign investments. It turns out that the latter effect dominates, and home bias decreases.

Figures 5 to 7 are drawn for $e = 0.02$ and $g = 0$. Figure 5 shows how the equilibrium varies with the unobserved heterogeneity of managers, σ_η. The relationship is not always monotonic, but an increase in heterogeneity leads to an increase in home bias in the second period and for big enough σ_η, in the first period as well. When the unobserved heterogeneity is large, the speed of learning is important, and the information asymmetry across markets plays a bigger role.

Figure 6 shows that home bias decreases with uncertainty about fundamentals. Here, we have two competing effects. Uncertainty about fundamentals increases the informational disadvantage of the foreign market, and therefore leads to higher home bias. However, it also increases the need for cross-market diversification, which pushes investors to distribute their capital evenly across the markets. As we see in figure 6, the latter effect dominates.

Figure 7 shows that home bias decreases with the manager-specific risk, σ_ε. When the manager-specific risk is high, diversification motives are important. In such a case, three things happen. The total number of managers operating increases, as the last manager deciding to operate provides a high diversification benefit for investors and hence attracts more capital. This in turn increases the quality difference between domestic and foreign managers. The second effect increases n. As σ_ε increases, the manager who was indifferent between the domestic and foreign markets now finds it profitable to enter the domestic market because of the extra capital it attracts for diversification reasons. However, investors are unwilling to concentrate a large fraction of their capital in the hands of domestic managers, which leads to the decrease in home bias. It is worth noting, however, that the first two effects dominate when the ex-ante heterogeneity of managers, e, is higher.

4 Conclusion

This paper suggests that both asymmetric information at the individual level and uncertainty about the ability of portfolio managers play an important role in the delegated management industry. In our model, we show that these assumptions can explain a range of empirical observations. First, even if professional mutual fund managers are equally well informed about all markets, individual investments exhibit home bias. Second, the number of international funds may be larger than the number of domestic funds. And finally, the market value of international funds is on average smaller than the market value of domestic funds, since managers of funds investing domestically have higher ability to generate abnormal returns.

When managers are ex-ante heterogeneous, the managers investing domestically are of better quality. The concern may be raised that in our model individual investors cannot channel their capital via managers who serve foreign investors (domestic managers from the perspective of foreign investors). We believe that this assumption is not as ad hoc as it may seem. First, it is illegal for a foreign resident to directly purchase US mutual funds. Second, in countries in which it is legal, it may be more costly to evaluate the ability of managers based abroad and to understand the legal system governing mutual funds in other countries; moreover, non residents of a given country may face double taxation if they invest via mutual funds based in that country.

The paper supports the information-based explanation for home bias. The main criticism of information-based explanations of home bias has relied upon the assumption that there are no local information advantages at the fund level. Hence, the criticism goes, if individual agents invest through mutual funds, then information asymmetries at the individual level disappear and there is no home bias in fund managers' portfolios. However, Chan, Covrig, and Ng (2005) and Hau and Rey (2008) have extensively documented the existence of home bias at the fund level. We show that if investment decisions are delegated to fund managers with identical access to information on all markets, then home bias may occur as a result of asymmetric information at the individual level combined with uncertainty about the ability of the portfolio managers.

5 Appendix

In the proofs below, we assume that T is odd. This is without loss of generality, but allows us to shorten the proofs and formulas.

First, we prove the following claim, which we use extensively in the subsequent proofs.

Claim A We have

$$\sum_{N=0}^{T} \Pr(N|n) \frac{N\sigma_v^2 (1-2n)(T-N) + \left(\sigma_\varepsilon^2 + \sigma_{\alpha D}^2\right)(N-Tn)}{2N(T-N)\sigma_v^2 + T\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)} \begin{cases} > 0 \text{ for } n < \frac{1}{2} \\ < 0 \text{ for } n > \frac{1}{2} \end{cases} \tag{18}$$

Proof. Taking the derivative of the above expression with respect to σ_v^2, one gets

$$\begin{aligned} \tfrac{dRHS}{d\sigma_v^2} &= \textstyle\sum_{N=0}^{T} \Pr(N|n) \left(\frac{N\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)(T-N)(T-2N)}{\left(2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)^2} \right) = \\ &= \textstyle\sum_{N=0}^{\frac{T-1}{2}} \Pr(N|n) \frac{N\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)(T-N)(T-2N)}{\left(2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)^2} \left(1 - \left(\frac{n}{1-n}\right)^{T-2N}\right) \begin{cases} > 0 \text{ if } n < \frac{1}{2} \\ = 0 \text{ when } n = \frac{1}{2} \\ < 0 \text{ if } n > \frac{1}{2} \end{cases} . \end{aligned}$$

Therefore,

$$\sum_{N=0}^{T} \Pr(N|n) \frac{N\sigma_v^2 (1-2n)(T-N) + \left(\sigma_\varepsilon^2 + \sigma_{\alpha D}^2\right)(N-Tn)}{2N(T-N)\sigma_v^2 + T\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)} \begin{cases} > \sum_{N=0}^{T} \Pr(N|n) \frac{N-Tn}{T} = 0 \text{ for } n < \frac{1}{2} \\ < \sum_{N=0}^{T} \Pr(N|n) \frac{N-Tn}{T} = 0 \text{ for } n > \frac{1}{2} \end{cases} .$$

■

5.1 Proof of Lemma 1

Using equation (15), one gets

$$\Delta_1 = \frac{1}{\mu n(1-n)} \sum_{N=0}^{T} \Pr(N|n) \left(\frac{N\sigma_v^2 (1-2n)(T-N) + \left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)(N-Tn)}{2N(T-N)\sigma_v^2 + T\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)} \right),$$

which by Claim A is 0 only if $n = \frac{1}{2}$. The expression for Δ_2 has the same form as Δ_1 but with $\sigma_{\alpha D}^2$ in place of σ_η^2; therefore, by the same argument it is 0 only if $n = \frac{1}{2}$. Hence, only when $n = \frac{1}{2}$, the managers are indifferent between the markets.

5.2 Proof of Proposition 1

If $F_D \leq F_F$, we need that in equilibrium $\Delta_1 + \delta\Delta_2 \leq 0$. Since the formula for Δ_1 can be obtained from Δ_2 by setting $\sigma_{\alpha F}^2 = \sigma_{\alpha D}^2$, it is enough to show that $\Delta_2 \leq 0$ if and only if

$n > \frac{1}{2}$. Plugging (13) and (14) into (15), one gets

$$\Delta_2 = \frac{1}{\mu n\left(1-n\right)} \sum_{N=0}^{T} \Pr\left(N|n\right) \frac{N\sigma_v^2\left(1-2n\right)\left(T-N\right)+N\left(1-n\right)\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)-\left(T-N\right)n\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}{N\left(T-N\right)2\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}.$$

The expression inside the summation is increasing in $\sigma_{\alpha F}^2$, which means that if we substitute it with $\sigma_{\alpha D}^2$ in $\sigma_{\alpha F}^2$, we obtain something smaller. Therefore,

$$\Delta_2 > \frac{1}{\mu\left(1-n\right)n} \sum_{N=0}^{T} \Pr\left(N|n\right) \frac{\left(1-2n\right)N\left(T-N\right)\sigma_v^2+\left(N-Tn\right)\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)}{\left(2N\left(T-N\right)\sigma_v^2+T\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)\right)} \geq 0 \text{ if } n \leq \frac{1}{2}.$$

where the last inequality is by Claim A. This implies that $\Delta_2 \leq 0$ only if $n > \frac{1}{2}$.

Now, we move to proving that home bias occurs in expectation. We show that for $n > \frac{1}{2}$, $HB_2 > 0$, and that $HB_1 > 0$ follows immediately. By definition of Q_{Dt}^a, we have $Q_{Dt}^a = \sum_{N=0}^{T} \Pr\left(N|n\right) NE\left[x_{jt}^D|N\right]$. Hence, by Lemma 1 home bias is

$$HB_t = \sum_{N=0}^{T} \Pr\left(N|n\right)\left(NE\left[x_{jt}^D|N\right]\right) - \frac{1}{2}. \tag{19}$$

Using the (11) and (12), we get

$$\begin{aligned}
HB_2 &= \frac{1}{2}\sum_{N=0}^{T} \Pr\left(N|n\right) \frac{N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)-\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}{2\left(T-N\right)N\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)} > \\
&> \frac{1}{2}\sum_{N=0}^{T} \Pr\left(N|n\right)\left(\frac{\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)\left(2N-T\right)}{2\left(T-N\right)N\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}\right) = \\
&= \frac{1}{2}\sum_{N=0}^{\frac{T-1}{2}} \Pr\left(N|n\right)\left(\frac{\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)\left(T-2N\right)}{2\left(T-N\right)N\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}\left(\left(\frac{n}{1-n}\right)^{T-2N}-1\right)\right) > 0 \text{ for } n > \frac{1}{2},
\end{aligned}$$

where the penultimate inequality comes from the fact that the expression under the summation is increasing in $\sigma_{\alpha F}^2$, and $\sigma_{\alpha F}^2 < \sigma_{\alpha D}^2$.

5.3 Proof of Proposition 2

Abusing notation, let y^D and y^F be the expected quality in the domestic and in the foreign market. When making the entry decision, each manager expects that, excluding her, her investors will observe funds of average quality. Plugging the formulas for asset allocation into the difference between the expected amount of capital received in the domestic and in the foreign market in each period (equation (15)), and taking into account that $y^D = \frac{N-1}{N} y^D + \frac{1}{N} y_j$ if the manager enters the domestic market, and $y^F = \frac{T-N-1}{T-N} y^F + \frac{1}{T-N} y_j$ if the manager enters the foreign market, we get:

$$\begin{aligned} & \mu (1-n) n \Delta_2 (y_j) = \\ = \quad & \tfrac{1}{\gamma} \textstyle\sum_{N=0}^{T} \Pr(N|n) N (1-n) \left(\frac{\gamma\left((T-N)\sigma_v^2 + \left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)\right) + (T-N)\left(\frac{N-1}{N} y^D + \frac{1}{N} y_j - y^F\right)}{2N(T-N)\sigma_v^2 + N\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + (T-N)\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)} + \frac{\left(y_j - y^D\right)(N-1)}{\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right) N} \right) \\ & -\tfrac{1}{\gamma} \textstyle\sum_{N=0}^{T} \Pr(N|n) (T-N) n \left(\frac{\gamma\left(N\sigma_v^2 + \left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right) - N\left(y^D - \frac{T-N-1}{T-N} y^F - \frac{1}{T-N} y_j\right)}{2(T-N)N\sigma_v^2 + N\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + (T-N)\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)} + \frac{\left(y_j - y^F\right)(T-N-1)}{\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)(T-N)} \right) . \end{aligned}$$

Taking the derivative with respect to y_j, one gets:[8]

$$\begin{aligned} \mu (1-n) n \frac{d\Delta_2 (y_j)}{dy_j} \quad = \quad & \sum_{N=1}^{T-1} \Pr(N|n) \frac{T(1-n) - N}{\gamma\left(2N(T-N)\sigma_v^2 + N\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + (T-N)\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right)} \\ & + \sum_{N=1}^{T-1} \Pr(N|n) \left(\frac{(N-1)(1-n)}{\gamma\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)} - \frac{(T-N-1) n}{\gamma\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)} \right) + \\ & - \Pr(0|n) \frac{n(T-1)}{\gamma\left(\sigma_{\alpha F(0)}^2 + \sigma_\varepsilon^2\right)} + \Pr(T|n) \frac{(1-n)(T-1)}{\gamma\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)}. \end{aligned}$$

First, we show that in equilibrium either better managers enter the domestic market, $\frac{d\Delta_1(y_j)}{dy_j} + \delta \frac{d\Delta_2(y_j)}{dy_j} > 0$, or all managers are indifferent between both markets, $\frac{d\Delta_1(y_j)}{dy_j} + \delta \frac{d\Delta_2(y_j)}{dy_j} = 0$. We prove this assuming, by contradiction, that better managers enter the foreign market, $\frac{d\Delta_1(y_j)}{dy_j} + \delta \frac{d\Delta_2(y_j)}{dy_j} < 0$.

STEP 1: $y^F \geq y^D \Rightarrow n > \frac{1}{2}$

If better managers enter the foreign market, then $y^F \geq y^D$. Plugging y^F into the formula for $\Delta_2 (y_j)$ and grouping terms with y^D and y^F, we obtain the following formula for the

[8] Note, that one has to be careful here and remember that $x_{tj} (N = 0) = 0$.

expected excess capital of the mutual fund with $y_j = y^F$ investing in the foreign market:

$$\mu(1-n)n\Delta_2\left(y^F\right) =$$

$$= \sum_{N=0}^{T}\Pr(N|n)\underbrace{\frac{\gamma\left(\sigma_v^2(1-2n)+\frac{(1-n)}{(T-N)}\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)-\frac{n}{N}\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)-\frac{(N+n-1)}{N}\left(y^F-y^D\right)}{\gamma\left(2\sigma_v^2+\frac{N}{N(T-N)}\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)\frac{+(T-N)}{N(T-N)}\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)}}_{\equiv FT}$$

$$+\sum_{N=0}^{T}\Pr(N|n)\frac{\left(y^F-y^D\right)}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}(1-n)(N-1)\ .$$

We have

$$\frac{\partial FT}{\partial\sigma_{\alpha F}^2} = \frac{N(T-N)\left(\gamma\sigma_{\alpha D}^2+\gamma\sigma_\varepsilon^2+(N+n-1)\left(y^F-y^D\right)+N\gamma\sigma_v^2\right)}{\gamma\left(2N(T-N)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)^2} > 0,$$

which implies that

$$\begin{aligned}\mu(1-n)n\Delta_2\left(y^F\right) \quad &> \quad \sum_{N=0}^{T}\Pr(N|n)\frac{\gamma\left(N\sigma_v^2(1-2n)(T-N)+(N-Tn)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)-(N+n-1)(T-N)\left(y^F-y^D\right)}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)}\\ &\quad +\sum_{N=0}^{T}\Pr(N|n)\frac{\left(y^F-y^D\right)}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}(1-n)(N-1)\ .\end{aligned}$$

Now, for $n<\frac{1}{2}$, the right hand side is increasing in σ_v^2, since for $n<\frac{1}{2}$

$$\begin{aligned}\frac{d\left(\mu(1-n)n\Delta_2\left(y^F\right)\right)}{d\sigma_v^2} &= \sum_{N=0}^{T}\Pr(N|n)\frac{N\gamma(T-N)(T-2N)\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)+2N(N+n-1)(T-N)^2\left(y^F-y^D\right)}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)^2} =\\ &= \sum_{N=0}^{\frac{T-1}{2}}\Pr(N|n)\frac{\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)N(T-N)(T-2N)}{\left(2N(T-N)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)^2}\left(1-\left(\frac{n}{1-n}\right)^{T-2N}\right)+\\ &\quad +\sum_{N=0}^{T}\Pr(N|n)\frac{2N(N+n-1)(T-N)^2\left(y^F-y^D\right)}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)^2} > 0\ ;\end{aligned}$$

therefore, for $n\leq\frac{1}{2}$ we have

$$\begin{aligned}\mu(1-n)n\Delta_2\left(y^F\right) \quad &> \quad \sum_{N=0}^{T}\Pr(N|n)\left(\frac{\gamma(N-Tn)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}{\gamma T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}+N\left(y^F-y^D\right)\frac{N+n-Tn-1}{T\gamma\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)}\right) =\\ &= \left\{\text{using } E\left[N^2\right]=Tn-Tn^2+(Tn)^2\right\} = 0.\end{aligned}$$

This implies that for $n\leq\frac{1}{2}$, we have $\Delta_2\left(y^F\right)>0$. Since $\Delta_1(y_j)$ can be obtained from $\Delta_2(y_j)$ by setting $\sigma_{\alpha F}^2=\sigma_{\alpha D}^2=\sigma_\eta^2$; it is immediate that for $n\leq\frac{1}{2}$, $\Delta_1\left(y^F\right)>0$ as well.

This means that a manager with $y_j = y^F$ has an incentive to deviate to the domestic market. Therefore, for $y^F \geq y^D$ to be an equilibrium, we need $n > \frac{1}{2}$.

STEP 2: $n \geq \frac{1}{2} \Rightarrow \frac{d\Delta_1(y_j)}{dy_j} + \delta \frac{d\Delta_2(y_j)}{dy_j} > 0$

For the second period, $\frac{d\Delta_2(y_j)}{dy_j}$ can be rewritten:

$$\begin{aligned}
\mu(1-n)n\frac{d\Delta_2(y_j)}{dy_j} &= \sum_{N=0}^{T} \Pr(N|n) \frac{T(1-n)-N}{\gamma\left(2N(T-N)\sigma_v^2 + N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right) + (T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)} \\
&\quad + \sum_{N=0}^{T} \Pr(N|n) \left(\frac{(N-1)(1-n)}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)} - \frac{(T-N-1)n}{\gamma\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)} \right).
\end{aligned}$$

The expression in the summation for each N is bigger than when evaluated at $\sigma_{\alpha F}^2 = \sigma_{\alpha D}^2$, because differentiating it with respect to $\sigma_{\alpha F}^2$ yields

$$\begin{aligned}
&\tfrac{1}{\gamma}\left(\tfrac{-(T(1-n)-N)N}{\left(2N(T-N)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)^2} + \tfrac{(T-N-1)n}{\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)^2}\right) = \\
= \quad & \tfrac{N(n+Nn-1)(T-N)\left(\sigma_\varepsilon^2+\sigma_{F\alpha}^2\right)^2+(T-N)(T-N-1)n\left(2N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)^2\right)}{\gamma\left(2N(T-N)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)^2\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)^2} \quad + \\
&+ \tfrac{N(T-N)\sigma_v^2+\left(N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)}{\gamma\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)^2\left(2N(T-N)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)} 4N(T-N)(T-N-1)n\sigma_v^2 \ ,
\end{aligned}$$

which is obviously positive. Therefore,

$$\begin{aligned}
\mu(1-n)n\frac{d\Delta_2(y_j)}{dy_j} &> \textstyle\sum_{N=0}^{T} \Pr(N|n) \tfrac{T(1-n)-N}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)} + \sum_{N=0}^{T} \Pr(N|n) \tfrac{N+2n-Tn-1}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)} = \\
&= -\textstyle\sum_{N=0}^{T} \Pr(N|n) \tfrac{2N(T-N)\sigma_v^2(1-2n)+\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)(N-Tn)}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)} > 0 \ ,
\end{aligned}$$

where the last inequality comes from Claim A.

Hence, we have proved that for $n \geq \frac{1}{2}$, we have $\frac{d\Delta_2(y_j)}{dy_j} > 0$. By a similar argument it is straightforward to establish that also $\frac{d\Delta_1(y_j)}{dy_j} > 0$. Hence, we have proved that when $n \geq \frac{1}{2}$, then $\frac{d\Delta_1(y_j)}{dy_j} + \delta \frac{d\Delta_2(y_j)}{dy_j} > 0$, which contradicts the assumption that better managers go to the foreign market. As a result

Hence, step 1 and step 2 imply that in equilibrium we have $\frac{d\Delta_1(y_j)}{dy_j} + \delta \frac{d\Delta_2(y_j)}{dy_j} \geq 0$, $y^D > y^F$, and if $\frac{d\Delta_1(y_j)}{dy_j} + \delta \frac{d\Delta_2(y_j)}{dy_j} = 0$, then it must be that $n < \frac{1}{2}$.

STEP 3 There exists a threshold $\bar{n} < \frac{1}{2}$, such that for all $n > \bar{n}$, we have home bias in both periods.

Let $\sigma_{M1}^2 = \sigma_\eta^2$ and $\sigma_{M2}^2 = \sigma_{\alpha M}^2$. Then we have

$$\begin{aligned} HB_t &= \frac{1}{2}\sum_{N=0}^{T} \Pr(N|n) \frac{N\left(\sigma_{Ft}^2+\sigma_\varepsilon^2\right) - (T-N)\left(\sigma_{Dt}^2+\sigma_\varepsilon^2\right)}{2(T-N)N\sigma_v^2 + N\left(\sigma_{Ft}^2+\sigma_\varepsilon^2\right) + (T-N)\left(\sigma_{Dt}^2+\sigma_\varepsilon^2\right)} \\ &\quad + \sum_{N=0}^{T} \Pr(N|n) \frac{(T-N)N\left(y^D - y^F\right)}{2(T-N)N\sigma_v^2 + N\left(\sigma_{Ft}^2+\sigma_\varepsilon^2\right) + (T-N)\left(\sigma_{Dt}^2+\sigma_\varepsilon^2\right)}. \end{aligned}$$

The second expression is always positive, and the first expression is increasing in σ_{Ft}^2; therefore,

$$\begin{aligned} HB_t &> \frac{1}{2}\sum_{N=0}^{T} \Pr(N|n) \frac{N\left(\sigma_{Ft}^2+\sigma_\varepsilon^2\right) - (T-N)\left(\sigma_{Dt}^2+\sigma_\varepsilon^2\right)}{2(T-N)N\sigma_v^2 + N\left(\sigma_{Ft}^2+\sigma_\varepsilon^2\right) + (T-N)\left(\sigma_{Dt}^2+\sigma_\varepsilon^2\right)} \\ &\geq \frac{1}{2}\sum_{N=0}^{T} \Pr(N|n) \left(\frac{\left(\sigma_\varepsilon^2+\sigma_{Dt}^2\right)(2N-T)}{2(T-N)N\sigma_v^2 + T\left(\sigma_{Dt}^2+\sigma_\varepsilon^2\right)} \right) = \\ &= \frac{1}{2}\sum_{N=0}^{\frac{T-1}{2}} \Pr(N|n) \left(\frac{\left(\sigma_\varepsilon^2+\sigma_{Dt}^2\right)(T-2N)}{2(T-N)N\sigma_v^2 + T\left(\sigma_{Dt}^2+\sigma_\varepsilon^2\right)} \left(\left(\frac{n}{1-n}\right)^{T-2N} - 1 \right) \right) > 0 \text{ for } n > \frac{1}{2}. \end{aligned}$$

Hence, either there is home bias, in both periods, or $n < \frac{1}{2}$, or both.

References

[1] Ahearne, A., W. Griever, and F. Warnock (2004), "Information Costs and Home Bias: An Analysis of U.S. Holdings of Foreign Equities," *Journal of International Economics,* 62, 313–336.

[2] Bae, K., R. Stulz, and H. Tan (2008), "Do Local Analysts know more? A Cross-Country Study of Performance of Local Analysts and Foreign Analysts," *Journal of Financial Economics*, 88, 581-606.

[3] Barber, B. and T. Odean (2001), "Boys will Be Boys: Bender, Overconfidence, and Common Stock Investment," *Quarterly Journal of Economics,* 141, 261-292.

[4] Barber, B. and T. Odean (2002), "Online Investors: Do the Slow Die First," *Review of Financial Studies,* 15, 455-487.

[5] Barron, J. and J. Ni (2008), "Endogenous Asymmetric Information and International Equity Home Bias: The Effects of Portfolio Size and Information Costs," *Journal of International Money and Finance,* 27, 617–635.

[6] Basak, S., A. Pavlova, and A. Shapiro (2007), "Optimal Asset Allocation and Risk Shifting in Money Management," *Review of Financial Studies,* 20, 1-39.

[7] Baxter, M. and U. J. Jermann (1997), "The International Diversification Puzzle is Worse Than You Think," *American Economic Review,* 87, 170-180.

[8] Berk, J. and R. Green (2004), "Mutual Fund Flows and Performance in Rational Markets," *Journal of Political Economy,* 112, 1269–1295.

[9] Black, F. (1974), "International Capital Market Equilibrium with Investment Barriers," *Journal of Financial Economics,* 1, pp. 337–352.

[10] Bonser-Neal, C., G. Brauer, R. Neal, and S. Wheatley (1990), "International Investment Restrictions and Closed-end Country Fund Prices," *Journal of Finance*, 45, 523-547.

[11] Brennan, M. and H. Cao (1997), "International Portfolio Flows," *Journal of Finance,* 52, 1851–1880.

[12] Chan, K., V. Covrig, and L. Ng (2005), "What Determines the Domestic Bias and Foreign Bias?," *Journal of Finance,* 60, 1495–1534.

[13] Chevalier, J. and G. Ellison (1999), "Are Some Mutual Fund Managers Better Than Others? Cross-Sectional Patterns in Behavior and Performance," *Journal of Finance,* 54, 875-899.

[14] Choe, H., B. Kho, and R. Stulz (2005). "Do domestic investors have an edge? The trading experience of foreign investors in Korea," *Review of Financial Studies*, 18,795-829.

[15] Claessens, S. and M. Rhee (1994), "The Effects of Equity Barriers on Foreign Investment in Developing Countries", in: Frankel, J.A. (Ed.), Internationalization of Equity Markets. University of Chicago Press, Chicago and London, 231-271.

[16] Coeurdacier, N. and P.O. Gourinchas (2008), "When Bonds Matter: Home Bias in Goods and Assets," working paper.

[17] Coeurdacier, N., P. Martin, and R. Kollmann (2009), "International Portfolios, Capital Accumulation and Foreign Assets Dynamics," forthcoming *Journal of International Economics.*

[18] Cooper, I., and E. Kaplanis (1994), "Home Bias in Equity Portfolios, Inflation Hedging, and International Capital Market Equilibrium," *Review of Financial Studies,* 7, 45–60.

[19] Coval, J, and T. Moskowitz (2001), "The Geography of Investment: Informed Trading and Asset Prices," *Journal of Political Economy,* 109, 811–841.

[20] Cuoco, D., and R. Kaniel (2007), "Equilibrium Prices in the Presence of Delegated Portfolio Management," working paper.

[21] Dahlquist, M., L. Pinkowitz, R. Stulz, and R. Williamson (2003), "Corporate Governance and The Home Bias," *Journal of Financial and Quantitative Analysis*, 38, 87-110.

[22] Dang, T., Y. Wu, and J. Zechner (2008), "Market Discipline and Internal Governance in the Mutual Fund Industry," *Review of Financial Studies*, 21, 2307-2343.

[23] Dvorak, T. (2005), "Do Domestic Investors Have an Information Advantage? Evidence from Indonesia, 2005" *Journal of Finance*, 60, 817-839.

[24] Engel, C. and A. Matsumoto (2008), "The International Diversification Puzzle when Goods Prices are Sticky: It's Really about Exchange-Rate Hedging, not Equity Portfolios," forthcoming in *American Economic Journal: Macroeconomics.*

[25] Errunza, V. and E. Losq (1985), "International Asset Pricing under Mild Segmentation: Theory and Test," *Journal of Finance,* 40, 105-124.

[26] French, K. and J. Poterba (1991),"Investor Diversification and International Equity Markets," *American Economic Review,* 81, 222–226.

[27] Garcia, D. and J. Vanden (2009),"Information Acquisition and Mutual Funds," forthcoming in the *Journal of Economic Theory.*

[28] Gehrig, T. (1993), "An Information Based Explanation of the Domestic Bias in International Equity Investment," *Scandinavian Journal of Economics,* 95, 97–109.

[29] Gelos, R.G. and S-J. Wei (2005), "Transparency and International Portfolio Holdings," *Journal of Finance,* 60, 2987-3020.

[30] Glode, V. (2009), "Why Mutual Funds Underperform," working paper.

[31] Gottesman, A. and M. Morey (2006), "Manager education and mutual fund performance," *Journal of Empirical Finance,* 13, 145-182.

[32] Grote, M. and M. Umber (2006), "Home biased? A Spatial Analysis of the Domestic Merging Behavior of US Firms," working paper.

[33] Hardouvelis, G., R. La Porta, and T. Wizman (1994), "What Moves the Discount on Country Equity Funds?," in: Frankel, J.A. (Ed.), Internationalization of Equity Markets. University of Chicago Press, Chicago and London, 345-397.

[34] Hatchondo, J. (2008), "Asymmetric Information and the Lack of International Portfolio Diversification," *International Economic Review,* 49, 1297-1330.

[35] Hau, H. (2001), "Location matters," *Journal of Finance,* 56, 1959-1983.

[36] Hau, H. and H. Rey (2008), "Home Bias at the Fund Level," *American Economic Review Papers and Proceedings,* 98, 333-338.

[37] He, Z. and W. Xiong (2008), "Multi-market Delegated Asset Management," working paper.

[38] Heathcote, J. and F. Perri (2007), "The International Diversification Puzzle is not as Bad as You Think," working paper.

[39] Huberman, G. (2001), "Familiarity Breeds Investment," *Review of Financial Studies* 14, 659-680.

[40] Ivkovich, Z. and S. Weisbenner (2005), "Local Does As Local Is: Information Content of the Geography of Individual Investors' Common Stock Investments," *Journal of Finance,* 60, 267–306.

[41] Kang, J. and R. Stulz (1997), "Why is There a Home Bias? An Analysis of Foreign Portfolio Equity Ownership in Japan," *Journal of Financial Economics,* 46, 3-28.

[42] Karlsson, A. and L. Norden (2007), “Home Sweet Home: Home Bias and International Diversification among Individual Investors,” *Journal of Banking & Finance,* 31, 317-333.

[43] Kho, B.C., R. Stulz, and F. Warnock (2009), “Financial Globalization, Governance, and the Evolution of the Home Bias,” *Journal of Accounting Research,* 47, 597-635.

[44] Kothari, S. and J. Warner (2001),“Evaluating Mutual Fund Performance,” *Journal of Finance*, 56, 1985-2010.

[45] Kraay, A., N. Loayza, L. Serven, and J. Ventura (2005), “Country Portfolios,” *Journal of the European Economic Association,* 3, 914–945.

[46] Lynch, A. and D. Musto (2003), “How Investors Interpret Past Fund Returns,” *Journal of Finance*, 58, 2033–2058.

[47] Malloy, C. (2005), “The Geography of Equity Analysis,” *The Journal of Finance*, 60, 719-755.

[48] Mamaysky, H., M. Spiegel, and H. Zhang (2007), “Estimating the Dynamics of Mutual Fund Alphas and Betas,” *Review of Financial Studies,* 21, 233-264.

[49] Martin, P. and H. Rey (2004), “Financial Super-markets: Size Matters for Asset Trade,” *Journal of International Economics*, 64, 335-361.

[50] Morse, A. and S. Shive (2009), “Patriotism in Your Portfolio,” forthcoming *Journal of Financial Markets.*

[51] Sercu, P. and R. Vanpee (2008), “Home Bias in International Equity Portfolios: A Review,” working paper.

[52] Shukla, R. and G. Van Inwegen (1995), “Do locals perform better than foreigners? An analysis of UK and US mutual fund managers,” *Journal of Economics and Business,* 47, 241-254.

[53] Solnik, B. (2008), “Home Bias and Regret: An International Equilibrium Model,” working paper.

[54] Stulz, R. (1981), "On Effects of Barriers to International Investment," *Journal of Finance,* 36, 923-934.

[55] Tesar, L. and I. Werner (1995), "Home Bias and High Turnover," *Journal of International Money and Finance,* 14, 467–492.

[56] Van Nieuwerburgh, S. and L. Veldkamp (2009), "Information Immobility and the Home Bias Puzzle," *Journal of Finance,* 64,1187-1215.

[57] Wei, B. (2007), "Managerial Ability, Open-End Fund Flows, and Closed-End Fund Discounts," working paper.

[58] Zhou, C. (1998), "Dynamic Portfolio Choice and Asset Pricing with Differential Information," *Journal of Economic Dynamics and Control,* 22, 1027–1051.

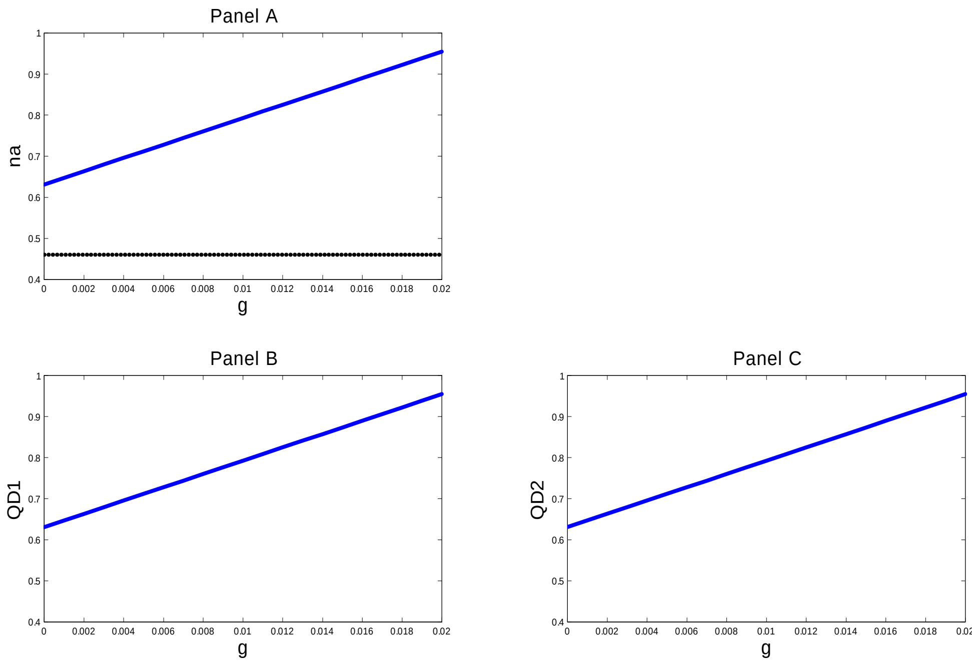

Figure 1: Panel A plots the fraction of managers investing domestically, n_a, Panel B shows the total expected amount of capital invested in the domestic market in the first period, Q^a_{D1}, and Panel C presents the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, using different values of g for the model with homogeneous managers.

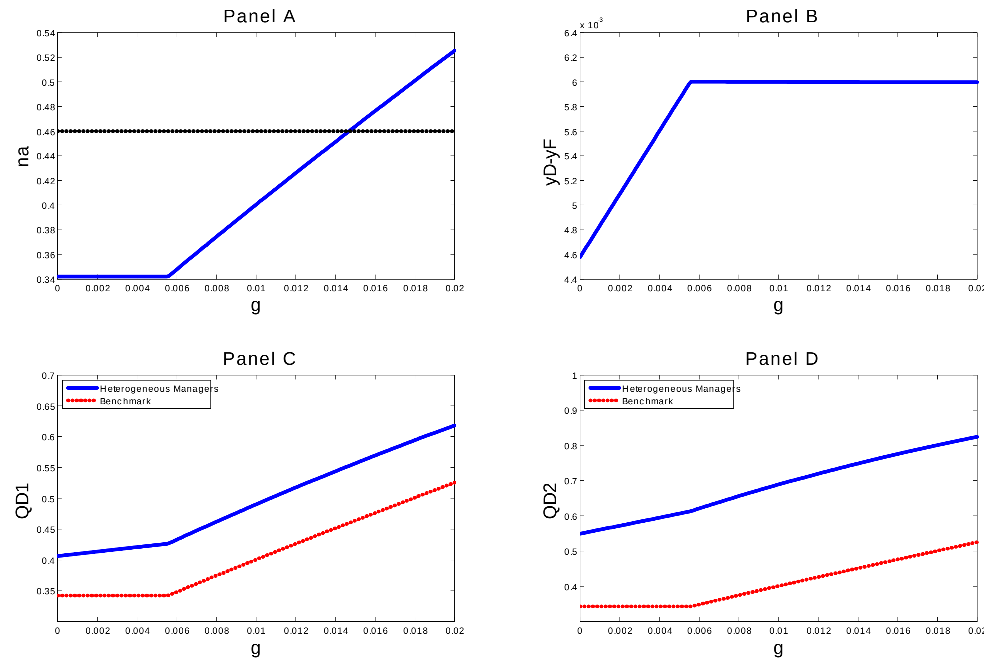

Figure 2: Example with $e = 0.08$. Panel A plots the fraction of managers investing domestically, n_a, Panel B shows the difference between the average ability of fund managers in the domestic market and foreign market, $y^D - y^F$, Panel C exhibits the total expected amount of capital invested in the domestic market in the first period, Q^a_{D1}, Panel D presents the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, using different values of g for the model with heterogeneous fund managers. Panels C and D also plot the total expected amount of capital invested in the domestic market in the first and second period respectively for the benchmark case in which investors can observe foreign fundamentals as well and the fraction of managers investing domestically is given by Panel A.

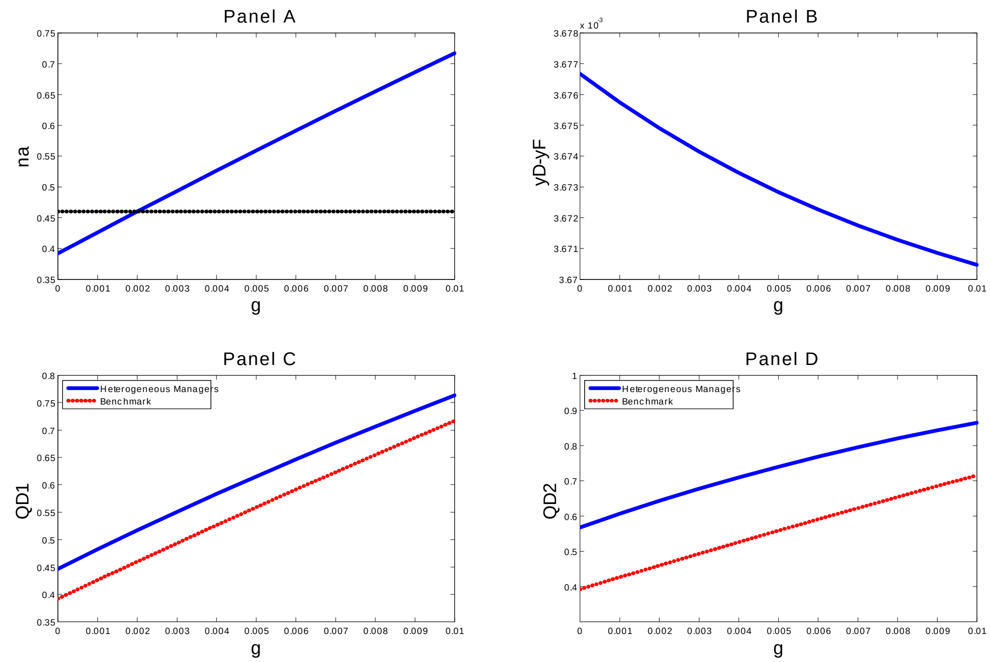

Figure 3: Example with $e = 0.02$. Panel A plots the fraction of managers investing domestically, n_a, Panel B shows the difference between the average ability of fund managers in the domestic market and foreign market, $y^D - y^F$, Panel C exhibits the total expected amount of capital invested in the domestic market in the first period, Q^a_{D1}, Panel D presents the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, using different values of g for the model with heterogeneous fund managers. Panels C and D also plot the total expected amount of capital invested in the domestic market in the first and second period respectively for the benchmark case in which investors can observe foreign fundamentals as well and the fraction of managers investing domestically is given by Panel A.

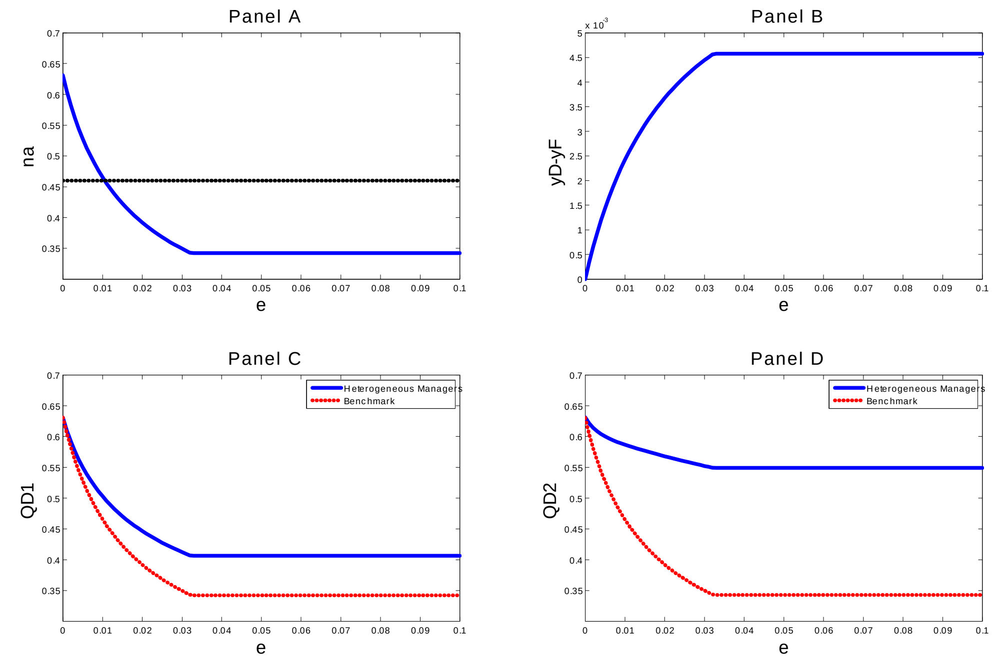

Figure 4: Panel A plots the fraction of managers investing domestically, n_a, Panel B shows the difference between the average ability of fund managers in the domestic market and foreign market, $y^D - y^F$, Panel C exhibits the total expected amount of capital invested in the domestic market in the first period, Q^a_{D1}, Panel D presents the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, using different values of e for the model with heterogeneous fund managers. Panels C and D also plot the total expected amount of capital invested in the domestic market in the first and second period respectively for the benchmark case in which investors can observe foreign fundamentals as well and the fraction of managers investing domestically is given by Panel A.

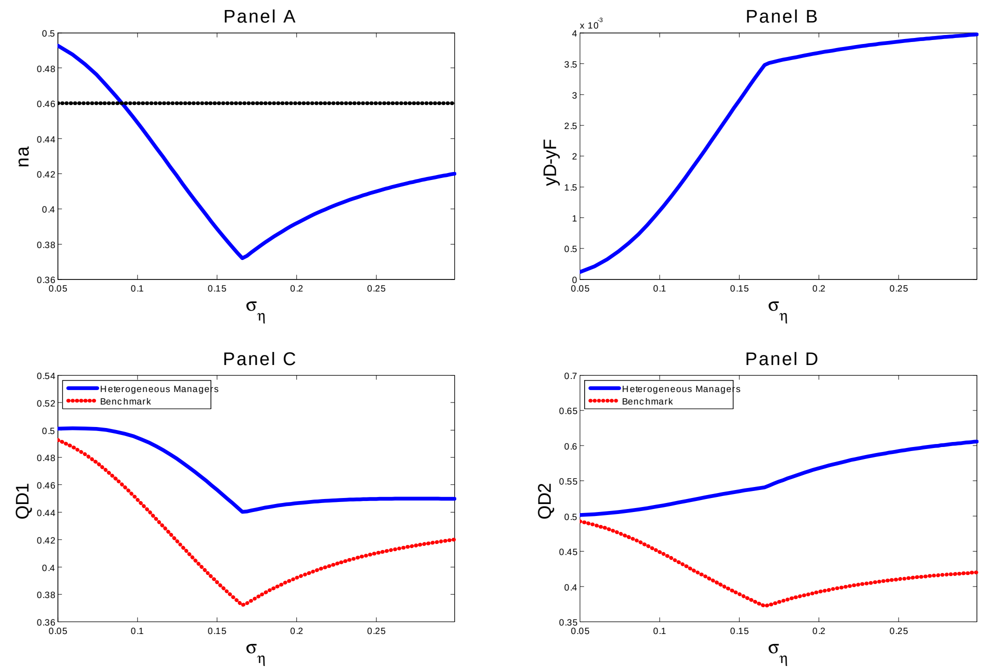

Figure 5: Panel A plots the fraction of managers investing domestically, n_a, Panel B shows the difference between the average ability of fund managers in the domestic market and foreign market, $y^D - y^F$, Panel C exhibits the total expected amount of capital invested in the domestic market in the first period, Q^a_{D1}, Panel D presents the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, using different values of σ_η for the model with heterogeneous fund managers. Panels C and D also plot the total expected amount of capital invested in the domestic market in the first and second period respectively for the benchmark case in which investors can observe foreign fundamentals as well and the fraction of managers investing domestically is given by Panel A.

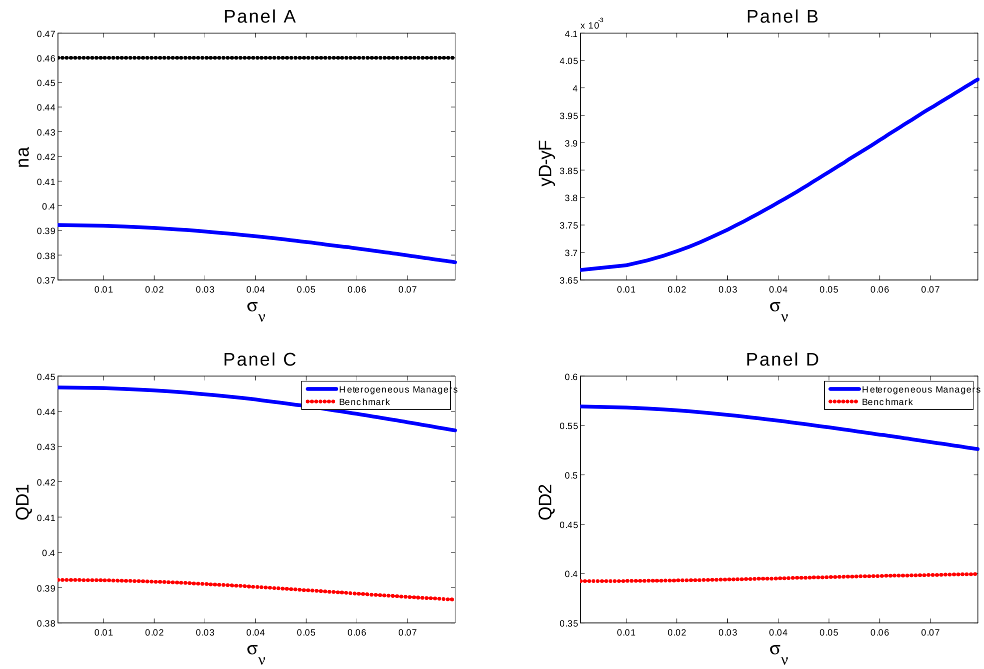

Figure 6: Panel A plots the fraction of managers investing domestically, n_a, Panel B shows the difference between the average ability of fund managers in the domestic market and foreign market, $y^D - y^F$, Panel C exhibits the total expected amount of capital invested in the domestic market in the first period, Q^a_{D1}, Panel D presents the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, using different values of σ_ν for the model with heterogeneous fund managers. Panels C and D also plot the total expected amount of capital invested in the domestic market in the first and second period respectively for the benchmark case in which investors can observe foreign fundamentals as well and the fraction of managers investing domestically is given by Panel A.

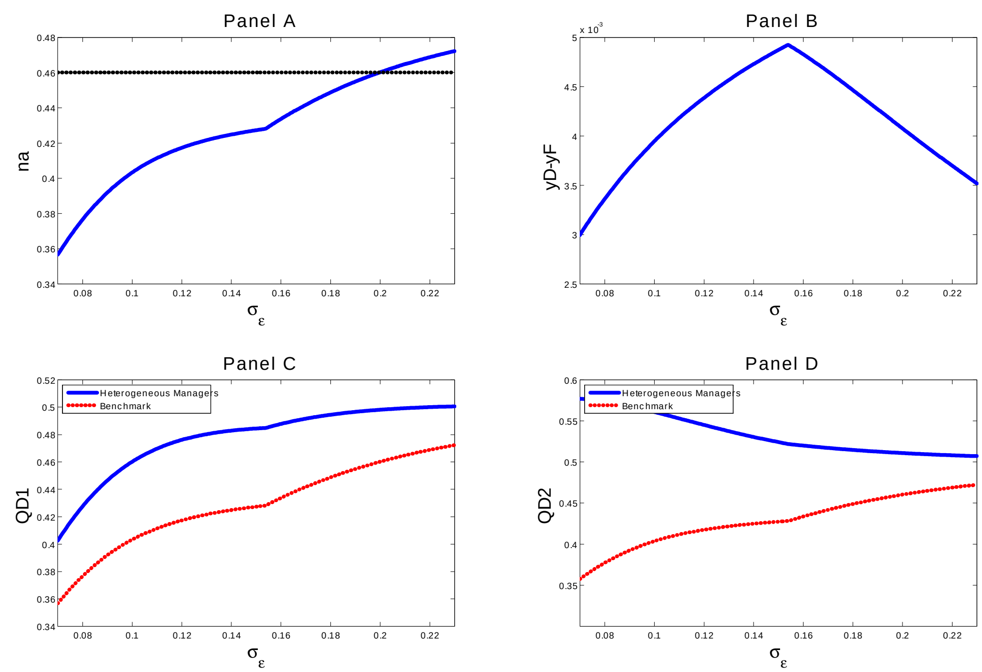

Figure 7: Panel A plots the fraction of managers investing domestically, n_a, Panel B shows the difference between the average ability of fund managers in the domestic market and foreign market, $y^D - y^F$, Panel C exhibits the total expected amount of capital invested in the domestic market in the first period, Q^a_{D1}, Panel D presents the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, using different values of σ_ε for the model with heterogeneous fund managers. Panels C and D also plot the total expected amount of capital invested in the domestic market in the first and second period respectively for the benchmark case in which investors can observe foreign fundamentals as well and the fraction of managers investing domestically is given by Panel A.