Asymmetric Information, Portfolio Managers and Home Bias

Wioletta Dziuda
Kellogg School of Management

Jordi Mondria
University of Toronto

June 2009

Preliminary Version

Abstract

Why do investors excessively tilt their portfolio towards domestic assets? Recent studies suggest asymmetric information plays a significant role in the home equity bias puzzle. A key assumption in theoretical models is that agents invest in assets and process information on their own. However, most international investments are executed by managers in financial institutions. These institutions allocate significant resources to processing information, making the asymmetric information assumption less appealing. In this paper, we explain home bias at the fund level by showing how information asymmetry at the individual level has relevant implications at the portfolio management level. Agents delegate their investment decisions to portfolio managers of different and uncertain ability. Investors are better informed about the performance of domestic markets; and therefore, are more able to evaluate the ability of managers operating in these markets. This, in turn, makes investing in domestic markets less risky and attracts more managers. Additionally, highly skilled managers benefit more from higher transparency, and this is why they are more likely to operate in the domestic market. We simulate the model and find that on average 76% of investment is in the domestic market.

1 Introduction

Many explanations for the puzzles in international finance rely on asymmetric information – individual investors are assumed to have more precise information about domestic markets than foreign markets. In particular, the idea that agents have a local information advantage has generated a large literature on the equity home bias puzzle. Because individual agents watch domestic TV, listen to domestic radio and read domestic newspapers, if agents process information and invest on their own, asymmetric information may result in home bias. However, most international investments are executed by portfolio managers in financial institutions.[1] This fact does not pose a problem for information-based theories of equity home bias if fund managers suffer from asymmetric information as well. However, many argue that the presence of institutionally managed funds sets limits to information-based stories of home bias. These institutions overcome information barriers about foreign markets by allocating significant resources to information processing, eliminating the home bias as they are well informed.

In this paper, we propose a model of delegated asset management to study the implications of asymmetric information at the individual level on the equity home bias puzzle. We find that if investment decisions are delegated to fund managers with identical access to information in all markets, asymmetric information at the individual level combined with the uncertainty about the ability of the portfolio managers may result in home bias.

The model builds on Berk and Green (2004) and it is 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), and Cuoco and Kaniel (2007), Mamaysky, Spiegel, and Zhang (2007), Wei (2007), Dang, Wu and Zechner (2008), Garcia and Vanden (2009) and Glode (2009). The model consists of investors who delegate their investment decisions to fund managers of different and uncertain abilities. Each manager operates in one market only, and the entry decision is irreversible. Investors have a local monitoring advantage – because they have more information about the fundamentals in the domestic economy, they are able to evaluate better the performance of domestic fund managers. When assessing the ability of the managers in the domestic market, investors compare their performance with

[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.

the domestic fundamentals, while when assessing the ability of the managers operating in the foreign market, they are able to compare only the performance across managers. As a result, investors learn faster about the ability of domestic managers, which allows them to allocate their capital in the domestic market more efficiently. That, in turn, leads investors to allocate more funds to the domestic market and generates home bias.

If managers are ex-ante identical, the initial home bias generated by the information asymmetry at the individual level attracts more fund managers to the domestic market. The domestic market becomes more diversified, which amplifies the equity home bias even further.

If managers are ex-ante heterogeneous on their ability, then more skilled managers enter the domestic market, which deepens the home bias generated by the initial local monitoring advantage.

The home bias puzzle was raised by French and Poterba (1991) and Tesar and Werner (1995). They showed that, at the beginning of the 90's, 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 US 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%.

Recently, Chan, Covrig and Ng (2005) and Hau and Rey (2008) have reported three stylized facts about the 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.

Following 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. Our model implies that investors are more able to asses the ability of managers operating in domestic markets; hence, in this market they are able to reallocate their investments to managers that are believed to be highly skilled more efficiently. That implies that the domestic market is more transparent and it rewards the expected ability more. If ex-ante investors differ in the signal about their ability, more skilled managers enter the domestic market. This induces investors to channel even more funds to the domestic market. Hence, the market value of domestic mutual funds is higher than the market value of foreign funds and there is home bias. On average, the calibrated model implies that individual investors allocate 76% of their funds to domestic fund managers and the rest to foreign fund managers. Although our model underestimates the empirical home bias, it comes very close given the stylized nature of it.

In addition to explaining three stylized facts from the data, this model offers the testable prediction that investors obtain, on average, higher returns on their capital in domestic funds. Coval and Moskowitz (2001) provide evidence that fund managers who display a stronger local bias achieve higher risk-adjusted returns. In the same line, Ivkovich and Weisbenner (2005) show that the average household obtains additional returns from its local holdings relative to its non-local holdings. Also, Grote and Umber (2006) show that the most successful M&A deals are the ones that display a stronger local bias. These findings are normally interpreted as investors having a local information advantage. These results are also consistent with the implications of our model. Because more skilled fund managers decide to operate locally, better deals and substantial abnormal risk adjusted returns are obtained in nearby investments.

There is a large literature on the equity home bias puzzle. Following Sercu and Vanpee (2008), there are five types of explanations to the equity home bias puzzle. The first set of explanations to this puzzle focused on the lack of perfect financial integration, see Black (1974), Stulz (1981) and Martin and Rey (2004). Empirical evidence shows that there are higher tax burdens, higher transaction costs and more government regulations on foreign investors than domestic investors, see Bonser-Neal et al. (1990), Hardouvelis et al. (1994), Claessens and Rhee (1994) and Errunza and Losq (1985). A second set of explanations to this puzzle relies on investors hedging domestic risks, see Cooper and Kaplanis (1994), Baxter and Jermann (1997), Engel and Matsumoto (2008), Heathcote and Perri (2007), Gourinchas and Coeurdacier (2008) and Coeurdacier, Martin and Kollmann (2008). A third set of explanations focuses on corporate governance, transparency and political risk see Dahlquist, Pinkowitz and Stulz (2003), Ahearne, Griever and Warnock (2004), Gelos and Wei (2005), Kraay, Loayza, Serven and Ventura (2005) and Kho, Stulz and Warnock (2009). A fourth set of explanations focuses on 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). The last set of explanations to the equity home bias puzzle relies on asymmetric information, see Gehrig (1993), Brennan and Cao (1997), Zhou (1998), Barron and Ni (2008) and Van Nieuwerburgh and Veldkamp (2009). Empirical evidence suggests that domestic fund managers or investors have an information advantage when investing in domestic markets, see Kang and Stulz (1997), Coval and Moskowitz (1999), Hasan and Simaan (2000), Portes and Rey (2005), Chan, Covrig and Ng (2005), Hau and Rey (2008) and Covrig et al. (2008). This paper suggests that even if fund managers do not have local information advantages, information-based stories of home bias cannot be disregarded as a complementary explanation to the equity home bias puzzle.

2 Benchmark 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 domestic market, invests in the foreign market, or stays out. There is a fixed cost of entry F_M to market M, where $M \in \{D, F\}$. Each manager can enter only one market, and the entry decision is irreversible. Let μ be the mass of managers who decide to operate in any of the markets, and let n denote the fraction of operating managers that enter the domestic market. A manager j operating in market M has the ability to generate excess returns with respect to a passive benchmark: $R_{tj}^M = \alpha_j + v_{Mt} + \varepsilon_{tj}$.

Abnormal 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 easily available to everybody in a given market and is disseminated via media or the word of mouth. The fundamentals, v_{Mt}, measure how on average one could outperform the benchmark in country M using only country M's assets if one had only the access to this type of information. Some of the relevant information, however, is more difficult or costly to gather and might be available to managers of the mutual funds only. Moreover, a highly trained manager might be better at interpreting this information. The ability, α_j, capture this additional knowledge and asset picking ability that a manager brings to the table. We assume that α_j is normally distributed, $\alpha_j \sim N\left(\bar{\alpha}, \sigma_\alpha^2\right)$, and is independent of other managers' abilities. And finally, ε_{tj} is the error term, which is normally distributed and independent over time and across managers, $\varepsilon_{tj} \sim N\left(0, \sigma_\varepsilon^2\right)$. 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 he operates in, is constant over time, and is unknown to managers and investors.

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 observed in the domestic market, N, is a random variable with the binomial distribution:

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

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

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

Assumption B Investors observe domestic fundamentals, while they do not observe foreign fundamentals.

The first period is divided in three stages. First, managers decide simultaneously whether to enter, and if yes, into which market. Then, each investor draws T mutual funds and chooses their optimal portfolio. Finally, returns are realized. In the second period, investors observe the realized returns of the mutual funds they invested in, $R_1^D \equiv \left\{R_{1j}^D\right\}_{j=1}^N$ 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 relocate their assets accordingly, incurring no switching costs.

Before we move to solving the model, let us discuss some of the assumptions.

Assumption B approximates the observation that domestic investors listen to the domestic media and talk to other individuals who might have expertise in domestic assets; therefore, they can estimate what abnormal return they should expect from the mutual funds. They have much less information, however, about the foreign market.

The assumption that managers can operate only in one market is clearly a simplification, but it can be justified on many grounds. First, it might be disadvantageous for a manager to operate in many markets because there might be returns to scale in information processing as in Van Nieuwerburgh and Veldkamp (2009).[2] Another theoretical support for the existence of funds with narrow mandates is provided by He and Xiong (2008) with a model of delegated asset management in multiple markets and agency frictions. And finally, empirical evidence provided by Hau and Rey (2008) shows that the distribution of the markets in which mutual funds operate is bimodal. The distribution has a peak for completely home biased funds and a peak for funds operating only in foreign markets.

2.1 Portfolio choice

In this section, we study portfolio choice of investors in each period, after the entry decision has been made and after each investor draws the funds she observes. Let $q_{Dt}(N)$ and $q_{Ft}(N)$ denote the amount of capital invested in each market at time t by an investor who observes N mutual funds in the domestic and $T-N$ mutual funds in the foreign market. Since investors have one unit of capital, the investment satisfies $q_{Dt}(N)+q_{Ft}(N)=1$. Let $x^M_{jt}(N)$ denote the fraction of the capital that fund j receives from an investor that observes N domestic and $T-N$ foreign funds, and fund j among them. In what follows, we omit the arguments when confusion is unlikely.

2.1.1 The first period

We can view the portfolio choice as a two step procedure: first, taking the total amount invested in each market as given, the investor decides how to distribute $q_{D1}(N)$ and $q_{F1}(N)$ among the funds she observes in each market. Second, she decides on $q_{D1}(N)$ and $q_{F1}(N)$, taking into account how she will allocate these among the funds.

Since in the first period investors perceive all managers to be identical, the investor allocates the same amount of capital to all managers observed in a given market:

$$x^D_{j1}(N)=\frac{q_{D1}(N)}{N}, \qquad x^F_{j1}(N)=\frac{q_{F1}(N)}{T-N} \quad . \tag{1}$$

[2] 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 a portfolio choice and an information processing choice.

Taking this into account, the investor chooses $q_{D1}(N)$ and $q_{F1}(N)$ to maximize her utility

$$\max_{q_{D1},q_{F1}} q_{D1}(\bar{\nu}+\bar{\alpha}-f)+q_{F1}(\bar{\nu}+\bar{\alpha}-f)-\frac{1}{2}\gamma\left(\left(q_{D1}^2+q_{F1}^2\right)\sigma_v^2+\left(\frac{q_{D1}^2}{N}+\frac{q_{F1}^2}{T-N}\right)\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)\right),$$

subject to the budget constraint $q_{D1}+q_{F1}=1$. The optimal amount of funds invested in each market is given by

$$q_{D1}=\frac{\sigma_v^2+\frac{1}{T-N}\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}{2\sigma_v^2+\left(\frac{1}{T-N}+\frac{1}{N}\right)(\sigma_\alpha^2+\sigma_\varepsilon^2)},\qquad q_{F1}=\frac{\sigma_v^2+\frac{1}{N}\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}{2\sigma_v^2+\left(\frac{1}{T-N}+\frac{1}{N}\right)(\sigma_\alpha^2+\sigma_\varepsilon^2)}. \tag{2}$$

The difference in the amount of capital invested in each market depends only on the number of mutual funds observed in each market. The market with a higher number of mutual funds allows investors to better diversify the fund's specific risk; and therefore, it receives more funds. The amount of capital invested by this investor in each observed mutual fund is obtained by plugging equation (2) into equation (1). Equation (1) implies that each manager in the more diversified market receives less capital than each manager in the other market.

2.1.2 The second period

In the second period, investors update their beliefs about each manager's ability. In the domestic market, investors observe the realized returns of the managers they invested with, $\left\{R_{j1}^D\right\}_{j=1}^N$, and the fundamentals v_{D1}, and update

$$\phi_{j1}\left(R_{j1}^D,v_{D1}\right)\equiv E\left[\alpha_j\mid R_{11}^D,...,R_{N1}^D,v_{D1}\right]=E\left[\alpha_j\mid R_{j1}^D,v_{D1}\right]=\frac{\bar{\alpha}\sigma_\varepsilon^2+\left(R_{j1}^D-v_{D1}\right)\sigma_\alpha^2}{\sigma_\varepsilon^2+\sigma_\alpha^2}, \tag{3}$$

$$\sigma_{\alpha D}^2\equiv Var\left(\alpha_i\mid R_{j1}^D,v_{D1}\right)=\frac{\sigma_\alpha^2\sigma_\varepsilon^2}{\sigma_\varepsilon^2+\sigma_\alpha^2}. \tag{4}$$

In the foreign market, investors observe the realized returns of all managers $\left\{R_{j1}^F\right\}_{j=1}^{T-N}$, but they do not observe the fundamentals v_{F1}; hence

$$\begin{aligned}\phi_{j1}\left(R_1^F\right) &\equiv E\left[\alpha_j \mid R_{11}^F, ..., R_{(T-N)1}^F\right] = \\ &= \bar{\alpha} + \frac{\left[(T-N)\,\sigma_v^2 + \sigma_\varepsilon^2 + \sigma_\alpha^2\right]\sigma_\alpha^2\left(R_{j1}^F - \bar{v} - \bar{\alpha}\right) - \sum_{k=1}^{T-N}\sigma_v^2\sigma_\alpha^2\left(R_{k1}^F - \bar{v} - \bar{\alpha}\right)}{\left(\sigma_\varepsilon^2 + \sigma_\alpha^2\right)\left((T-N)\,\sigma_v^2 + \sigma_\varepsilon^2 + \sigma_\alpha^2\right)},\end{aligned} \tag{5}$$

$$\sigma_{\alpha F}^2 \equiv Var\left(\alpha_j \mid R_{11}^F, ..., R_{(T-N)1}^F\right) = \frac{\sigma_\alpha^2}{\left(\sigma_\alpha^2 + \sigma_\varepsilon^2\right)}\frac{\sigma_\varepsilon^4 + \sigma_\alpha^2\left(\sigma_v^2 + \sigma_\varepsilon^2\right) + (T-N)\,\sigma_v^2\sigma_\varepsilon^2}{\sigma_\alpha^2 + \sigma_\varepsilon^2 + (T-N)\,\sigma_v^2}. \tag{6}$$

Formulas (4) and (6) are at 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 particular manager's ability. Investors can isolate the impact of fundamentals from the impact of the 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 his performance to the performance of other managers operating in this market. As a result, the uncertainty about the ability of the managers after the first period is higher in the foreign market, $\sigma_{\alpha F}^2 > \sigma_{\alpha D}^2$.

After updating their beliefs, investors choose the allocation of capital between the domestic and the foreign market, q_{D2} and q_{F2}, and the allocation of funds within each market, $\left\{x_{j2}^D\right\}_{j=1}^N$ and $\left\{x_{j2}^F\right\}_{j=1}^{T-N}$. Given the amount of capital invested in each market, q_{D2} and q_{F2}, investors choose $\left\{x_{j2}^D\right\}_{j=1}^N$ that solve

$$\max_{\left\{x_{j2}^D\right\}_{j=1}^N} \sum_{j=1}^N \left(\bar{\nu} + \phi_{j1}\left(R_{j1}^D, v_{D1}\right) - f\right) x_{j2}^D - \frac{1}{2}\gamma\left(\left(\sum_{j=1}^N x_{j2}^D\right)^2\sigma_v^2 + \sum_{j=1}^N \left(x_{j2}^D\right)^2\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right), \tag{7}$$

subject to $\sum_{j=1}^N x_{j2}^D = q_{D2}$. The allocation of funds in the domestic market is

$$x_{j2}^D = \frac{q_{D2}}{N} + \frac{\phi_{j1}\left(R_{j1}^D, v_{D1}\right) - \frac{1}{N}\sum_{i=1}^N \phi_{i1}\left(R_{i1}^D, v_{D1}\right)}{\gamma\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)}. \tag{8}$$

Analogously, the allocation of funds in the foreign market is

$$x_{j2}^{F}=\frac{q_{F2}}{T-N}+\frac{\phi_{j1}\left(R_{1}^{F}\right)-\frac{1}{T-N}\sum_{i=1}^{T-N}\phi_{i1}\left(R_{1}^{F}\right)}{\gamma\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)}. \tag{9}$$

The optimal allocation of capital between the domestic and the foreign market is obtained by plugging the optimal distribution of capital across managers, which is given by equations (8) and (9), into the objective function given by equation (7). Investors choose q_{D2} and q_{F2} to maximize this objective function subject to the budget constraint $q_{D2}+q_{F2}=1$. The optimal investment in each market is

$$q_{D2}=\frac{\gamma\left(\sigma_{v}^{2}+\frac{1}{T-N}\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)\right)+\frac{1}{N}\sum_{i=1}^{N}\phi_{i1}\left(R_{i1}^{D},v_{D1}\right)-\frac{1}{T-N}\sum_{i=1}^{T-N}\phi_{i1}\left(R_{1}^{F}\right)}{\gamma\left(2\sigma_{v}^{2}+\frac{1}{T-N}\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)+\frac{1}{N}\left(\sigma_{\alpha D}^{2}+\sigma_{\varepsilon}^{2}\right)\right)}, \tag{10}$$

$$q_{F2}=\frac{\gamma\left(\sigma_{v}^{2}+\frac{1}{N}\left(\sigma_{\alpha D}^{2}+\sigma_{\varepsilon}^{2}\right)\right)-\frac{1}{N}\sum_{i=1}^{N}\phi_{i1}\left(R_{i1}^{D},v_{D1}\right)+\frac{1}{T-N}\sum_{i=1}^{T-N}\phi_{i1}\left(R_{1}^{F}\right)}{\gamma\left(2\sigma_{v}^{2}+\frac{1}{T-N}\left(\sigma_{\alpha F}^{2}+\sigma_{\varepsilon}^{2}\right)+\frac{1}{N}\left(\sigma_{\alpha D}^{2}+\sigma_{\varepsilon}^{2}\right)\right)}. \tag{11}$$

Formulas (10) and (11), hint already at the presence of home bias. From the perspective of the an investor, if markets are equally diversified and the average expected ability in both markets after the first period is the same, then $q_{D2}>q_{F2}$, that is, this investor channels more capital into the domestic market. The reason is that the estimate of each manager's ability is more precise in that market, and from the perspective of the investors, the domestic market is less risky. Hence, the investor can better allocate her capital across mutual funds. However, home bias depends on 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, the managers decide simultaneously whether they invest in the domestic market, in the foreign market, or stay out. Conditional on operating, they choose a market in which they expect to attract more capital. What is the payoff of a fund if it enters the domestic market? If n is the fraction of all operating managers in the domestic market, and $\Pr(N|n)$ is the fraction of consumers that observe N domestic funds, then, there are $\Pr(N|n)\,N$ observations of this kind. This implies that the number of consumers that observe

N domestic funds per domestic fund is $\Pr(N|n)\frac{N}{\mu n}$. Analogously, the number of consumers that observe $T-N$ foreign funds per foreign fund is $\Pr(N|n)\frac{T-N}{\mu(1-n)}$. Hence, the expected excess profit of a manager from entering the domestic market is

$$\Delta_t \equiv \frac{1}{\mu}\sum_{N=0}^{T}\Pr(N|n)\left(\frac{N}{n}E\left[x_{jt}^{D}|N\right]-\frac{T-N}{1-n}E\left[x_{jt}^{F}|N\right]\right). \tag{12}$$

In equilibrium n must be such that the expected excess profit from entering the domestic market is equal to the difference in the entry costs:

$$f\left(\Delta_1+\delta\Delta_2\right)=F_D-F_F. \tag{13}$$

where δ is the discount factor.

2.3 Results

2.3.1 Benchmark case

We are interested in home bias generated by imperfect information about managers' ability combined with investors' asymmetric information about markets' fundamentals. Hence, we need to analyze the 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 $\sigma_{\alpha F}^2=\sigma_{\alpha D}^2$. Using the formulas derived above, conditional on N, the allocation in the first period is the same as in the asymmetric case, and the allocation in the second period is like in expressions (8), (9), (10) and (11), but with $\sigma_{\alpha D}^2$ substituted for $\sigma_{\alpha F}^2$.

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

Lemma 1 *When the cost of entry in both markets is the same, $F_D=F_F$, in the benchmark case the equilibrium fraction of firms operating in each market is $\frac{1}{2}$, and in expectations each market attracts the same amount of capital.*

2.3.2 Asymmetric case

Let n_a and n_b be the equilibrium fraction of firms operating in the domestic market in the model with asymmetric information and the benchmark model, 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}.

Definition *Home bias is* $HB = Q^a_{D1} - Q^b_{D1} + \delta \left(Q^a_{D2} - Q^b_{D2} \right).$

For now, we will consider the case in which the entry cost is the same in each market. Proposition (1) states that in equilibrium there are more mutual funds in the domestic market.

Proposition 1 *In equilibrium, if* $F_D = F_F$*, 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, investors have more precise information about managers' ability in the domestic market; therefore, they can distribute their investments better than in the foreign market. This causes them to channel more capital to the domestic market even if the number of mutual funds in each market is the same. However, due to this primary home bias, more managers enter the domestic market. This results in a multiplier effect: the domestic market becomes more diversified attracting more capital. Home bias becomes even more severe.

3 Heterogeneous managers

In this section, we analyze what happens when managers are not ex-ante identical. The ability of each manager consists of a publicly observed signal, y_j and an unknown, random factor η_i; that is, $\alpha_j = y_j + \eta_j$, where $\eta_j \sim N\left(0, \sigma^2_\eta\right)$, and η_j and η_i are independent for $i \neq j$. The signals are observed before managers choose in which market to operate. The rest of the game is as in the previous section. When we want to stress that we look at a manager in a particular market, we denote the signal of manager j who enters market M by y^M_j.

This public signal can be interpreted as the curriculum vitae of the fund manager being public information. Chevalier and Ellison (1999) showed that managers who attended higher-SAT undergraduate institutions have systematically higher risk adjusted excess returns. Also in their paper, they make reference to a 1994 study by Morningstar, Inc. reported on by Business Week (July 4, 1994, p. 6) in which *"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."*

3.1 Allocation of capital by investors

Given the signal structure, in the first period the expected ability of manager j is y_j. Let us look first at investment choices of an investor who observes N mutual funds in the domestic market, 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 the foreign mutual funds that she observes. It is straightforward to derive the first period optimal allocation of capital across markets

$$q_{D1} = \frac{\gamma\left(\sigma_v^2 + \frac{1}{T-N}\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right) + y^D - y^F}{\gamma\left(2\sigma_v^2 + \left(\frac{1}{T-N} + \frac{1}{N}\right)\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right)}, \tag{14}$$

$$q_{F1} = \frac{\gamma\left(\sigma_v^2 + \frac{1}{N}\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right) - y^D + y^F}{\gamma\left(2\sigma_v^2 + \left(\frac{1}{T-N} + \frac{1}{N}\right)\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right)}. \tag{15}$$

The amount of capital invested by this investor in fund j with signal y_j is

$$x_{j1}^D = \frac{\gamma\left(\sigma_v^2 + \frac{1}{T-N}\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right) + y^D - y^F}{\gamma N\left(2\sigma_v^2 + \left(\frac{1}{T-N} + \frac{1}{N}\right)\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right)} + \frac{y_j - y^D}{\gamma\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)}, \tag{16}$$

if the fund operates in the domestic market, and

$$x_{j1}^F = \frac{\gamma\left(\sigma_v^2 + \frac{1}{N}\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right) - y^D + y^F}{\gamma\left(T-N\right)\left(2\sigma_v^2 + \left(\frac{1}{T-N} + \frac{1}{N}\right)\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)\right)} + \frac{y_j - y^F}{\gamma\left(\sigma_\eta^2 + \sigma_\varepsilon^2\right)}, \tag{17}$$

if the fund operates in the foreign market.

The total amount of capital invested in a given market is increasing in the diversification of this market and in the difference between the average expected quality of managers in this market and the other market. Each manager is better off in a market that is not well diversified, has higher average expected quality, and has lower expected average quality compared to the quality of that fund's manager.

As before, in the second period investors update their beliefs about the ability of the managers. In the domestic market, each investor observes signals about abilities, $\{y_j\}_{j=1}^N$, and the realized returns, $\left\{R_{j1}^D\right\}_{j=1}^N$, of all managers which she encounters, as well as the domestic fundamentals, v_{D1}. She updates her beliefs in the following way

$$\phi_{j1}\left(y_j, R_{j1}^D, v_{D1}\right) \equiv E\left[\alpha_j \mid \{y_j\}_{j=1}^N, R_{11}^D, ..., R_{N1}^D, v_1^D\right] = E\left[\alpha_j \mid y_j, R_{j1}^D, v_{D1}\right], \tag{18}$$

$$\sigma_{\alpha D}^2 \equiv Var\left(\alpha_i \mid y_j, R_{j1}^D, v_{D1}\right) = \sigma_\varepsilon^2 \frac{\sigma_\eta^2}{\sigma_\varepsilon^2 + \sigma_\eta^2}. \tag{19}$$

In the foreign market, each investor observes signals about about abilities, $\{y_j\}_{j=1}^{T-N}$, and the realized returns, $\left\{R_{j1}^F\right\}_{j=1}^{T-N}$, of all managers which she encounters, but she does not observe the foreign benchmark, v_{F1}. She updates her beliefs in the following way

$$\phi_{j1}\left(\{y_j\}_{j=1}^{T-N}, R_1^F\right) \equiv E\left[\alpha_j \mid \{y_j\}_{j=1}^{T-N}, R_{11}^F, ..., R_{(T-N)1}^F\right] \tag{20}$$

$$\begin{aligned} \sigma_{\alpha F}^2 &\equiv Var\left(\alpha_j \mid \{y_j\}_{j=1}^{L}, R_{11}^F, ..., R_{(T-N)1}^F\right) = \\ &= \frac{\sigma_\eta^2}{\sigma_\varepsilon^2 + \sigma_\eta^2} \frac{\sigma_\varepsilon^4 + \sigma_\eta^2\left(\sigma_v^2 + \sigma_\varepsilon^2\right) + (T-N)\sigma_v^2\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + \sigma_\eta^2 + (T-N)\sigma_v^2} \end{aligned} \tag{21}$$

The second period optimal allocation of capital across markets is

$$q_{D2} = \frac{\gamma\left(\sigma_v^2 + \frac{1}{(T-N)}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)\right) + \left(\frac{1}{N}\sum_{j=1}^N \phi_{j1}\left(y_j, R_{j1}^D, v_{D1}\right) - \frac{1}{(T-N)}\sum_{j=1}^{(T-N)} \phi_{j1}\left(\{y_j\}_{j=1}^{(T-N)}, R_1^F\right)\right)}{\gamma\left(2\sigma_v^2 + \frac{1}{(T-N)}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right)}, \tag{22}$$

$$q_{F2} = \frac{\gamma\left(\sigma_v^2 + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right) - \left(\frac{1}{N}\sum_{j=1}^N \phi_{j1}\left(y_j, R_{j1}^D, v_{D1}\right) - \frac{1}{(T-N)}\sum_{j=1}^{(T-N)} \phi_{j1}\left(\{y_j\}_{j=1}^{(T-N)}, R_1^F\right)\right)}{\gamma\left(2\sigma_v^2 + \frac{1}{(T-N)}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right)}, \tag{23}$$

and across managers is

$$x_{j2}^D = \frac{1}{N} q_{D2} + \frac{\phi_{j1}\left(y_j, R_{j1}^D, v_{D1}\right) - \frac{1}{N}\sum_{j=1}^N \phi_{j1}\left(y_j, R_{j1}^D, v_{D1}\right)}{\gamma\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)}, \tag{24}$$

$$x_{j2}^F = \frac{1}{T-N} q_{F2} + \frac{\phi_{j1}\left(\{y_j\}_{j=1}^{(T-N)}, R_1^F\right) - \frac{1}{(T-N)}\sum_{j=1}^{(T-N)} \phi_{j1}\left(\{y_j\}_{j=1}^{(T-N)}, R_1^F\right)}{\gamma\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)}. \tag{25}$$

3.2 Market entry

When deciding which market to enter, a manager with signal y_j estimates how her ability will be perceived in the second period, and this estimate is the same in both markets:

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

The ex-ante expected optimal allocation of capital received by a manager with y_j in the second period from an investor who observes N domestic mutual funds is obtained using equations (24) and (25):

$$E\left[x_{j2}^D|N\right] = \frac{\gamma\left(\sigma_v^2 + \frac{1}{T-N}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)\right) + \left(y^D - y^F\right)}{N\gamma\left(2\sigma_v^2 + \frac{1}{T-N}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right)} + \frac{\left(y_j - y^D\right)}{\gamma\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)}, \qquad (26)$$

if the manager is in the domestic market, and

$$E\left[x_{j2}^F|N\right] = \frac{\gamma\left(\sigma_v^2 + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right) - \left(y^D - y^F\right)}{(T-N)\,\gamma\left(2\sigma_v^2 + \frac{1}{T-N}\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right) + \frac{1}{N}\left(\sigma_{\alpha D}^2 + \sigma_\varepsilon^2\right)\right)} + \frac{\left(y_j - y^F\right)}{\gamma\left(\sigma_{\alpha F}^2 + \sigma_\varepsilon^2\right)}, \qquad (27)$$

if the manager is in the foreign market.

3.3 Equilibrium

We can state the following proposition.

Proposition 2 *In any equilibrium, the average quality in the domestic market is higher, $y^D \geq y^F$, and 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 all $y_j < \bar{y}$ enter the foreign market;

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

Before we discuss the implication of this result, let us explain the intuition behind it. To understand which managers enter the domestic market, we need to see how the entry incentives vary with the expected quality y_j. Let $\sigma_{\alpha Mt}^2$ be the uncertainty about the quality of a manager in period t in market M, and let us look at how much capital is attracted by manager with quality y_j when he enters market M (this notation allows us to express equations (16), (17), (26) and (27) in one; $\neg M$ denotes market other than M):

$$
\begin{aligned}
& \frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{N}{n}E\left[x_{j2}^{M}|N\right] && (28)\\
= \; & \frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{N}{n}\frac{\gamma\left(\left(T-N\right)\sigma_v^2+\left(\sigma_{\alpha Mt}^2+\sigma_\varepsilon^2\right)\right)+\left(T-N\right)\left(y^M-y^{\neg M}\right)}{\gamma\left(2N\left(T-N\right)\sigma_v^2+N\left(\sigma_{\alpha Ft}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha Dt}^2+\sigma_\varepsilon^2\right)\right)}\\
& +\frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{N}{n}\frac{\left(y_j-y^M\right)}{\gamma\left(\sigma_{\alpha Mt}^2+\sigma_\varepsilon^2\right)}.
\end{aligned}
$$

An increase in manager j's expected quality y_j has two effects: a direct and an indirect one. The direct effect makes the difference between the quality of this manager and the average quality in his market, $\left(y_j - y^M\right)$, increase. The magnitude of this effect depends on how effective a given market is in rewarding quality. If $\sigma_{\alpha Mt}^2$ is the same in both markets, as it is in the first period, 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, $\sigma_{\alpha Dt}^2 < \sigma_{\alpha Ft}^2$; hence, other things equal, better managers 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 (28)); and second, the difference $\left(y_j - y^M\right)$ decreases (the second term in equation (28)). 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. This means that the manager with quality y_j would like to affect y^M as little as possible, which is positively correlated with market diversification.

These two effects together imply that unless the domestic market is strongly undiversified, better managers go to the domestic market. This immediately allows us to conclude that if in equilibrium all managers are indifferent between the markets, it must be that the domestic market is less diversified, $n < \frac{1}{2}$.

Why is there no equilibrium in which $n < \frac{1}{2}$ and better firms go to the foreign market? In such equilibrium, the domestic market would be less diversified, have firms of low quality and reward quality more in the second period. Under these circumstances, a very good manager from the foreign market would benefit a lot in the domestic market from having quality well above the average; hence, he would have an incentive to deviate at the entry stage.

Let us now discuss the implications of Proposition (2). In the 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 the curious fact that there are more mutual funds investing mainly in the foreign assets, but these funds are smaller on average than the ones 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 there are fewer funds investing domestically. Whether this is the case, depends on the distribution of the signals about quality, but the intuition developed by the proof of Proposition (2) suggests that there are fewer domestic funds when there is large heterogeneity in how mutual funds are perceived.[3] When the heterogeneity is large, the average quality in the foreign market is very low compared with the quality in the domestic market. Consider a manager operating in the domestic market. If he deviated to the foreign market, since he is better than average, he would receive much more capital than the average manager in the foreign market. This deviation will not be optimal only if the average capital per manager in the foreign market is low to start with, and this can be the case only if this market is very crowded.

4 Numerical Analysis

For the following numerical analysis, 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). 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

[3] In our simulations, we always obtained $n < \frac{1}{2}$.

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. This implies that the standard deviation of the ability of a fund manager, σ_α in the benchmark model or σ_η in the model with heterogeneous managers, is set to 20%. A nice property of this model is that the numerical results are independent of the mean of the ability of the fund manager, $\bar{\alpha}$, and the mean of the fundamentals in the economy, $\bar{\nu}$. Hence, there is no need to take a stand on the debate of the relative performance of fund managers with respect to passive benchmarks. For the model with heterogeneous managers, in the numerical example, we assume that y_j follows a uniform distribution over the interval $[0, 0.08]$. In this example I assume that managers outperform the passive benchmark, but, as we mentioned above, we obtain exactly the same results if we impose that y_j follows a uniform distribution where managers underperform the benchmark. Following Wei (2007), 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. Then, the parameters for domestic fixed costs, F_D, and the mass of operating managers, μ, are always multiplied to each other, and there is no need to calibrate each of these parameters separately. The results of our model depend on μF_D. 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. We choose μF_D to be 0.42% for the value of the ratio of the size of an average fund over the minimum fund size to be 4.7.

Figure 1 shows the results of the calibration for the benchmark model. Panel A shows the equilibrium fraction of firms operating in the domestic market in the benchmark model with asymmetric information, n_a. According to Proposition 1 if $g = 0$, then $n_a > \frac{1}{2}$. In particular, the calibrated model implies $n_a = 63.1\%$. This panel also shows that the higher is g, the larger is the fraction of firms in the domestic market in equilibrium. According to Panel B, if $g = 0$, on average, the total expected amount of capital invested in the domestic market is $Q^a_{D2} = 63.1\%$. This panel also shows that the higher is g, the higher is the amount of capital invested in the domestic market. In particular, for $g = 1.5\%$, the amount of capital invested in the domestic market is $Q^a_{D2} = 87.3\%$. The benchmark model has the salient feature that in equilibrium $n_a > \frac{1}{2}$. This contradicts the evidence provided by Chan, Covrig and Ng (2005) and Hau and Rey (2008) in which on average, the number of international funds is larger than the number of domestic funds. For the benchmark model to generate $n_a = 46\%$, we need foreign fixed costs, F_F, to be lower than domestic fixed costs, F_D, or $g < 0$, which is difficult to support.

Figure 2 shows the results of the calibration for the model with heterogeneous fund managers. Following Proposition 2, in equilibrium $y^D \geq y^F$, and one of the following holds: a) there is a threshold ability $\bar{y}$, such that all $y_j \geq \bar{y}$ enter the domestic market and all $y_j < \bar{y}$ enter the foreign market when $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} > 0$ in equilibrium; or b) all managers are indifferent between the markets and there are fewer managers in the domestic market when $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} = 0$ in equilibrium. In both equilibria, there also exists a threshold ability such that managers stay out. Panel A shows the value of this derivative for different values of g. If $g = 0$, then equilibrium b) exists and $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} = 0$ in equilibrium. Panel B shows that if $g = 0$, then the fraction of domestic funds n_a that makes all managers indifferent between operating in the domestic and foreign market is given by $n_a = 34.02\%$. According to Panel C, if $g = 0$, then the total expected amount of capital invested in the domestic market is $Q^a_{D2} = 55\%$. According to Chan, Covrig and Ng (2005) and Hau and Rey (2008) on average, the fraction of domestic funds is 46%. For this equilibrium to generate the fraction of domestic funds implied by the data $n_a = 46\%$, we need $g = 1.5\%$, as one can see in Panel B. According to Panel A, if $g = 1.5\%$, then $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} > 0$. Hence, there exists a threshold equilibrium. According to Panel C, even though $n_a < \frac{1}{2}$, if $g = 1.5\%$, then the total expected amount of capital invested in the domestic market is $Q^a_{D2} = 76.25\%$. 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. From Panel D, in this equilibrium, for any g, the average ability of fund managers in the domestic market, y^D, is higher than the average ability in the foreign market, y^F. Therefore, in this equilibrium with a 1.5% difference in fixed costs, the calibrated model accounts for three salient features of the data about fund managers at the international level. Although our model underestimates the empirical home bias, it comes very close given its stylized nature.

5 Conclusion

The main criticism to information-based stories of home bias relies upon the assumption that there is no local information advantages at the fund level. Hence, if individual agents invest through mutual funds, then information asymmetries at the individual level disappear and there is no home bias in fund manager's portfolios. However, Chan, Covrig and Ng (2005) and Hau and Rey (2008) have extensively reported the existence of home bias at the fund level. This paper develops a stylized model of delegated asset management that generates home bias at the fund level. We show that if investment decisions are delegated to fund managers with identical access to information in all markets, asymmetric information at the individual level combined with the uncertainty about the ability of the portfolio managers may result in home bias. In particular, the calibrated model accounts for three salient features of the data about fund managers at the international level: (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.

To conclude, information-based stories of home bias cannot be disregarded as a complementary explanation to the equity home bias puzzle such as hedging domestic risks channels, barriers for foreign investments stories, corporate governance and transparency issues and behavioral-based explanations.

6 Appendix

6.1 Proof of Lemma 1

Using equation (12), one gets

$$\begin{aligned}
\Delta_1 &= \frac{1}{\mu}\sum_{N=0}^{T}\Pr(N|n)\left(\frac{N}{n}\frac{(T-N)\sigma_v^2+\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}{2N(T-N)\sigma_v^2+T(\sigma_\alpha^2+\sigma_\varepsilon^2)}-\frac{T-N}{1-n}\frac{N\sigma_v^2+\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}{2(T-N)N\sigma_v^2+T(\sigma_\alpha^2+\sigma_\varepsilon^2)}\right)\\
&= \frac{1}{\mu n(1-n)}\sum_{N=0}^{T}\Pr(N|n)\left(\frac{N\sigma_v^2(1-2n)(T-N)+\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)(N-Tn)}{2N(T-N)\sigma_v^2+T(\sigma_\alpha^2+\sigma_\varepsilon^2)}\right).
\end{aligned}$$

We will show that $\Delta_1 = 0$ when $n = \frac{1}{2}$ and that $\Delta_1 < 0$ iff $n > \frac{1}{2}$. In the benchmark model Δ_2 has the same form as Δ_1 but with $\sigma^2_{\alpha D}$ in place of σ^2_α, the same will hold for Δ_2. Taking the derivative of $\Delta_1(n)$ with respect to σ^2_v, one gets

$$sign\left(\frac{dRHS}{d\sigma_v^2}\right) = \sum_{N=0}^{T} \Pr(N|n)\left(\frac{N\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)(T-N)(T-2N)}{\left(2N(T-N)\sigma_v^2+T(\sigma_\alpha^2+\sigma_\varepsilon^2)\right)^2}\right) = \tag{29}$$

$$= \sum_{N=0}^{\frac{T}{2}} \binom{T}{N} n^N (1-n)^{T-N} \frac{N\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)(T-N)(T-2N)}{\left(2N(T-N)\sigma_v^2+T(\sigma_\alpha^2+\sigma_\varepsilon^2)\right)^2}\left(1-\left(\frac{n}{1-n}\right)^{T-2N}\right)\begin{cases} > 0 \text{ if } n < \frac{1}{2} \\ = 0 \text{ when } n = \frac{1}{2} \\ < 0 \text{ if } n > \frac{1}{2} \end{cases}$$

The result completing this proof will be used extensively in the later proofs, hence we state it as a claim.

Claim A Using (29), we get

$$\sum_{N=0}^{T} \Pr(N|n) \frac{N\sigma_v^2(1-2n)(T-N)+\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)(N-Tn)}{2N(T-N)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)} \begin{cases} > \sum_{N=0}^{T}\Pr(N|n)\frac{N-Tn}{T} = 0 \text{ for } n<\frac{1}{2} \\ < \sum_{N=0}^{T}\Pr(N|n)\frac{N-Tn}{T} = 0 \text{ for } n>\frac{1}{2} \end{cases} \tag{30}$$

Hence, $\Delta_1(n)\begin{cases} > 0 \text{ if } n < \frac{1}{2} \\ = 0 \text{ when } n = \frac{1}{2} \\ < 0 \text{ if } n > \frac{1}{2} \end{cases}$.

6.2 Proof of Proposition 1

If $F_D \le F_F$, we need that in equilibrium $\Delta_1 + \delta\Delta_2 \le 0$. Plugging (1) and (2) into (12), one gets

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

Plugging (8) and (9) into (12), one gets

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

The first term in the bracket is increasing in σ^2_F, and the second term is decreasing in σ^2_F, and since σ_F^2 is greater than σ_D^2, when we plug σ_D^2 instead of σ_F^2, we get:

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

Hence,

$$\Delta_1+\delta\Delta_2 > \frac{2}{\mu n(1-n)}\sum_{N=0}^{T}\Pr(N|n)\left(\frac{N\sigma_v^2(1-2n)(T-N)+\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)(N-Tn)}{2N(T-N)\sigma_v^2+T\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}\right)$$

The right hand side is 0 for $n=\frac{1}{2}$, because of symmetry. Also, we have:

$$\begin{aligned}\frac{dRHS}{d\sigma_v^2} &= \frac{1}{(1-n)n}\sum_{N=0}^{T}\binom{T}{N}n^N(1-n)^{T-N}\frac{N(N-T)\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)(2N-T)}{\left(2N(T-N)\sigma_v^2+T\left(\sigma_\varepsilon^2+\sigma_{D\alpha}^2\right)\right)^2} \\ &= \frac{\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)}{(1-n)n}\sum_{N=0}^{\frac{T}{2}}\binom{T}{N}n^N(1-n)^{T-N}\frac{N(N-T)(T-2N)}{\left(2N(T-N)\sigma_v^2+T\left(\sigma_\varepsilon^2+\sigma_{D\alpha}^2\right)\right)^2}\left(1-\left(\frac{n}{1-n}\right)^{T-2N}\right) \\ &\begin{cases}\geq 0 \text{ if } n<\frac{1}{2} \\ <0 \text{ if } n>\frac{1}{2}\end{cases}.\end{aligned}$$

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

$$\Delta_1+\delta\Delta_2 > \frac{2}{\mu n(1-n)}\sum_{N=0}^{T}\Pr(N|n)\left(\frac{(N-Tn)}{T}\right)=0.$$

Therefore, $\Delta_1+\delta\Delta_2=0$ only if $n>\frac{1}{2}$.

Now, we will move to proving that home bias occurs in expectations. By definition of Q_{Dt}^a, we have

$$Q_{Dt}^a=\sum_{N=0}^{T}\Pr(N|n)NE\left[x_{jt}^D|N\right].$$

Hence, home bias is

$$HB_t=\sum_{N=0}^{T}\Pr(N|n)\left(NE\left[x_{jt}^D|N\right]\right)-\frac{1}{2}. \tag{31}$$

Using formula for $E\left[x_{jt}^{D}|N\right]$, we get

$$\begin{aligned}
HB_1 &= \sum_{N=0}^{T}\Pr\left(N|n\right)\left(N\frac{\left(T-N\right)\sigma_v^2+\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}{2N\left(T-N\right)\sigma_v^2+T\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}-\frac{1}{2}\right)\\
&= \frac{1}{2}\sum_{N=0}^{T}\Pr\left(N|n\right)\left(\frac{\left(2N-T\right)\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}{2N\left(T-N\right)\sigma_v^2+T\left(\sigma_\alpha^2+\sigma_\varepsilon^2\right)}\right)>0 \text{ if } n>\frac{1}{2}.
\end{aligned}$$

Hence, we have a home bias in the first period. In the second period, using the (10) and (11), we get

$$\begin{aligned}
HB_2 &= \sum_{N=0}^{T}\Pr\left(N|n\right)\left(\frac{N\left(T-N\right)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)}{2\left(T-N\right)N\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}-\frac{1}{2}\right)\\
&= \frac{1}{2}\sum_{N=0}^{T}\Pr\left(N|n\right)\left(\frac{N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)-\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}{2\left(T-N\right)N\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}\right)\\
&> \text{because the last expression is increasing in } \sigma_{\alpha F}^2 \text{ and } \sigma_{\alpha F}^2<\sigma_{\alpha D}^2 >\\
&> \frac{1}{2}\sum_{N=0}^{T}\Pr\left(N|n\right)\left(\frac{\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)\left(2N-T\right)}{2\left(T-N\right)N\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}\right)>0 \text{ for } n>\frac{1}{2}.
\end{aligned}$$

6.3 Proof of Proposition 2

The manager enters the domestic market if $\Delta_1\left(y_j\right)+\delta\Delta_2\left(y_j\right)>0$ and the foreign market if $\Delta_1\left(y_j\right)+\delta\Delta_2\left(y_j\right)<0$ and is indifferent when $\Delta_1\left(y_j\right)+\delta\Delta_2\left(y_j\right)=0$. First, we will look at how the entry incentives depend on the quality signal.

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 him, his 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 (12)), we get:

$$\begin{aligned}
\Delta_1(y_j) &= \frac{1}{\mu n(1-n)}\cdot(\\
&\sum_{N=0}^{T}\Pr(N|n)\frac{N\sigma_v^2(1-2n)(T-N)+\left(\sigma_\varepsilon^2+\sigma_\eta^2\right)(N-Tn)}{2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)} \\
&+\sum_{N=0}^{T}\Pr(N|n)\frac{(T-N)N\left((1-n)\left(\frac{N-1}{N}y^D+\frac{1}{N}y_j-y^F\right)+n\left(y^D-\frac{T-N-1}{T-N}y^F-\frac{1}{T-N}y_j\right)\right)}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)} \\
&+\sum_{N=0}^{T}\Pr(N|n)\frac{N(1-n)\left(y_j-\frac{N-1}{N}y^D-\frac{1}{N}y_j\right)-(T-N)n\left(y_j-\frac{T-N-1}{T-N}y^F-\frac{1}{T-N}y_j\right)}{\gamma\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)}),
\end{aligned}$$

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

Taking the derivatives of $\Delta_1(y_j)$ and $\Delta_2(y_j)$ with respect to y_j, we get:

$$\frac{d\Delta_1(y_j)}{dy_j}=\frac{1}{\mu n(1-n)}\left(\sum_{N=0}^{T}\Pr(N|n)\frac{T(1-n)-N}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)}+\frac{2n-1}{\gamma\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)}\right), \tag{32}$$

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

The derivative $\frac{d\Delta_1(y_j)}{dy_j}+\delta\frac{d\Delta_2(y_j)}{dy_j}$ does not depend on y_j; hence, there can be at most three types of equilibria: one in which better firms enter the domestic market, $\frac{d\Delta_1(y_j)}{dy_j}+\delta\frac{d\Delta_2(y_j)}{dy_j}>0$, one in which better firms enter the foreign market, $\frac{d\Delta_1(y_j)}{dy_j}+\delta\frac{d\Delta_2(y_j)}{dy_j}<0$, and one in which all firms are indifferent between both markets, $\frac{d\Delta_1(y_j)}{dy_j}+\delta\frac{d\Delta_2(y_j)}{dy_j}=0$.

We will show now that better firms going to the foreign market cannot be an equilibrium: first, we will establish that better firms might go to the foreign market only if $n > \frac{1}{2}$ (STEP 1). Otherwise, a manager with $y_j = y^F$ would like to go to a less diversified, lower quality domestic market which offers a high return to quality. Then we will show that when $n > \frac{1}{2}$, $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} > 0$, which means that the better managers want to go to the domestic market (STEP 2), which is a contradiction.

STEP 1

Assume that better managers enter the foreign market, $y^D < y^F$. Plugging y^F into the formula for $\Delta_1(y_j)$ and grouping terms with y^D and y^F, we obtain the following formula for the expected excess capital of the mutual fund with $y_j = y^F$ operating in the foreign market:

$$\begin{aligned}\Delta_1\left(y^F\right) &= \frac{1}{\mu n(1-n)}\sum_{N=0}^{T}\Pr(N|n)\frac{N\sigma_v^2(1-2n)(T-N)+\left(\sigma_\varepsilon^2+\sigma_\eta^2\right)(N-Tn)}{2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)} \\ &\quad+\frac{\left(y^F-y^D\right)}{\mu n(1-n)}\cdot \\ &\quad\underbrace{\sum_{N=0}^{T}\Pr(N|n)\frac{\left(\sigma_\varepsilon^2+\sigma_\eta^2\right)\left(N(N-T+n-1)+T^2n-T^2n^2\right)+2N(T-N)\sigma_v^2(1-n)(Tn-1)}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)}}_{\equiv\text{ST}}\end{aligned}$$

The derivative of the second term with respect to σ_v^2 is

$$\frac{d(\text{ST})}{d\sigma_v^2} = \sum_{N=0}^{T}\Pr(N|n)\frac{2N(T-N)^2(N+n-1)}{\gamma\left(2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)^2} > 0,$$

hence we get that $\Delta_1\left(y^F\right)$ is larger than than the right hand side evaluated at $\sigma_v^2 = 0$ in the second term:

$$\begin{aligned}\Delta_1\left(y^F\right) &> \frac{1}{\mu n(1-n)}\sum_{N=0}^{T}\Pr(N|n)\frac{N\sigma_v^2(1-2n)(T-N)+\left(\sigma_\varepsilon^2+\sigma_\eta^2\right)(N-Tn)}{2N(T-N)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)} \\ &\quad+\frac{\left(y^F-y^D\right)}{\mu n(1-n)}\sum_{N=0}^{T}\Pr(N|n)\frac{\left(-N+T^2n-T^2n^2-NT+Nn+N^2\right)}{\gamma\left(T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)}.\end{aligned}$$

Using the fact that for the binomial distribution, $E[N] = Tn$ and $E\left[N^2\right] = Tn - Tn^2 + (Tn)^2$, we get that the second term is 0. By Claim A, the first expression is positive for $n \leq \frac{1}{2}$, hence we have that

$$\text{if } y^F > y^D, \quad \Delta_1\left(y^F\right) > 0 \text{ for } n \leq \frac{1}{2}. \tag{33}$$

In the second period, we have:

$$\begin{aligned}
\Delta_2\left(y^F\right) &= \underbrace{\frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{N}{n}\frac{\gamma\left(\left(T-N\right)\sigma_v^2+\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)\right)+\left(T-N\right)\left(y^D-y^F\right)\frac{N-1}{N}}{\gamma\left(2N\left(T-N\right)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)}}_{\mathrm{FT}_2} \\
&\quad \underbrace{-\frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{T-N}{1-n}\frac{\gamma\left(N\sigma_v^2+\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)+N\left(y^F-y^D\right)}{\gamma\left(2N\left(T-N\right)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)}}_{\mathrm{ST}_2}+ \\
&\quad +\frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{N-1}{n}\frac{\left(y^F-y^D\right)}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}
\end{aligned}$$

We have

$$\frac{d(\mathrm{FT}_2)}{d\sigma_{\alpha F}^2} = \frac{1}{\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{N}{n}\frac{\left(T-N\right)\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2+N\sigma_v^2+\left(N-1\right)\left(y^F-y^D\right)\right)}{\gamma\left(2N\left(T-N\right)\sigma_v^2+N\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)+\left(T-N\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)^2} > 0,$$

and

$$\frac{d(\mathrm{ST}_2)}{d\sigma_{\alpha F}^2} < 0.$$

Hence, if we plug $\sigma_{\alpha D}^2 < \sigma_{\alpha F}^2$ instead of $\sigma_{\alpha F}^2$, the right hand side is smaller than $\Delta\left(y^F\right)$:

$$\begin{aligned}
\Delta_2\left(y^F\right) &\geq \frac{1}{\left(1-n\right)n\mu}\sum_{N=0}^{T}\Pr\left(N|n\right)\cdot(\\
&\quad N\left(1-n\right)\frac{\gamma\left(\left(T-N\right)\sigma_v^2+\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)+\left(T-N\right)\left(y^D-y^F\right)\frac{N-1}{N}}{\gamma\left(2N\left(T-N\right)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)} \\
&\quad -\left(T-N\right)n\frac{\gamma\left(N\sigma_v^2+\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)-N\left(y^D-y^F\right)}{\gamma\left(2\left(T-N\right)N\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)}+\left(N-1\right)\left(1-n\right)\frac{\left(y^F-y^D\right)}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}) \\
&= \underbrace{\frac{1}{\left(1-n\right)n}\sum_{N=0}^{T}\binom{T}{N}n^N\left(1-n\right)^{T-N}\frac{\left(1-2n\right)N\left(T-N\right)\sigma_v^2+\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)\left(N-Tn\right)}{\left(2N\left(T-N\right)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)}}_{\geq 0 \text{ for } n\leq\frac{1}{2} \text{ by By Claim A from the proof of Lemma 1}} \\
&\quad +\frac{\left(y^F-y^D\right)}{\left(1-n\right)n\mu}\cdot\left(\sum_{N=0}^{T}\Pr\left(N|n\right)\frac{\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)\left(-N+T^2n-T^2n^2-NT+Nn+N^2\right)+\left(Tn-1\right)\left(1-n\right)2N\left(T-N\right)\sigma_v^2}{\gamma\left(2N\left(T-N\right)\sigma_v^2+T\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)\right)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}\right)
\end{aligned}$$

Now, the right hand side is identical to $\Delta_1\left(y^F\right)$ if we replace $\sigma_{\alpha D}^2$ with σ_η^2, hence, by the same argument we have

$$\text{if } y^F > y^D, \quad \Delta_2\left(y^F\right) > 0 \text{ for } n \leq \frac{1}{2}. \tag{34}$$

We have shown that when $y^F > y^D$ and $n < \frac{1}{2}$, then the manager operating in the foreign market with $y_j = y^F$, would receive more capital in the domestic market in both periods. Hence, for $y^F > y^D$ to be an equilibrium, we need $n > \frac{1}{2}$.

STEP 2

For the first period, $\frac{d\Delta_1(y_j)}{dy_j}$ can be rewritten:

$$\begin{aligned}\frac{d\Delta_1\left(y_j\right)}{dy_j} &= \frac{1}{\mu n\left(1-n\right)}\sum_{N=0}^{T}\Pr\left(N|n\right)\left(\frac{\left(2n-1\right)N\left(T-N\right)\sigma_v^2}{\gamma\left(2N\left(T-N\right)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)}\right)\\ &\quad -\frac{1}{\mu n\left(1-n\right)}\sum_{N=0}^{T}\Pr\left(N|n\right)\left(\frac{\left(1-2n\right)N\left(T-N\right)\sigma_v^2+\left(\sigma_\varepsilon^2+\sigma_\eta^2\right)\left(N-Tn\right)}{\gamma\left(2N\left(T-N\right)\sigma_v^2+T\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)\right)\left(\sigma_\eta^2+\sigma_\varepsilon^2\right)}\right)\end{aligned}$$

The first term is weakly positive for $n \geq \frac{1}{2}$. By Claim A from the proof of Lemma 1, the second term is also positive when $n \geq \frac{1}{2}$, hence

$$\frac{d\Delta_1\left(y_j\right)}{dy_j} > 0 \text{ for } n \geq \frac{1}{2}. \tag{35}$$

In the second period:

$$
\begin{aligned}
\frac{d\Delta_2(y_j)}{dy_j} &= \sum_{N=0}^{T}\Pr(N|n)\frac{1}{n(1-n)\gamma}\frac{(T(1-n)-N)}{N\left(\sigma_\varepsilon^2+\sigma_{F\alpha}^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)+2(T-N)N\sigma_v^2} \\
&\quad \sum_{N=0}^{T}\Pr(N|n)\left(\frac{N-1}{n}\frac{1}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}-\frac{T-N-1}{1-n}\frac{1}{\gamma\left(\sigma_{\alpha F}^2+\sigma_\varepsilon^2\right)}\right) \\
&> \sum_{N=0}^{T}\Pr(N|n)\frac{1}{n(1-n)\gamma}\frac{(T(1-n)-N)}{N\left(\sigma_\varepsilon^2+\sigma_{F\alpha}^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)+2(T-N)N\sigma_v^2} \\
&\quad +\sum_{N=0}^{T}\Pr(N|n)\left(\frac{N-1}{n}\frac{1}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}-\frac{T-N-1}{1-n}\frac{1}{\gamma\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)}\right) \\
&= \sum_{N=0}^{T}\Pr(N|n)\frac{1}{n(1-n)\gamma}\frac{(T(1-n)-N)}{N\left(\sigma_\varepsilon^2+\sigma_{F\alpha}^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)+2(T-N)N\sigma_v^2} \\
&\quad +\sum_{N=0}^{T}\Pr(N|n)\frac{N+2n-Tn-1}{n\gamma\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)(1-n)} \\
&= \frac{1}{n(1-n)\gamma}\sum_{N=0}^{T}\Pr(N|n)\frac{(T(1-n)-N)}{N\left(\sigma_\varepsilon^2+\sigma_{F\alpha}^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)+2(T-N)N\sigma_v^2} \\
&\quad +\frac{1}{n(1-n)\gamma}\frac{2n-1}{\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)} \\
&= \tfrac{1}{n(1-n)\gamma}\textstyle\sum_{N=0}^{T}\Pr(N|n)\tfrac{-\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)(N-Tn)+(2n-1)2(T-N)N\sigma_v^2+(2n-1)N\left(\sigma_{F\alpha}^2-\sigma_{D\alpha}^2\right)}{\left(N\left(\sigma_\varepsilon^2+\sigma_{F\alpha}^2\right)+(T-N)\left(\sigma_{\alpha D}^2+\sigma_\varepsilon^2\right)+2(T-N)N\sigma_v^2\right)\left(\sigma_\varepsilon^2+\sigma_{\alpha D}^2\right)} \\
&> 0 \text{ for } \geq \frac{1}{2} \text{ by Claim A.}
\end{aligned}
$$

Hence

$$
\frac{d\Delta_2(y_j)}{dy_j} > 0 \text{ for } n \geq \frac{1}{2}. \tag{36}
$$

Hence, we have proved that when $n \geq \frac{1}{2}$, then $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} \geq 0$, which contradicts the assumption that better firms go to the foreign market.

Hence, in equilibrium we have $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} \geq 0$. By (33), (34), (35) and (36), for $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j} = 0$, it must be that $n < \frac{1}{2}$ and $y^D > y^F$ (otherwise $y_j = y^F$ would like to deviate to the domestic market). This completes part (c) of the proposition.

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

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

[4] 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.

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

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

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

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

[9] 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.

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

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

[12] 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.

[13] 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.

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

[15] 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.

[16] Coval, J, and T. Moskowitz (1999), "Home Bias at Home: Local Equity Preference in Domestic Portfolios," *Journal of Finance,* 54, 2045–2073.

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

[18] Covrig, V., P. Fontaine, S. Jimenez-Garces, and M. Seasholes (2008), "Information and the Dispersion of Cross-Border Equity Holdings," working paper.

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

[20] 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.

[21] 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.

[22] 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.*

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

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

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

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

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

[28] Glode, V. (2009), “Why Mutual Funds Underperform,” working paper.

[29] Gordon, R. and A. Lans Bovenberg (1996), “Why Is Capital So Immobile Internationally? Possible Explanations and Implications for Capital Income Taxation,” *American Economic Review,* 86, 1057–1075.

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

[31] Grinblatt, M. and M. Keloharju (2000), “The Investment Behavior and Performance of Various Investor Types: A Study of Finland’s Unique Data Set,” *Journal of Financial Economics,* 55, 43–67.

[32] Grote, M.H. and M.P. 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] Hasan, I. and Y. Simaan (2000), “A Rational Explanation for Home Country Bias,” *Journal of International Money and Finance*, 19, 331-361.

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

[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 P. Fabrizio (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] Karolyi, A. G. (2002), "Did the Asian Financial Crisis Scare Investors Out of Japan," *Pacific Basin Finance Journal,* 10, 411–442.

[44] 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.

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

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

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

[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] Portes, R. and H. Rey (2005), "The Determinants of Cross Border Equity Flows," *Journal of International Economics,* 65, 269-296.

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

[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.

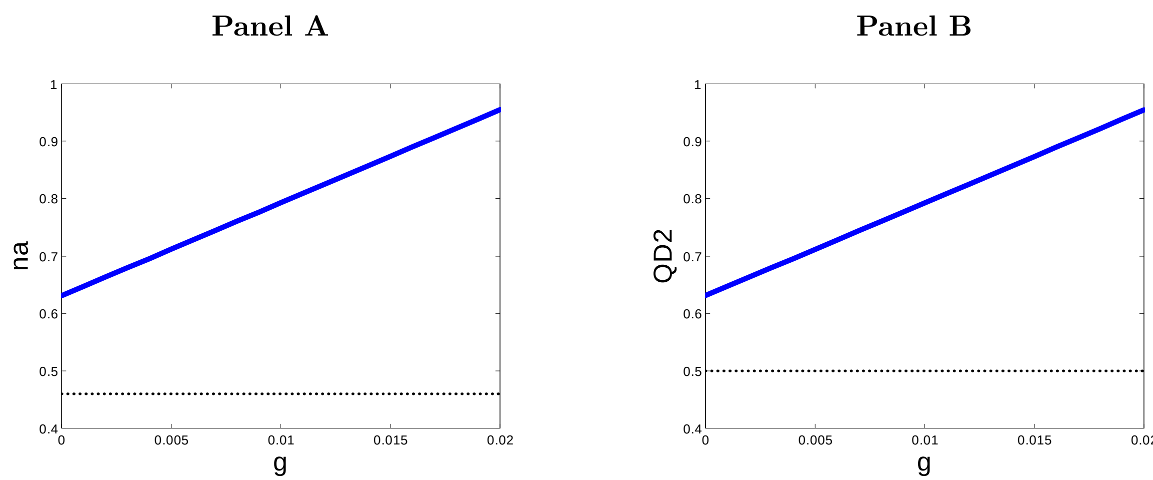

Figure 1: This figure plots the fraction of managers operating in the domestic market, n_a, (Panel A) and the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, (Panel B) using different values of g for the benchmark model.

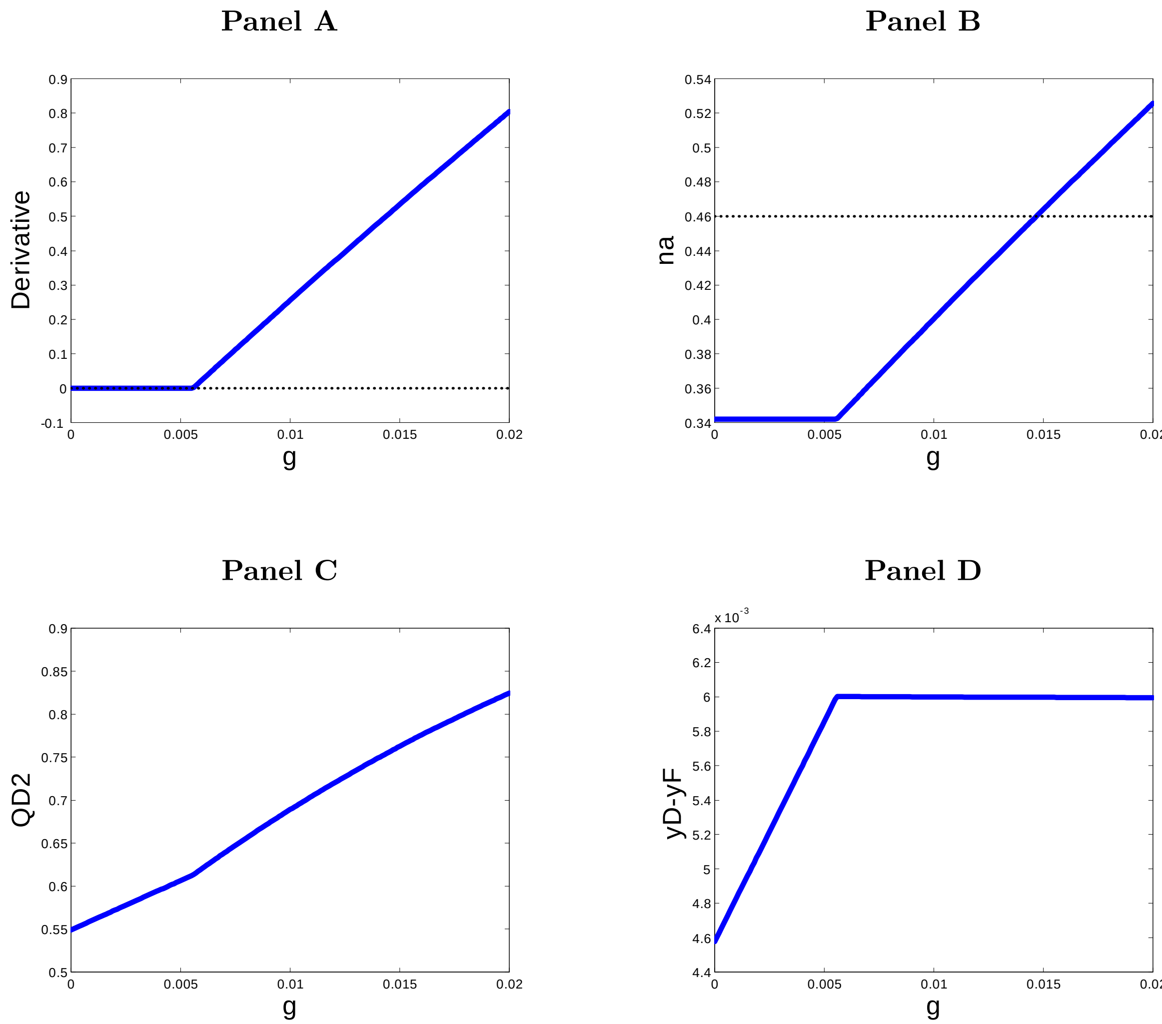

Figure 2: This figure plots the derivative of the expected excess profit from entering the domestic market with respect to fund manager's ability, $\frac{d\Delta_1(y_j)}{dy_j} + \delta\frac{d\Delta_2(y_j)}{dy_j}$, (Panel A), the fraction of managers operating in the domestic market, n_a, (Panel B), the total expected amount of capital invested in the domestic market in the second period, Q^a_{D2}, (Panel C) and the difference between the average ability of fund managers in the domestic market and foreign market, $y^D - y^F$, (Panel D) using different values of g for the model with heterogeneous fund managers.