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Human Capital, Endogenous Information Acquisition, and Home Bias in Financial Markets

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Abstract

Considerable attention has been devoted in the financial literature to excessive portfolio concentrations in domestic risky assets relative to those predicted by standard finance models – generally identified as "home bias" – across international markets. The innovation we offer is ascribing home bias to endogenous information acquisition, or "asset management" (see EHY 2008), resulting from variations in human capital endowments. We develop discriminating hypotheses about the roles of "specific" and "general" human capital endowments and the direct and opportunity costs of asset management in determining how home bias varies among individual investors and across financial markets. Our model also provides insights concerning differences across countries in the degree to which their domestic asset prices are "information revealing". These hypotheses are tested against 8 national probability samples of individual portfolio compositions in the US over 1992-2007, and 7 international samples over 2001-2007 including 23 countries. The findings are consistent with our hypotheses.

JEL Classification: D82, F30, G11, G12, G15, J24

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1. Introduction

Recent literature has offered new insights concerning deviations of portfolio compositions and related financial market characteristics from what standard finance models predict, by allowing for imperfectly informed markets and the role of private information (see Bacchetta and Van Wincoop, 2006; Van Nieuwerburgh and Veldkamp [VV], 2009; and Ehrlich, Hamlen and Yin [EHY], 2008). Like EHY, we view equilibrium prices of risky assets as less than fully information-revealing, private information production as an endogenous variable, and heterogeneity in individual human capital endowments as a major determinant of observed variability in risky asset holdings, portfolio returns, market risk premiums, and market volatility.

Our paper expands the single risky asset – multiple investors framework of EHY (2008) to one that includes multiple risky assets and diverse investors who differ in both "specific" and "general" human capital. "Specific" human capital relates to endowed or predetermined knowledge that enhances one's efficiency in producing information about specific individual assets, whereas "general" human capital relates to predetermined knowledge that increases one's efficiency in producing private information for all risky assets. Both act as complementary efficiency parameters that enable investors to form private forecasts which increase information precision, i.e., the posterior inverse variance of the forecasted future returns on specific risky assets, conditional on information signals.

We call this activity "asset management". Its optimal allocation across specific assets, and thus the precision of private information it produces, is determined by the individual human capital endowments as well as the direct and opportunity costs of individual asset management.[1] Higher information precision concerning an asset lowers the investor's required rate of return on, and thus the demand for that asset. Higher *average* precision concerning a specific asset – representing the *aggregate* precision of private information acquired by all investors – increases the asset price's "informativeness", or what we prefer to term *price information content* (PIC), i.e., the extent to which the price reveals information. An asset's PIC thus acts like an implicit public information signal which is uniformly available to all investors. The demand for risky assets at both the individual and market levels is affected by the interaction between the public and private signals associated with each asset, as well as the signals' relative magnitudes.

A natural application of this approach is rationalizing evidence on apparent concentration of portfolio holdings in specific asset categories, such as domestic vs. foreign assets, or assets of specific domestic industries, relative to what would be expected by a conventional CAPM framework. This "excessive

[1] Direct inputs may include purchase of informational services from analysts or brokers, which we do not model in this paper, but this does not affect any of our results since heterogeneous analysts offer information signals of varying precision. Searching for good analysts and monitoring their performance is part of what we call asset management. Thus, unlike studies where purchased financial services are final inputs in the production of private information (see, e.g., Admati and Pfleiderer, 1990; Veldkamp, 2006), in our approach investors draw independent inferences from information obtained from sellers.

concentration" has been dubbed "home bias" in international markets, or "home bias at home" favoring specific industries or firms within a national market. In this paper we focus on international home bias. In our approach, however, the "bias" is nothing but an optimal concentration level – the outcome of endogenously determined private information.

The issues tackled by our model are not new. The basic equilibrium framework we use, of imperfectly-informed markets and heterogeneous investors possessing private information, has been developed in Verrecchia (1982) and Admati (1985). These studies assume, however, that information costs or private information bundles are exogenously given. The "home bias" puzzle has also occupied the attention of a vast literature over the last four decades. Conventional explanations tended to emphasize the influence of institutional barriers to capital mobility, or variations in costs and benefits of diversification, across international markets on home bias (for detailed literature reviews, see, e.g., Lewis, 1999; and Sercu and Vanpée, 2007). These explanations have become less convincing with the development of a more integrated financial industry which provides increasingly inexpensive vehicles to facilitate global diversification.[2]

More recent studies, however, notably VV(2009) offer insights about home bias that are more in line with the thrust of our model, using an alternative approach. They too argue that home bias reflects endogenously determined private information differentials across investors. In their analysis, however, investors have different initial priors about asset returns, and the information production function they rely on exhibits increasing returns to scale. Thus, home investors completely specialize in acquiring private information about either domestic or foreign assets. Also, while VV back their analysis by stylized facts, they do not offer systematic empirical tests to explain the pattern of observed diversities in home bias at the individual or market levels. Our model allows for interior solutions in asset management and private information precision and offers testable propositions concerning variations in "home bias" as a function of identifiable determinants of private information acquisition and the demand for risky assets.

Following the noisy-prices, rational expectations literature, we develop a two-period model with multiple risky assets traded in an integrated world financial exchange. While sharing identical prior beliefs about the distribution of the returns on all stocks, our investors differ by their endowments of general and specific human capital. We view *specific* human capital as encompassing knowledge of country specific characteristics such as language, cultural heritage, and the country's political, economic, and legal systems, which generate a comparative advantage to domestic investors in accessing private information about their home-country assets than about other countries' assets. Prior empirical studies confirm the role of such factors in portfolio decisions (e.g. La Porta *et al*., 1998; Grinblatt and Keloharju, 2001; Massa and Simonov, 2006).

2 For example, the Morgan Stanley Capital International index for the All Country World Index (MSCI/ACWI)) render opportunities to hold a value weighted global index fund capturing about 85% of the world market at 0.35% of net asset value per year.

The novelty of our analysis, however, comes from our focus on variations in endowments of *general* human capital, which are captured by individual and average schooling attainments, on the assumption that formal schooling, producing basic knowledge and cognitive skills, is common to all countries. General human capital augments the productivity of specific human capital in generating information about both domestic and foreign risky assets. This allows us to develop testable propositions concerning variations in the optimal portfolio concentrations by individual investors in the same country, and by representative investors in different countries.

Our key propositions relate to the determinants of the absolute levels of demand for domestic and foreign assets, as well as their portfolio shares at both the individual and market levels. At the individual level, we show that general human capital increases the optimal demand, thus absolute holding, of both domestic and foreign assets. Whether the *ratio* of domestic relative to foreign assets in the individual portfolio also rises with the investor's general human capital depends on market-level variables, including the gap between the price-information-content (PIC) of domestic vs. foreign assets, PIC_d - PIC_f . All other determinants of optimal asset management held constant, if PIC_d greatly exceeds PIC_f, for example, we expect individual portfolio concentrations in home assets to be a decreasing function of individual schooling attainments. In other cases, however, home bias could be monotonically increasing in schooling attainments.

At the market level, by contrast, the average information precision and PIC for domestic and foreign assets are endogenously determined. It is natural to assume that the representative domestic investor in all countries has a higher level of specific human capital concerning home assets, relative to foreign assets. All other determinants of asset management held constant, our model implies that the equilibrium portfolio concentration in domestic assets, or "home bias" must be an inverted-U-shaped function of the average schooling attainments of domestic investors in all countries. The rationale is that an upward shift in a country's average general human capital is likely to induce greater asset management and private information precision about the home asset when the public information signal in the home country, PIC_d, is lower than that in foreign countries. As average human capital and PIC_d increases, however, the return on further managing domestic relative to foreign assets gets diluted. Beyond a critical level of average schooling and *PIC*, optimal asset management shifts toward foreign assets and "home bias" begins to fall systematically as average schooling continues to rise. Indeed, as *PIC* approaches an infinite value, prices become fully revealing and "home bias" disappears altogether.

Our model thus produces discriminating implications about the determinants of variations of portfolio concentrations across both individual investors in given countries and representative investors across countries. It also provides a uniform framework to explain corresponding diversities in risk premiums, volatility contagion, and returns to human capital in managing assets across international markets. We allude to these implications in the concluding section.

The paper is organized as follows: Section 2 introduces our analytical framework. Section 3 develops our basic optimization and equilibrium analysis. Sections 4 and 5 offer testable propositions at the micro- and macro- levels, respectively, and sections 6 and 7 present empirical evidence consistent with these propositions. Section 8 discusses alternative hypotheses and assesses the information costs bearing on Home bias. We end with concluding remarks.

2. The Model

Our model generalizes Verrecchia (1982) and EHY (2008) to a multiple-asset, heterogeneous investors framework. Individual investors operate in *m* countries with competitive exchange economies and corresponding financial markets. Each country has one distinct risky asset or country mutual fund and includes a large number of investors who can trade in all countries' assets. We assume that markets are fully integrated with no capital controls, so asset prices are equalized across all markets. Country k has N_k investors so $N \equiv \sum_{k=1}^{m} N_k$ denotes the total number of world investors. Investors' heterogeneity stems from variations in human capital endowments, wage earnings, initial wealth, and countries of residence.

Investors live over two periods. In the first period they search for information signals and allocate their portfolios among competing domestic and foreign assets, and in the second they realize portfolio returns, which are used to finance consumption. Portfolio decisions are thus influenced by two major information channels: One is public, conveyed by assets' market prices as signals. The other is a private channel empowered by individually acquired information signals.

The initial financial wealth of investor i in each country is comprised of risk-free bonds, B_{i0} traded at a normalized price of unity, and a vector of risky assets, $\tilde{x}^i$ traded at world prices. The per capita supply of the risky asset k is given by $\tilde{x}_k$. The country's mutual fund k is traded at equilibrium price $\tilde{P}_k$ in the first period and pays off a gross return of $\tilde{\mu}_k$ in the second period. The vector of market clearing prices of all risky assets is thus given by $\tilde{P} \equiv (\tilde{P}_1, \tilde{P}_2, ..., \tilde{P}_m)'$. Similarly, $\tilde{\mu} = (\tilde{\mu}_1, \tilde{\mu}_2, ..., \tilde{\mu}_m)'$ and $\tilde{x} = \frac{1}{N}\sum_{i=1}^{N} \tilde{x}^i$ = $(\tilde{x}_1, \tilde{x}_2, ..., \tilde{x}_m)'$ denote the vectors of assets' return and *per capita* supplies of each of the m risky assets, respectively.

Although the realizations of return and supply are unobservable until the second period, their *prior* joint distribution is commonly known to all investors. The vector of returns $\tilde{\mu}$ follows a normal distribution with mean $\bar{\mu}$ and variance Σ_μ. The supply of risky assets $\tilde{x}$ is normally distributed with mean $\bar{x}$ and variance Σ_x. For simplicity, we assume that $\tilde{\mu}$ and $\tilde{x}$ are uncorrelated and Σ_x is a diagonal matrix.[3] The assumed existence of random exogenous supply shocks is critical in the analysis, because such shocks cannot be forecasted through search for information signals. Thus, the market prices of risky assets become "noisy" – they cannot fully reveal the private information held by each investor, which in turn generates incentives for investors to collect costly private information.

The objective of information collection, or asset management, is to generate a forecast of returns based on the observed asset prices and moments of the unconditional distributions of future returns known to all investors, plus private information signals that lower forecast errors. The ($m \times 1$) vector of private forecasts acquired by investor i, $\tilde{z}_i$, is unbiased but imperfectly correlated with the true return $\tilde{\mu}$ as follows: $\tilde{z}_i = \tilde{\mu} + \tilde{\varepsilon}_i$, where $\tilde{\varepsilon}_i$ follows a normal distribution $N\left(0, S_i^{-1}\right)$ and is uncorrelated with both $\tilde{\mu}$ and $\tilde{x}$. S_i is our measure of private information precision. For analytical simplicity, we assume that S_i is a diagonal matrix and $\tilde{\varepsilon}_i$ is independent of $\tilde{\varepsilon}_j$ for all $i \neq j$, i.e., that elements of the vector of forecast errors $\tilde{\varepsilon}$ are uncorrelated across both investors and assets. Investors do not have any control over the actual realization of the private forecast, $\tilde{z}_i$. They can increase the magnitude of each diagonal entry in the precision matrix S_i, however, by engaging in costly asset management activities.

Investor i's human wealth consists of an $(m+1)\times 1$ vector of human capital endowments containing both "general" and "country specific" elements, denoted by $H_i = \left[H_{i,0}, H_{i,1}, \ldots, H_{i,m}\right]$, and T hours of productive time. $H_{i,0}$ denotes an endowment of general human capital of investor i and its cumulative density function is defined over the compact set $F : [\underline{H}, \overline{H}] \rightarrow [0,1]$.[4] General human capital, which we proxy empirically as education, or formal schooling, stands for predetermined extra-territorial knowledge which augments the efficiency of all productive activities in all countries; it increases the investor's labor market skills, hence the market wage rate, as well as the efficacy of acquiring private information about all risky assets - both domestic and foreign. By contrast, individual specific human capital endowments associated with country *k*'s home asset, $H_{i,k}$, $k \neq 0$, represent the predetermined knowledge that improves the efficiency of acquiring private information just about that country's asset. At the international

3 Our model's basic solution and inferences do not rely on the independence of $\tilde{\mu}$ and $\tilde{x}$ or the diagonality of Σ_x. The former can be replaced with the the milder assumption that $\tilde{\mu}$ and $\tilde{x}$ are imperfectly correlated (see Admati, 1985). We assume that Σ_x is a diagonal matrix to simplify the exposition of the analytical proofs of some of our market level propositions.

4 The compactness of the set is one of the necessary conditions for proving the existence of rational-expectation equilibrium.

level the endowed specific human capital corresponds to the knowledge of specific country attributes such as cultural heritage, language, politics, economy, legal system and institutions.[5]

Several aspects of our concept of "specific human capital" should be flashed out. First, it does not need to be comparable *across* countries. This is partly because we do not have a good proxy measure for the importance of command over language, communication ability, or cultural awareness in different countries. It is more like a country-based social capital. Indeed, whether $H_{i,k}$ is equal to or different from $H_{j,l}$ (where *j* refers to residents of country *l*) has no bearing on any of our behavioral propositions. We do assume, however, as is plausible, that the average investor in each country is significantly more knowledgeable about her home asset (*k*) than about foreign assets (l), i.e. $H_{i,k} > H_{i,l}$ ($k \neq l$). Second, by our interpretation of specific human capital, its endowment measure $H_{i,k}$ can be thought of as largely uniformly distributed across all investors within a country, although its effectiveness is influenced the individual level of general human capital endowments, as defined by equation (1a) below.

Individuals can allocate their endowed productive time *T* between two sectors: the labor market and the household sector, where they search and acquire private information signals (leisure is subsumed under final-period consumption). Specifically, productive time is allocated between the management of each asset k , $q_{i,k}$, and labor hours, $T - q_i$ where $q_i \equiv \sum_{k=1}^{m} q_{i,k}$ denotes the total asset management time of investor i . The production function of information precision by investor *i* for home-asset *k* is assumed to be of a Cobb-Douglas type:

$$S_{i,k} = A q_{i,k}^{\theta_1} H_{i,0}^{\theta_2} H_{i,k}^{\theta_3} \tag{1a}$$

where A stands for technological factors facilitating private information acquisition, $0 < \theta_1 \leq 1$, $\theta_2 > 0$ and $\theta_3 > 0$. The actual asset management time employed is

$$q_{i,k} \equiv q(S_{i,k}) = \left[S_{i,k} / \left(A H_{i,0}^{\theta_2} H_{i,k}^{\theta_3} \right) \right]^{1/\theta_1} \tag{1b}$$

Hence, the total cost of asset management function, $C(S_i; H_i)$, is given by

$$C_i \equiv C(S_i; H_i) = \sum_{k=1}^{m} \left(w_i (H_{i,0}, \lambda_i) q(S_{i.k}) + C_{k,0} \right) \tag{1c}$$

5 La Porta *et al.* (1998) and Grinblatt and Keloharju (2001) have emphasized the importance of these factors in portfolio decisions.

where $C_{k,0}$ is a fixed cost associated with the management of risky asset k, and $w_i(H_{i,0}, \lambda_i)$ is investor i's wage rate which is a function of both general human capital and job-related factors.[6] We assume that w_i is uncorrelated with asset returns, partly because there is no consensus in the literature regarding the direction of this correlation, but mainly in order to focus on the contribution of human capital to information production. (We return to this issue in section 7.) Information costs are a convex function of private information S_i, as $0 < \theta_1 \le 1$.

The market value of investor i's initial wealth is $W_{i0} = B_{i0} + P'\tilde{x}^i + Tw_i(H_{i,0}, \lambda_i)$. The decision rule in our model is maximization of the expected utility of second-period (final) wealth, or consumption, $W_{i1} = \tilde{\mu}' D_i + B_{i1}$, where D_i and B_{i1} denote, respectively, the demand for risky assets and the risk-free bond by investor i. The utility function is assumed to be exponential, with a common risk-tolerance coefficient, r. The investor's objective is thus

$$\max_{\{S_i, D_i, B_{i1}\}} E\left[-\exp\left(-W_{i1}/r\right)\right] \tag{2}$$

subject to the initial periods budget constraint

$$\tilde{P}' D_i + B_{i1} + C_i = W_{i0} \tag{2a}$$

The assumed exponential utility function, or constant absolute risk aversion, is standard in the literature because of its computational advantage: it allows for closed form solutions, as wealth is normally distributed. As is well-known, however, this function does not allow for any pure wealth effects. Thus, if we assume a common risk tolerance, *r*, to focus on variation in opportunities, not preferences, portfolio decisions would be attributable solely to diversity in private information, hence to varying general and specific human capital endowments.[7]

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6 λ_i accounts for job-specific factors affecting individual wages, such as job training or work experience. $C_{k,0}$ incorporates fixed costs of analysts or trading costs which are common to all investors, but can also be influenced by one's portfolio size owing to economies of scale in information production and asset trading.

7 A simple extension of our model can allow for diversity in both risk tolerance and specific human capital.

3. Optimization and Equilibrium Analysis

3.1 Optimal Demand for Risky Assets

The investor's maximization problem (2) can be decomposed heuristically into two stages by the law of iterated expectation, although both parts are solved simultaneously. In the second stage the investor solves for an optimal demand for the *m* risky assets in the portfolio, subject to both the implicit public information signal within the market price and the private information signal produced by optimal asset management. In the first part the optimal demand for assets the investor relies on her optimal demand rule to solve for optimal private information collection or "asset management". The general maximization problem can be stated as follows:

$$\begin{aligned}&\max_{\{S_i\}} E_{\tilde{z}_i,\tilde{P}}\left[\max_{\{D_i,B_{i1}\}} E_{\tilde{\mu}^i}\left[-\exp\left(-W_{i1}/r\right)\middle|z_i,P\right]\right]\\ &=\max_{\{S_i\}} E_{\tilde{z}_i,\tilde{P}}\left[\max_{\{D_i,\}} E_{\tilde{\mu}^i}\left[-\exp\left(-\left\{(\mu^i-P)'D_i+W_{i0}-C\left(S_i;H_i\right)\right\}/r\right)\middle|z_i,P\right]\right]\end{aligned} \tag{3}$$

where $\mu^i = E\left[\tilde{\mu}\middle|z_i,P\right]$ and $E_{\tilde{X}}$ denotes an expectation operator defined over the distribution of a random variable $\tilde{X}$ and z_i and P denote the realizations of $\tilde{z}_i$ and $\tilde{P}$, respectively. Equation (3) is restated alternatively to be maximized over just S_i and D_i using equation (2a).

In solving the second stage maximization problem in (3) – determining the optimal demand for *m* risky assets conditional on optimal asset management – we invoke (and prove) the existence of a rational expectations-asset market equilibrium as stated in previous literature (e.g., Admati, 1985; Verrecchia and Kim, 1991; and EHY, 2008). Investors are assumed to follow a linear conjecture concerning the properties of the equilibrium price,

$$\tilde{P} = \phi_0 + \phi_1\tilde{\mu} - \phi_2\tilde{x} \tag{3a}$$

By the linear conjecture, the joint distribution of $(\tilde{\mu},\tilde{z}_i,\tilde{P})$ is normal. In this case, investors' conditional demand for risky assets is thus given by

$$\tilde{D}_i \equiv D\left(z_i,P\right) = rV_i^{-1}\left(E\left[\tilde{\mu}\middle|z_i,P\right]-P\right), \quad \text{where} \tag{4a}$$

$$V_i \equiv Var\left(\tilde{\mu}\middle|z_i,P\right) = \left(\Sigma_\mu^{-1}+S_i+r^2S\Sigma_x^{-1}S\right)^{-1} \tag{4b}$$

$$E[\tilde{\mu}|z_i, P] = \eta_{0i} + \eta_{1i} z_i + \eta_{2i} P \text{ and} \tag{4c}$$

$$S \equiv \frac{1}{N}\sum_{i=1}^{N} S_i = \int_{\underline{H}}^{\overline{H}} S(H)\mathrm{d}F(H) \tag{4d}$$

Equation (4b) implies that the gap between the prior variance of the returns on risky assets, $\sum_{\mu}^{-1}$, and the lower posterior variance, V_i , as perceived by the informed investor is affected by both the private information signal, S_i, and the implicit public signal, $r^2 S \sum_x^{-1} S$, reflecting the mean private information level about the asset. We term the latter "price information content", or PIC.[8]

Using the market clearing condition, $\frac{1}{N}\sum_{i=1}^{N}\tilde{D}_i = \tilde{x}$, we can show that in equilibrium, the coefficient matrices ϕ's and η's in equations (3a) and (4c) represent a consistent solution (see Appendix A.1 for the exact expressions of ϕ's and η's). This indicates that the equilibrium outcome is indeed a rational-expectation-equilibrium.[9]

From (4a) and (4b), investor i's expected excess demand (over per-capita supply) for risky asset k is

$$\overline{D}_{i,k} \equiv E[\tilde{D}_{i,k}] = r\left(S_{i,k} - S_{A,k}\right)E[\tilde{\mu}_k - \tilde{P}_k] + \bar{x}_k \qquad \text{for all } i, k \tag{5a}$$

where

$$E\left[\tilde{\mu} - \tilde{P}\right] = \tfrac{1}{r}\left(\Sigma_{\mu}^{-1} + S + r^2 S\Sigma_x^{-1} S\right)^{-1}\bar{x} \tag{5b}$$

and $S_{A,k}$ denotes the k^{th} diagonal entry of average precision of private information concerning asset *k*, and $S_A \equiv S = \frac{1}{N}\sum_{i=1}^{N} S_i$. Investor i's expected demand for asset *k* in equation (5a) has a few immediate implications. First, the expected demand for each risky asset consists of two components: one that is driven by private information, $\overline{D}_{i,k} - \bar{x}_k = r\left(S_{i,k} - S_{A,k}\right)E[\tilde{\mu}_k - \tilde{P}_k]$ and another that includes elements

8 Put differently, PIC, which Verrecchia (1982) calls "price informativeness", accounts for the difference between the variance of the risky returns that is conditional on both private and implicit public signals, $Var(\tilde{\mu}|z_i, P) = \left(\Sigma_{\mu}^{-1} + S_i + r^2 S\Sigma_x^{-1} S\right)^{-1}$, rather than just a private signal $Var(\tilde{\mu}|z_i) = \left(\Sigma_{\mu}^{-1} + S_i\right)^{-1}$.

9 For proof see, for instance, Admati (1985). The solutions we derive also indicate why investors must generally recognize that the observed prices are subject to supply noises, i.e., $\phi_2 \neq 0$ in equation (3a). If $\phi_2 = \mathbf{0}$, then $\mu = \phi_1^{-1}(P - \phi_0)$ by (3a). Since rational investors know ϕ_0 and ϕ_1, the observed prices would become fully revealing of available private information, eliminating the incentive to engage in costly asset management.

common to all investors, $E[\tilde{\mu}_k - \tilde{P}_k]$ and $\bar{x}_k$. Note that if $S_{i,k}$ = $S_{A,k}$, the expected individual demand would just equal the asset's expected supply, and thus be identical across all investors in all markets, as predicted by CAPM. Second, the component of demand driven by private information is proportional to $S_{i,k} - S_{A,k}$ or the information advantage of investor *i* relative to the world's average investor. Third, the deviation between the average supply of asset *k* per investor and the expected demand for *k* by investor *i*, $\overline{D}_{i,k} - \bar{x}_k$, is proportional to the expected excess return on *k*, $E[\tilde{\mu}_k - \tilde{P}_k]$.

3.2 Optimal Demand for Private Information and Asset Management

Having solved for optimal demand conditional on available information precision, we can now shift attention to the first stage of the maximization problem (3) - the determination of the optimal asset management. In the following analysis we focus on the demand for the optimal information precision for asset *k*, $S_{i,k}$, rather than its optimal "management", i.e., the allocation of time to search for and apply information signals, $q_{i,k}$, essentially for expositional convenience. The derived-demand for asset management time can then be inferred from the solution for $S_{i,k}$, using the production function (1). The closed-form solution for optimal information precision for asset k, $S_{i,k}$, is given by

$$S_{i,k} = \max\left\{0, S_{i,k} \left| \frac{r}{2} V_{i,kk} - \frac{\partial C_i}{\partial S_{i,k}} = 0 \right.\right\} \quad for \;\; k = 1, 2, ..., m \tag{6a}$$

where $S_{i,k}$ and $V_{i,kk}$ are k^{th} diagonal entries in the S_i and V_i matrices (see Appendix A.2).[10]

Equation (6a) is a generalization of the optimal demand for private information in Verrecchia (1982) and EHY (2008), where *k* = 1. An interior optimum requires the marginal revenue of asset management with respect to risky asset k , $MR_{i,k}$, to be equated to its marginal cost , $MC_{i,k}$. Substituting (1a) ~ (1c) into (6a) yields

$$\begin{aligned} MR_{i,k} &= \frac{r}{2} V_{i,kk} = w_i \frac{\partial q_{i,k}}{\partial S_{i,k}} \\ &= \frac{1}{\theta_1} w_i S_{i,k}^{\frac{1-\theta_1}{\theta_1}} \left(A H_{i,0}^{\theta_2} H_{i,k}^{\theta_3} \right)^{-1/\theta_1} = MC_{i,k} \quad for \;\; k = 1, 2, ..., m \end{aligned} \tag{6b}$$

[10] Equation (6a) is a natural extension of EHY (2008) and Verrecchia (1982). Note that each investor's optimal precision S_i is a function of $V_{i,kk}$, which in turn (see equation 4b) is a function of the average precision *S*. Since the latter represents the aggregation of individual asset management, equilibrium requires their mutual consistency. We can also prove the existence of information equilibrium in this framework.

Equation (6b) indicates that $MR_{i,k}$ is proportional to investor i's posterior variance of the risky asset k's return, $V_{i,kk}$. In other words, the marginal gain of managing a specific asset is highest when the investor is most uncertain about the return. Also, $MR_{i,k}$ is decreasing in $S_{i,k}$, as more precise information reduces the posterior variance of the assets' returns $V_{i,kk}$, while $MC_{i,k}$ is non-decreasing in $S_{i,k}$, since $0 < \theta_1 \leq 1$. Thus, the second order optimality condition for $S_{i,k}$ is satisfied. Equation (6b) also indicates that since the specific human capital level possessed by an investor concerning the home asset (*d*) always exceeds that concerning a foreign asset (*f*), or $H_{i,d} > H_{i,f}$, the marginal cost curve of home information production is always lower than that of the foreign information production.

In the following sections, we derive the model's behavioral implications at the micro and macro levels. To simplify matters, we focus on a world with just two countries and two related assets: a home (*d*) and a foreign asset (*f*), which can be perceived of as a value weighted fund consisting of all $m-1$ foreign risky assets.

4. Behavioral Propositions at the Micro Level

We begin by developing the behavioral implications of the model at the micro level. By assuming a large competitive economy, individual investors' choices do not affect aggregate level variables such as the equilibrium price $\tilde{P}$ and the average information precision, S. We focus on the impact of exogenous shifts in the model's human capital and related endowments.

4.1 General Human Capital, Private Information and the Demand for Risky Asset

An increase in general human capital, proxied by education $H_{i,0}$, imposes opposing effects on the optimal demand for private information and the corresponding portfolio choices. While it raises the efficiency of private information acquisition for both risky assets, thus shifting the marginal cost curves downward (see equation (6b)), it also raises the opportunity cost of asset management, w_i, thus raising the marginal cost curves in the opposite direction. Formally, the net effect of an unconditional increase in $H_{i,0}$ will increase optimal private information and the demand for all risky assets if the elasticity of q_i with respect to $H_{i,0}$ in equation (1b) $\varepsilon_{q_i H_{i,0}} \equiv \frac{H_{i,0}}{q_{i,k}} \frac{\partial q_{i,k}}{\partial H_{i,0}}\Big|_{\mathrm{d}S_i = 0} = \theta_2 / \theta_1$ exceeds the elasticity of the wage with respect to general human capital in equation (1c), $\varepsilon_{w_i, H_{i,0}} \equiv \frac{\partial w_i}{\partial H_{i,0}} \frac{H_{i,0}}{w_i}$. From equation (1a), this would be the case when the production of private information precision is enhanced much more by general human capital $H_{i,0}$ than by asset management time, $q_{i,k}$, or $\theta_1 << \theta_2$. A conditional increase in general human capital at a given wage level, by comparison, will raise unambiguously the optimal private information and demand for all assets.

Proposition 1: An unconditional increase in general human capital, $H_{i,0}$, raises the investor's optimal private information precision and absolute demand for risky assets provided that $(\varepsilon_{q_i H_{i,0}} - \varepsilon_{w_i, H_{i,0}}) > 0$. A conditional increase in $H_{i,0}$, given the opportunity cost of time, w_i, unambiguously raises the corresponding information precision and assets' demand. Formally,

$$\left.\frac{\partial S_{i,k}}{\partial H_{i,0}}\right|_{\mathrm{d}w_i=0} > 0 \text{ and } \left.\frac{\partial \overline{D}_{i,k}}{\partial H_{i,0}}\right|_{\mathrm{d}w_i=0} > 0 \quad , \quad \text{and} \tag{7a}$$

$$\left.\frac{\partial S_{i,k}}{\partial H_{i,0}}\right|_{\mathrm{d}w_i=0} > \frac{\partial S_{i,k}}{\partial H_{i,0}} \text{ and } \left.\frac{\partial \overline{D}_{i,k}}{\partial H_{i,0}}\right|_{\mathrm{d}w_i=0} > \frac{\partial \overline{D}_{i,k}}{\partial H_{i,0}} \quad \text{for k = } d, f. \tag{7b}$$

Equations (7a) and (7b) imply that the conditional elasticities of demand for both domestic and risky asset with respect to investors' schooling, given their market wage rates, should be larger in absolute magnitudes than the respective unconditional elasticities. This is because an unconditional increase in $H_{i,0}$ also increases the opportunity costs of asset management, which at least partially offsets the education effect.

4.2 General Human Capital Effects on Portfolio Concentration

Although more education increases the demand for all risky assets, it is not clear whether it also increases individual demand for domestic relative to foreign stocks, $\overline{D}_{i,d} / \overline{D}_{i,f}$.[11] A general insight into this question can be derived by partially differentiating equation (5a) with respect to $H_{i,0}$ as follows:

$$\frac{\partial\left(\overline{D}_{i,d} / \overline{D}_{i,f}\right)}{\partial H_{i,0}} = \left[\frac{\partial S_{i,d}}{\partial H_{i,0}} E\left[\tilde{\mu}_d - \tilde{P}_d\right] - \frac{\partial S_{i,f}}{\partial H_{i,0}} E\left[\tilde{\mu}_f - \tilde{P}_f\right] \frac{\overline{D}_{i,d}}{\overline{D}_{i,f}}\right] \frac{1}{\left(\overline{D}_{i,f}\right)} \tag{8}$$

where subscripts *d* and *f*, denote investor *i*'s domestic and foreign assets.

[11] $\overline{D}_{i,d} / \overline{D}_{i,f}$ is a suitable measure of the cross-sectional variation in the portfolio concentration at the individual level within countries, as equilibrium prices and total market capitalization are constant across individuals, and the measure is also monotonically related to $\overline{D}_{i,d} / (\overline{D}_{i,d} + \overline{D}_{i,f})$.

By equation (8), three major factors determine the way the optimal portfolio concentration in domestic assets varies with general human capital. The first is the impact of education on domestic investors' relative advantage in producing forecasts about their home asset, i.e., the magnitude of ($\partial S_{i,d} / \partial H_{i,0}$) relative to ($\partial S_{i,f} / \partial H_{i,0}$), which is ambiguous at the individual level.[12] The second is the magnitude of expected excess returns on the home, relative the foreign asset, ($E[\tilde{\mu}_d - \tilde{P}_d]$ vs. $E[\tilde{\mu}_f - \tilde{P}_f]$), which is affected by the determinants of $E[\tilde{\mu} - \tilde{P}] = \frac{1}{r}(\Sigma_\mu^{-1} + S + r^2 S^2 \Sigma_x^{-1})^{-1} \bar{x}$. The third is the investor's initial expected demand for domestic, relative to foreign assets, $\overline{D}_{i,d} / \overline{D}_{i,f}$, which typically exceeds 1.

Proposition 2: The Impact of higher individual general human capital ($H_{i,0}$) on *relative* information precision and the relative demand for home vs. foreign assets ("individual home bias") is generally ambiguous. Even if individuals' relative home advantage in producing private information were always rising with $H_{i,0}$, and thus induced a higher concentration in home assets, market-level factors could offset (reinforce) this outcome. If the expected excess return on the domestic asset were sufficiently lower (higher) than that on the foreign asset, $E[\tilde{\mu}_d - \tilde{P}_d]$ << (>>) $E[\tilde{\mu}_f - \tilde{P}_f]$, "home bias" could decrease (increase) with $H_{i,0}$.

As indicated by equation (5b), the expected excess return on any specific risky asset *k*, $E[\tilde{\mu}_k - \tilde{P}_k]$, is higher the higher is the asset's prior "riskiness", as measured by the variances of the asset's return and supply, $(\Sigma_\mu)_{kk}$ and $(\Sigma_x)_{kk}$ respectively, but the lower is the asset's price information content PIC$_k$ = $\Delta_{kk} \equiv r^2 S_{A,k}^2 (\Sigma_x^{-1})_{kk}$, where Δ_{kk} denotes k^{th} diagonal entry of the matrix $\Delta \equiv r^2 S \Sigma_x^{-1} S$. This is because a higher *PIC* for a home asset (*PIC$_d$*), reflecting a higher level of average information precision about the home asset, $S_{A,d}$, lowers the perceived risk of the home asset. This, in turn, increases its price and lowers its excess return and thus the individuals' demand for the home asset. Furthermore, a higher *PIC$_d$* also lowers the schedule of marginal benefits from "managing" the home asset, $MR_{i,k}$ = (r/2) $V_{i,dd}$ in equation (6b), which exerts a negative feedback on the investor's demand for the home asset. Equation (8) indicates that for a country like the US, where stock market volatility and supply shocks are relatively low and *PIC$_d$* is relatively high owing to high schooling attainments, "individual home bias" might be a

[12] Although by equation (1a), a higher $H_{i,0}$ lowers both the level and slope of the marginal cost schedule of "managing" asset *d* relative to asset *f*, the impact on optimal information precision is ambiguous, since it depends on the difference in the levels and slopes of the respective marginal revenue schedules in equation (6b), except at sufficiently high levels of $H_{i,0}$, where we can prove that $\partial(S_{i,d} - S_{i,f}) / \partial H_{i,0} > 0$. See Appendix A.3.

monotonically decreasing function of individual schooling attainments. In other countries, however, "individual home bias" may be monotonically increasing in schooling attainments.[13]

4.3 The Impact of Shifts in the Opportunity Costs and Technology of Asset Management

Proposition 3: (*wage and technology effects*) For the same reasons driving propositions 1 and 2, a conditional increase in individual opportunity costs of asset management, w_i , will generate opposite effects on the absolute demand for domestic and foreign assets and their relative portfolio concentration, or "individual home bias", relative to the impact of a higher endowment of general human capital as summarized by propositions 1 and 2. A better technology of information collection (A in equation 1a), in contrast, will have the same qualitative effects as those of a higher level of general human capital, as summarized by propositions 1 and 2.

Proposition 4: (*Specific human capital effects*). An upward shift in country-specific human capital, $H_{i,k}$, increases optimal asset management and expected demand for asset k, as well as asset *k*'s relative portfolio concentration (see Appendix A.4). Clearly, a higher specific human capital $H_{i,k}$ improves the efficiency of asset management concerning the home asset, and thereby also optimal $S_{i,k}$, $\overline{D}_{i,k}$ and $\overline{D}_{i,k} / \overline{D}_{i,l}$. Recent studies offer supportive evidence for this proposition. See, e.g., Huberman (2001) and Massa and Simonov (2006).

5. Behavioral Propositions at the Macro Level

Unlike our analysis at the micro level, where both asset prices (P_k) and the degree to which they convey information (PIC_k) were taken to be given to investors, at the macro or country level, both of these variables must be treated as endogenous variables. To simplify the analysis, we assume that each country has a continuum of identical representative investors whose characteristics may differ across countries. We also derive our main insights for a two-country case: domestic (*d*) and foreign (*f*). As in the micro section, we invoke the assumption that the representative investor's specific human capital corresponding to home assets, is strictly larger than that which corresponds to foreign assets, or $H_{d,d} > H_{d,f}$ and $H_{f,d} < H_{f,f}$.

Since we retain the competitive nature of markets, our representative investors take the market equilibrium outcomes like price and price information content (PIC) as given. We do account, however, for the fact that changes in the model's underlying parameters will change the market equilibrium outcomes

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[13] Note that $PIC_k \equiv \Delta_{kk}$ is a quadratic function of average information precision, $S_{A,k}$. Even a small rise in the average schooling level in country d, raising $S_{A,d}$, can thus produce a much larger increase in PIC_d.

as well. Specifically, we focus on the impact of the main determinants of the demand for risky assets on the absolute and relative demands for domestic and foreign assets on the one hand, and the assets' market prices and PIC levels, on the other. Although the propositions below are expressed in terms of the impact of conditional increments in the average endowment of general human capital in reference countries, the qualitative impacts would work in the same direction for increments in technological variables which lower the costs of asset management, but in opposite directions as a result of conditional increments in investors' average opportunity costs of time, $w(H_{0,k}, \lambda_k)$, in conformity with proposition 3.

5.1 Variations in Average Precision, Excess Returns and Price Information Content

Proposition 5: (*General human capital, information advantage, and PIC)*. A conditional increase in country *d's* representative investor's general human capital, $H_{d,0}$, with no change in that of country *f*, $H_{f,0}$, subject to the conditions spelled out in proposition 1, increases the information advantage of country *d*'s investors concerning their home asset, relative to the average world investor $S_{d,k} - S_{A,k}$, as well as the price information content of the domestic asset (PIC_d), and generally the foreign, asset (PIC_f) as well.[14]

A formal proof is offered in Appendix A.6. We here trace its logic. Initially, by Proposition 1, a conditional upward shift in $H_{d,0}$ increases the private information precision of all investors in country d, and hence their average information precision concerning both home and foreign assets, $S_{d,k}$, *k = d, f*. The average (world) private information precision and price information content of asset *d*, and generally also of asset *f* , $S_{A,k}$, also rise with $H_{d,0}$ (see fn. 14). At the same time, the average information advantage of domestic investors over the average world investor, $S_{d,k} - S_{A,k}$ for *k = d, f*, also expands because the feedback effect of a higher PIC_f in the foreign country where general schooling remains constant, causes asset management activity and the information precision of asset *f* to fall. The two upper panels in Figure 1 present numerical simulations showing that $S_{d,k} - S_{A,k}$ and PIC_k, *k =d , f,* are indeed increasing functions of $H_{d,0}$ when $H_{f,0}$ (and all other parameters) remain constant.

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[14] By proposition 1, a conditional increase in $H_{d,0}$ always increases PIC_d and the domestic investor's information advantage about both domestic and foreign securities, but it may not always increase PIC_f . Specifically if $H_{d,f}$ is nil or close to nil and $H_{d,0}$ is relatively low, an increase in $H_{d,0}$ and PIC_d would induce a lower $S_{A,f}$, since we can show that $\partial S_{i,f} / \partial \Delta_{dd} \leq 0$ for all *i* (see appendix A.5). A continued decline in PIC_f when $H_{d,0}$ rises, however, increases the marginal benefit of managing the foreign asset for all investors, $V_{i,ff}$, so $S_{A,f}$ and PIC_f must eventually increase with $H_{d,0}$. Our extensive simulations show that both PIC_d and PIC_f are monotonically increasing functions of $H_{d,0}$ for positive values of $H_{d,f}$.

Proposition 6: *(General human capital, expected asset prices and expected excess returns)*. Expected prices on the home (foreign) asset d (f) are non-decreasing, and thus the excess returns on asset d (f) are non-increasing in the general human capital of the representative investor in country *d* (*f*), if the posterior covariance of returns on assets *d* and *f* is non-negative ($V_{df} \geq 0$).

Proof: Partially differentiating equation (5b) with respect to $S_{A,l}$ yields

$$\partial E[\tilde{\mu}_k - \tilde{P}_k]/\partial S_{A,l} = -V_{kl} E[\tilde{\mu}_k - \tilde{P}_k](2r^2 S_{A,l}(\Sigma_x^{-1})_{ll} + 1) < 0 \text{ for } k, l = d, f. \quad (9)$$

By proposition 5, if $H_{d,0}$ rises both $S_{A,d}$ (PIC_d) and $S_{A,f}$ (PIC_f) rise. Since $V_{df} \geq 0$, equation (9) holds.[15] Higher endowments of general human capital raise the information content of asset prices, which lowers their perceived risk and excess returns.

5.2 Variations in Expected Demand for Risky Assets at the Market Level

Proposition 7: (*Direct and cross effects of $H_{d,0}$ on expected demands for assets d and f*). The expected demands for both home (*d*) and foreign (*f*) securities by country *d*'s representative investor are inverted-U-shaped functions of conditional increments in the investor's general human capital, $H_{d,0}$. Because of market-clearing conditions in the asset markets, in contrast, the expected demands for home (*f*) and foreign (*d*) securities by country *f*'s representative investor would be inverse mirror images, or U-shaped functions of the same increments in $H_{d,0}$.

By equation (5a), expected *excess demand* (over the world's per-capita supply) for asset *k = d, f* by country *d*'s representative investor depends on the product of $(S_{d,k} - S_{A,k})E[\tilde{\mu}_k - \tilde{P}_k]$. The impact of a conditional rise in $H_{d,0}$ (schooling) on expected excess demand thus depends on the way it affects these two components. By proposition 5, more schooling always raises the domestic investor's information precision concerning asset *k*, $S_{d,k}$, which militates in favor of a higher expected demand for asset *k.* At the same time, by proposition 6, since the asset price P_k and its information component (PIC_k) also rise,

15 The assumption $V_{df} \geq 0$ in the two-country case is natural since it implies that expected excess returns on the countries' risky assets are positive. This is because $E[\tilde{\mu}_d - \tilde{P}_d]$ = $(V_{dd}\bar{x}_d + V_{df}\bar{x}_f)$ and $E[\tilde{\mu}_f - \tilde{P}_f]$ = $(V_{df}\bar{x}_d + V_{ff}\bar{x}_f)$. We implicitly invoke the assumption that both $V_{df} \geq 0$ and $(\Sigma_\mu)_{df} \geq 0$, since we expect both risky assets to command a positive risk premium under any given relative values of expected supplies, $\bar{x}_d$ and $\bar{x}_f$.

the corresponding expected excess return, $E[\tilde{\mu}_k - \tilde{P}_k]$, declines. This generates an offsetting effect on the expected demand for risky assets, both domestic and foreign. The net effect depends on the domestic investor's information advantage relative to the average world investor (i.e. the sign of $S_{d,k} - S_{A,k}$ for *k* =*d, f*). By equation (5a), the well informed investor ($S_{d,k} - S_{A,k} > 0$) reduces his demand for asset *k* as *PIC$_k$* increases. This is because for that investor, the perceived risk of asset *d*, e.g., is already lower than the average investor's, so the dominant influence of a higher *PIC$_d$* is that it lowers excess returns on asset *d*. For the less informed investor ($S_{d,k} - S_{A,k} < 0$), by contrast, the dominant effect of a higher *PIC$_d$* is that it lowers asset *d*'s riskiness, which reinforces the effect of more schooling on the investor's private information precision. The net effect on this investor would be an increase in expected demand for asset *d*.

Figure 1 demonstrates the general pattern of results. When $H_{d,0}$ is very low compared to $H_{f,0}$ the information advantage $S_{d,k} - S_{A,k}$ is likely to be negative (upper left panel), therefore $\overline{D}_{d,k} < \overline{x}_k$ for both domestic and foreign stocks (lower right panel). As $H_{d,0}$ increases, both the information advantage of the average domestic investor and PIC$_k$ increase. They reinforce each other as long as $S_{d,k} - S_{A,k} < 0$, which accelerates the increase in demand for domestic and foreign assets. As $H_{d,0}$ increases sufficiently and the relative information advantage of country *d*'s investor ("agent *d*"), ($S_{d,k} - S_{A,k}$), rises above zero, the impact of the resulting higher *PIC$_k$* on the expected excess returns erodes the effect of the higher relative information advantage. Therefore, when *PIC$_k$* reaches a sufficiently high level its effect starts dominating the impact of the relative information advantage. In the limit, where *PIC$_k$* approaches an infinite value so that P_k tends to become fully information revealing, asset *k'*s riskiness approaches zero and it's excess return should approach that of the risk-free rate (lower left panel). Investors' expected demand for each asset (*k*=*d, f*) should then approach the asset's average supply, as the CAPM model would predict. This analysis demonstrates why the absolute demands for both the domestic and the foreign asset in the reference country *d* are expected to be inverted-U-shaped functions of the general human capital of the representative investor in that country, $H_{d,0}$.

Since in equilibrium, the world's (i.e., country *d*'s plus *f*'s) demands for assets *d* and *f* must equal the world's supplies of these assets, the demands for foreign (*f*) and domestic (*d*) assets by the representative foreign investor as a function of increments in the average endowment of general human capital in country *d* (i.e., the cross effects of $H_{d,0}$) must be opposite mirror images of the corresponding demands by the representative investor of country *d* (not shown in Figure 1). The same holds for the relative information advantage of the foreign representative investor as a function of the average general human capital in country *d*, $H_{d,0}$.

5.3 General Human Capital and Optimal Portfolio Concentrations at the Country Level

Proposition 8: *(Direct effects and cross effects of $H_{d,0}$ on "home bias" in markets d and f)*. The optimal portfolio concentration in the home, relative to the foreign, asset of country *d*'s representative investor, $\overline{D}_{d,d} / \overline{D}_{d,f}$, is an inverted-U-shaped function of the direct effects of conditional increments in the investor's human capital endowment, $H_{d,0}$. The same holds for the cross-effects of $H_{d,0}$ on the optimal portfolio concentration in the home asset of country *f*'s representative investor, $\overline{D}_{f,f} / \overline{D}_{f,d}$. However, the inflection point of the inverted-U trajectory of $\overline{D}_{d,d} / \overline{D}_{d,f}$ occurs at a lower level of $H_{d,0}$ than that for $\overline{D}_{f,f} / \overline{D}_{f,d}$ (see Figure 2).

When the average level of general human capital in country *d*, $H_{d,0}$, is very low relative to $H_{f,0}$, the average domestic investor's relative information advantage $S_{d,k} - S_{A,k}$ for *k*=*d, f* is negative. (The opposite is the case in country f where $S_{f,k} - S_{A,k} > 0$.) By the analysis in the preceding section, an improvement in information advantage is reinforced by the impact of an increase in *PIC* on expected excess return on asset *k* = *d, f*. Given that the representative investor's specific human capital endowments are always higher for home relative to foreign assets ($H_{d,d} > H_{d,f}$), an increase in the average level of general human capital in country *d*, $H_{d,0}$, induces the average precision of both private information concerning the home asset ($S_{d,d}$) and the corresponding *PIC* (Δ_{dd}) to change faster than those of the foreign counterparts ($S_{d,f}$ and Δ_{ff}). Consequently, the portfolio concentration in country *d*'s home asset, $\overline{D}_{d,d} / \overline{D}_{d,f}$, first increases sharply as $H_{d,0}$ rises from zero (see the solid line in the upper panel of Figure 2). As country *d*'s representative investor's education continues to rise, however, her private information concerning the home asset ultimately approaches that of the average world investor ($S_{d,d} - S_{A,d} > 0$) while still being less informed concerning the foreign asset ($S_{d,f} - S_{A,f} < 0$). When $S_{d,d} - S_{A,d}$ becomes positive, her demand for the home asset starts slowing down while her demand for the foreign risky asset is still enhanced by the increase in PIC_f . The ratio of her expected demand for home vs. foreign stocks thus starts falling before her expected absolute demand for the home asset reaches an inflection point. As PIC_d continues to rise when $H_{d,0}$ increases, the home bias of the domestic market keeps falling and ultimately approaches the level predicted by CAPM. As the solid line in the upper left panel of Fig. 2 demonstrates, $\overline{D}_{d,d} / \overline{D}_{d,f}$ is an inverted-U-shaped function of $H_{d,0}$.

Note that while Proposition 8 defines as a measure of "home bias" the ratio of the expected absolute demands for the home relative to the foreign asset, $\overline{D}_{d,d} / \overline{D}_{d,f}$ the conventional empirical measure of "home bias" has been

$$HomeBias_k = 1 - \frac{1 - ACT_k}{1 - CAPM_k} = \frac{ACT_k - CAPM_k}{1 - CAPM_k} \tag{10}$$

where $ACT_k \equiv P_k D_{k,k} / (P' D_k)$ denotes the percent of domestic stocks in country *k*'s total portfolio of risky assets (*P'D*$_k$) while $CAPM_k \equiv P_k x_k / (P'x)$ is country *k*'s optimal portfolio share of asset *k* by CAPM, i.e., asset *k*'s share of the world's market capitalization. Unlike the ratio of absolute demands, equation (10) captures the deviation of the actual portfolio share of the home asset in country *k* from the CAPM's predicted share, normalized by country *k's* relative market capitalization. Under given average asset supplies $\overline{x}_k$, *k= d,f* , however, these two measures are monotonically related (see the broken v. solid lines in the upper panel of Figure 2).

The Cross effects of average education in country d on country f's home bias, measured as ($\overline{D}_{f,f} / \overline{D}_{f,d}$) or *HomeBias$_f$* in equation (10), are also inverted U-shaped functions of country *d*'s general human capital, $H_{d,0}$. This is because the foreign investor's absolute demand for each asset is a mirror image of the domestic investor's demand for the same asset due to the market clearing condition. Also, the inflection point of the home bias trajectory in country *f* occurs at a higher level of $H_{d,0}$ than that in country *d,* when both are depicted as functions of the same increments in $H_{d,0}$, as illustrated by the upper and lower panels of Figure 2.[16]

6. Micro-Level Evidence

The data set we use to test the micro-level implications of our model consists of six surveys of individual asset holdings for 1992, 1995, 1998, 2001, 2004, and 2007 that are reported in the Federal Reserve Board's *Survey of Consumer Finances* (SCF) based on separate national probability samples. This data source was also used in EHY (2008), but in this study we include only the surveys beginning in 1992,

16 By symmetry, our measure of domestic "home bias" ($\overline{D}_{d,d} / \overline{D}_{d,f}$) or *HomeBias$_d$* in equation (10) is an inverted-U-shaped functions of country *f*'s general human capital, $H_{f,o}$. Note that since the average schooling levels in countries with developed stock markets are typically high, the empirically observed segments of the home bias measures depicted in the upper panel of figures 2 may capture mostly the downward-sloping segments of the inverted-U-shaped curves. In the lower panel of figure 2, in contrast, depicting the "cross effects" of a higher $H_{d,0}$ on country *f*'s corresponding "home bias" measures, the inflection point occurs at a considerably higher level of average schooling. Empirically, then, the observed segments of the home bias measure in the lower panel of Figure 2 may be upward sloping.

which is the first year when SCF started reporting foreign asset holdings. All surveys contain information about household initial portfolio composition by asset categories, household wage income, and personal characteristics of household heads.

We adopt the regression specification in EHY (2008) as our baseline model to test the implications of propositions 1-3 concerning individual demand for domestic and foreign assets:

$$\ln RASST_k = a_0 + a_1 \ln EDU + a_2 \ln TASST + |a_3 \ln WAGE^*| + a_4 AGE + a_5 PROF + a_6 RAV + |a_7 SELF|, \; k = d, f \quad (11)$$

Consistent with our model, the dependent variable in this DEMAND equation is the log value of risky assets holdings, lnRASST, defined as all publicly tradable stocks and corporate bonds, which in turn are separated into domestic and foreign securities. Implicitly, we treat the remainder of the portfolio as a "safe" asset. The explanatory variables account for determinants of productivity at, and opportunity cost of, asset management by household heads. These include, the household head's number of years of schooling EDU (average schooling of husbands and wives yields similar results) and the predicted wage rate of the household's head, lnWAGE*, discussed below. As in the EHY (2008), we also include as a regressor, however, the investor's portfolio size or nonhuman wealth in logarithmic form, lnTASST. Although our theoretical model rules out pure wealth effects, portfolio size may account for economies of scale in asset management, which lower fixed analysts or trading costs per share in domestic and international asset categories, as well as for investors' experience in managing assets as an efficiency variable in information production (A in equation 1a). In this context, we further include an indicator of "managerial and professional-specialty occupations" lumping together managers of all types; specialty occupations varying from speech therapists to nuclear engineers, some of which might be conducive to asset management (PROF); and self-employment vs. salaried status which needs to be examined separately for reasons we explain later in this section. Investors also provide self-assessments of their relative risk aversion intensity (RAV), using 4 categories (1-4) in ascending order of risk aversion. While this may not be a reliable measure of risk tolerance, we introduce it as a robustness check on the validity of our hypotheses, which do not rely on differences in attitudes toward risk to explain risky assets demand and management. And although our model abstracts from life-cycle dynamics, we add the investor's age (AGE) to account for the "vintage" effect of schooling or see if one's life-cycle stage has an independent effect on demand.

The specification of the lnWAGE* regressor warrants a short discussion. Following EHY, we use a projected wage rate based on Mincer's human capital-earnings function, rather than the actually reported wage income for two reasons. Actual wage income is a function of labor hours, or (1-q) in equation 1b, which are an endogenous variable in our model. Also, for self-employed investors, reported wage income is subject to significant distortions since the portion of business income allocated to wages is a choice variable motivated by tax considerations. To overcome both problems we estimate an "expected wage rate" from a reduced form, generalized Mincer regression applied to just salaried workers, and then use the estimated coefficients from that regression to project an *imputed* wage rate for the self-employed. In the "extended Mincer model", we include EDU, EXP, EXP^2, GENDER, RACE, MARRIED, and HEALTH as regressors. The experience variable, EXP, may serve as an instrumental variable in this study since it is designed to measure experience in the labor market, not in asset management.

We run separate regressions for the salaried and the self-employed individuals in both the baseline and alternative models partly to account for the use of an imputed wage variable for the latter group and partly because business assets account for a relatively large proportion of the total portfolio of self-employed, and the latter assets are not included in our definition of securities that are tradable in a centralized exchange.

Since our theoretical analysis assumes that all investors have positive expected demands for the risky asset, in our "baseline model" we have thus restricted the regressions to include individuals with positive net wealth and risky-asset holdings. This restriction has the disadvantage, however, of excluding all the observations including zero holdings of both domestic and foreign securities. This limitation severely limits the sample size of especially salaried workers. Since only about 1/3 of the respondents report holding positive risky assets and only 20.8% of those hold foreign securities (of those 38% are salaried workers), we also run alternative regression specifications as robustness checks (see below). In terms of our theoretical model, zero holdings of tradable securities can be justified as corner solutions owing to fixed information and asset management costs. To allow for the inclusion of zero risky asset holdings, we also specify the dependent variable as log(1+RASST) in equation (11) [Model 2]. As an additional robustness test, we employ the selectivity bias method to account for the separate decision to hold zero securities, although our theoretical model does apply to this decision.

Following proposition 1, equation (11) allows for two basic specifications: one that excludes WAGE in the regression, to allow for estimation of the theoretical "unconditional" effect of EDU on DEMAND, and one that includes WAGE to allow for conditional effects of both education and wage effects. It also allows distinguishing wage and salary workers from all investors by including the dummy variable SELF as a separate regressor. While the exact functional form of equation (11) cannot be pinned down theoretically, following EHY, we enter EDU in log form. Variables defined in continuous dollar values are also introduced in log form, while those defined as discrete variables are entered in natural form. Box-Cox analyses of optimal transformation strongly support this regression format.

6.1 Demand Regressions

We first estimate our baseline model in equation (11) for 3 categories of risky assets: Total Risky Assets (TRA), Foreign Risky Assets (FRA), and Domestic Risky Assets (DRA). Since sample sizes are quite small annually, especially for salaried workers, we focus on a pooled regression model for all 6 annual data sets. In this specification, we restrict only the slope coefficients of lnEDU, lnWAGE* and lnTASST to be identical, allowing for both constant terms and the slope coefficients of all other regressors to vary across samples. The results are summarized in Table 1, where we report only the estimated coefficients of the model's key variables. The full results are reported in Appendix B.

The basic message we get from Table 1 is a solid confirmation of propositions 1-3. In almost all cases, education significantly raises the demand for all asset categories. The only exceptions appear in the regression concerning the demand for foreign risky assets by salaried workers owing to its small sample size and the relatively small variability in the EDU variable in this subsample. The WAGE* variable unambiguously lowers the demand for risky assets, which is a key discriminating implication of our theoretical framework. Moreover, the unconditional effect of education on the demand for the risky assets is lower in absolute value than its conditional effect where WAGE* is held constant, consistent with equation (7b) in proposition 1.

We believe that the relatively weak impact of education on the demand for foreign risky assets stems mainly from the small sample size dictated by the logarithmic transformation we use for the dependent variable, which eliminates all observations with zero foreign assets. Indeed, when we estimate equation (11) using Model 2 in which the alternative, monotonically related dependent variable is log (1+ RASST), the sample size increases significantly, especially in the foreign assets regression, where it expands about 5 folds. The results are listed in Table 1A. In this table, the impact of our 3 basic variables becomes significant at the 1% significance level, confirming all of our testable hypotheses in all regressions.

As a further robustness test, we apply a sample selection model as an alternative approach for incorporating observations with zero risky asset holdings. Specifically, we run the probit model in the selection stage using the same set of regressors as in equation (11) to explain investors' decision to hold positive amounts of domestic and foreign assets and then estimate the baseline regression model conditional of positive holdings of these risky assets. These results are also listed in Table 1B. Due to the small sample size for salaried workers, we only apply the sample selection model to all investors. This application produces our expected education and wage effects for both domestic and foreign risky assets.

6.2 Portfolio Concentration Regressions (Individual Home Bias)

To estimate the implications of proposition 2 concerning optimal portfolio concentrations in home securities, we use two alternative definitions of individual home bias (HB). Adopting our regression specification for the demand for risky assets in equation (11), we run the following regression specification:

$$HB = a_0 + a_1 lnEDU + a_2 lnTASST + |a_3 lnWAGE^*| + a_4 AGE + a_5 PROF + a_6 RAV + |a_7 SELF| \quad (12)$$

As in section 6.1, we run the regression by pooling all 6 data sets together, but allowing intercepts and slope coefficients of AGE, PROF, RAV, and SELF to vary across years.

The basic definition we use to run the portfolio concentration regression is HB^0 = log(1+DRA/TRA) - the logarithm of 1 plus the ratio of domestic risky assets (DRA) to all risky assets (TRA). Note that HB^0 is a monotonic transformation of HB' = DRA/TRA used to derive proposition 2 and should then account for this measure as well. We adopt HB^0 as our first measure in order to maximize the sample size since this transformation allows us to incorporate observations with zero DRA but also experiment with HB' = DRA/TRA, as a robustness check.

The results for this inclusive specification are summarized in Table 2, and those for the robustness checks are summarized in Table 2A. As proposition 2 indicates, the impact of the education variables at the individual investor level are generally ambiguous. While the general prediction is that the HB measure would be an inverted-U-shaped function of our schooling variable, for a country like the US, where the schooling level of the investors in our sample is relatively high, we expect to observe mainly the downward sloping segment of the HB trajectory (see Figure 1 in section 5). Indeed, our results for both definitions of the home bias variable are consistent with this conjecture: the schooling coefficient is negative and significant at the 1% level. More important, our discriminating implication concerning the impact of the lnWAGE* variable is also confirmed, since its coefficient has the *opposite sign* of that of the schooling variable as proposition 3 suggests. These results are also significant at the 1% level. Furthermore, the conditional education effect, holding WAGE* constant, is larger in magnitude than the corresponding unconditional one, as predicted by proposition 1.

The portfolio size variable appears to have generally insignificant effects in Table 2, largely perhaps because of the role this variable is playing in our regressions. Since our theoretical model rules out pure wealth effects, we have justified the inclusion of TASST in equations (11) and (12) as an technological variable accounting for economies of scale in information collection, or for trading experience and lower trading costs, since those with larger portfolios either inherit them or accumulate them through past investments. In Tables 1 and 1A we see that this variable has very similar effects in the regressions concerning home and foreign assets, which militates in favor of the second explanation. Thus, to the extent trading costs are similar for home and foreign assets, the coefficient of this variable should be insignificant in the home bias regressions.

7. Macro-Level Evidence

In this section we test the basic implications of our model at the macro level using IMF and World Federation of Exchange data on the aggregate capitalized values of home and foreign stock holdings. Since the financial data are available only in aggregate format, we can not construct a reasonable proxy for equity holdings per investor, because we do not have data on the number of participating investors in each market. However, this problem does not exist for measures of *relative holdings* of domestic and foreign equities, since we can normalize the aggregate data by computing their ratios. We thus focus on "home bias" at the macro level.

In implementing *proposition* 8 we attempt to test the following main hypotheses:

(1) *(Direct effects).* A country's home bias is an inverted-U function of its own general human capital. Our numerical analysis suggests that the upward sloping part of the trajectory is brief, occurring around very low educational attainments. Since our data are from developed countries, we may capture the downward-sloping portion of the trajectory in the upper panel of Figure 2.

(2) *(Cross effects)*. A country's home bias is an inverted-U function of general human capital in the foreign country. Our numerical analysis indicates that this curve has a longer upward sloping portion around the same range of years of schooling. Our estimated cross effects may thus capture the upward-sloping portion of the trajectory (see the lower panel in figure 2).

(3) *(Wage and portfolio size effects).* We expect the country's average wage measure, to the extent it effectively accounts for opportunity costs of time in non-market activities, to have an opposite sign to that of the education effect. We also expect the estimated impact of education on home bias to be larger in absolute magnitude when the wage measure is used as a regressor relative to the case when the wage measure is not controlled for. Consistently with our micro-level regressions we are also using GDP per-capita as a rough proxy for portfolio size, to account for potential economies of scale which reduces transaction and trading costs involved in asset management.

We use the following regression specifications to test our main hypotheses:

$$\log(\text{HomeBias}) = a_0 + a_1\log(\text{EDU}^d) + a_2\log(\text{EDU}^f) + |a_3\log(\text{WAGE}^{*d})| + |a_4\log(\text{WAGE}^{*f})| + a_5\log(\text{GDPPC}^d) + a_6\log(\text{GDPPC}^f) \qquad (13)$$

$$\text{equation (13)} + b\times\textit{other control variables} \qquad (13a)$$

Equation (13) is our "baseline model", as it aims to test the implications of our theoretical model assuming that the financial markets in our sample are fully integrated. Equation (13a) allows for additional controls to correct for deviations from this assumption. We construct our dependent variable HomeBias using equation (10) based on CAPM and ACT, which in turn are constructed from cross equity holdings and market capitalizations. The cross-country equity portfolio holding is collected from the Coordinated Portfolio Investment Survey (CPIS) of the International Monetary Fund (IMF) while the market capitalization is obtained from the time series database of the World Federation of Exchanges (WFE). Based on data availability, we construct a sample of 23 countries covering 7 years from 2001 to 2007. The 23 countries are Argentina, Australia, Austria, Brazil, Canada, Denmark, Finland, Germany, Hungary, Israel, Italy, Japan, South Korea, Mexico, New Zealand, Norway, Poland, Singapore, Spain, Sweden, Switzerland, the United Kingdom and the United States. These 23 countries account for about 80% of the capitalized value of the WFE database. Country *k*'s CAPM in year *t* is constructed as $CAPM_{k,t} = Mcap_{k,t} / \sum_{s=1}^{23} Mcap_{s,t}$, where $Mcap_{k,t}$ denotes the capitalized value of country *k*'s stock market in year *t.* while its ACT in year *t* is defined as the fraction of its domestic stocks in its total stock holdings in year *t*.

We use "*average schooling years of total population aged 25 and over as of 1999 (TYR99)*" taken from Barro and Lee (2000) as a measure of general human capital, EDU^d. Our results are robust to the choice of alternative measures by Barro and Lee (2000), such as the average schooling of male population 25 years and over. However, our schooling variable is not available on an annual basis over our sample period. We believe that this constraint should not affect our results significantly. First, we note that the distributions of average years of schooling in 1999 and 1995 are almost identical - the correlation coefficient is 0.99. We thus expect the cross-sectional distribution of average years of schooling to remain very similar over our sample period. Second, we find that the explanatory power of our regressions comes mostly from the cross-sectional variations as both our qualitative results and our measured R^2 from annual regressions we conducted as a robustness check are almost the same as in our pooled regressions.

In order to estimate cross effects of our main explanatory variables, EDU, WAGE*, and GDPPC, we need to control for measures of these variables in "foreign" market corresponding to each country as well as in the domestic market. We construct the "foreign education" variable, EDU^f, e.g., as a weighted average of schooling years for all countries except the *k*-th country, using the corresponding market capitalizations as weights. We use the same method to compute all other "foreign" regressors.

Unlike our micro-level sample, we do not have data related to the opportunity cost of time of actual equity holders in different countries. We are confined to use instead data on the average hourly rate of the population. The Bureau of Labor Statistics offers a measure defined as the 'international (real) hourly wage rate of the manufacturing sector'. However, this measure does not represent the wage rate applicable to the population of salaried investors in each country, nor can it serve as a good indicator of the opportunity cost of time of self-employed investors, whose ownership of equities also varies across different countries. Another concern is the possibility of inconsistent treatment of fringe benefits in computing an international wage rate. To correct for these problems we use instead a projected international wage derived from a Mincerian regression model, (as in Moskowitz and Vissing-Jorgensen, 2002). The equation we use, constrained by data availability for all countries in our sample, is the basic Mincer regression

$$\log(w_{k,t}) = a + b_0 EDU_k + b_1 EXP_{k,t} + b_2 (EXP_{k,t})^2 + error_{k,t}$$

where EDU_k is country *k*'s average education as of 1999 and $EXP_{k,t}$ is a proxy for the work experience of the representative investor in country *k* at time *t.* As in Yamarik, 2008, we compute $EXP_{k,t}$ by subtracting EDU_k from the country's average life expectancy at time *t*, which we take from the World Bank database.

We run our baseline regression model (13) including and excluding WAGE*, to compare the unconditional and conditional effects of education. We apply the regression model to the pooled cross-sectional samples for all 7 years after adding year dummies. As a robustness check, we also run the model using only the subsample of OECD countries. The estimated regression coefficients are summarized in Table 3.

The results of the baseline regression model in Table 3 support proposition 8 and our three tested macro-level hypotheses. A country's average education level always lowers its home bias, as anticipated in the upper panel of Figure 2 of section 5, and the magnitude of the impact, conditional on wage rate, is always significant at the 1% level (the t-values are constructed from White's robust standard errors). Also, the elasticity of the education effect conditioned on the wage rate is larger in absolute magnitude than the unconditional elasticity. This supports the basic hypothesis of the model about the enhancing effect of education on private information precision. The estimated cross effects of the conditional and unconditional impacts of average education in the relevant foreign subsets on home bias are statistically insignificant. One reason may be that they apply to the flat portion of the trajectory of the cross effects in the lower panel of figure 2. The impact of an economy's projected wage rate on home bias is always opposite to that of the country's education variables. In particular, the country's own wage rate always lowers its home bias, contrary to the impact of the country's education level, reflecting what we generally ascribe to the impact of the opportunity costs of asset management on the level of private information precision in its own country, and the estimated coefficient is significant at the 5% level. In contrast, the foreign wage effect is negative and significant, consistent with the cross effects of our basic determinants of asset management. The country's own per-capital GDP lowers home bias in conformity with our third hypothesis, while its foreign counterpart turns out to be statistically insignificant. These effects may indeed reflect the impact of "portfolio size" in our micro-level regressions. The fact that the results hold for both the full sample and the OECD subsample indicates the robustness of our findings.

It is also noteworthy that the regression line showing the correlation between our empirical home-bias measure and average schooling attainments, estimated from equation (13), bears a very strong resemblance to the corresponding theoretical trajectory, as simulated in Figure 2. In Figure 3, the two trajectories look quite congruent.

In addition to the baseline regression model, we have also estimated the expanded regression model (13a) by additional control variables which are frequently used in the international finance literature to account for factors that enhance integration, although these are only loosely connected to our model. They include: M/G^d and M/G^f – domestic and foreign market capitalizations relative to their respective GDPs; LONG – the longitudinal difference between domestic and foreign stock exchanges; EU, ENGLISH and SPANISH – dummy variables distinguishing EU countries and countries where the dominant language is English or Spanish. The results are reported in Appendix Table B3.

The results of the baseline model concerning the conditional and unconditional education effects are robust to the inclusion of additional controls in the expanded model. The same holds for the effect of the GDPPC. The qualitative effects of the projected wage rates remain the same but the impact of the country's own wage becomes statistically insignificant. A shortcoming of this variable may be both the quality of international data on average wage rates and the fact that, unlike the wage data in our micro-level regressions, which reflect the wage rates associated with the actual investors, the BLS average wage rate reflects that of manufacturing workers. Another constraint is the relatively small size of our pooled sample. The impact of the additional controls generally confirms previous findings, but not all are statistically significant.[17]

8. Additional Inferences Concerning the Observed Diversity in Home Bias

8.1 Alternative Hypotheses

Are the findings in our paper also consistent with alternative hypotheses involving overlooked diversification motives? This can be assessed on two alternative assumptions. If human capital is a safe asset, as we assume in this model, optimal diversification in an extended portfolio, including both traded and non-traded assets, would create a tendency to hold more risky financial assets (see EHY, 2008). This alternative hypothesis rests on a positive human wealth effect. But our consistent finding is that higher wages *lower* individuals' absolute demand for all risky assets (section 6). Indeed, the wage rate effect is consistently estimated to have an opposite sign of that of education.

Alternatively, if human capital were a risky asset, its impact on domestic v. foreign assets at the macro level would depend essentially on the estimated covariance of the wage rate and the return on domestic assets, $\mathrm{cov}(\mu_d, w_d)$. The literature reports contradicting findings, some suggesting a positive correlation, which should exacerbate the home bias puzzle (see, e.g., Baxter and Jermann, 1997), while others finding the opposite correlation (e.g., Bottazzi, Pesenti and Van Wincoop, 1996). A later study (Pesenti and Van Wincoop, 2002) finds that the hedge against human capital explains only a small portion of home bias. Neither of these studies accounts, however, for the pattern of the home-bias trajectory as a

[17] As checks for robustness of our regression specifications, we also run the baseline and expanded models by using projected wage rates from an extended Mincer regression model by including both sex ratios (the ratio of girls to boys in primary and secondary education) and infant mortality rates as additional instrument variables. The results are reported in Appendix Tables B4 and B5. These results are consistent with the ones reported in the text. As additional robustness tests, we have employed an alternative measure of average schooling attainments, based on Cohen and Soto (2007) in addition to the Barro and Lee measure in all regressions, and an alternative wage rate measure computed by OECD, in addition to our BLS measure, in our OECD-subsample regressions. All robustness tests produce similar findings.

function of conditional increments in schooling, or the *opposite* effects of schooling and the wage rate on home bias we predict and confirm empirically.

8.2 Information Costs

Our model ascribes the observed concentration in domestic assets to the relative information advantage the representative investor in country d has about home asset d over the foreign asset f. This advantage can be stated in terms of the differential information cost the representative investor would have to bear in order to achieve the same level of private information precision concerning the two assets, i.e., $S_{d,d} = S_{d,f}$. By equation (1c) defined for country d's investor, the information cost incurred in managing each asset is given by $C(S_{d,k}) = w_i q(S_{d,k}) + C_{k,0}$, where $q(S_{d,k}) = \left[S_{d,k} / AH_{d,0}^{\theta_2} H_{d,k}^{\theta_3}\right]^{1/\theta_1}$ is the time input involved in managing asset *k = d,f.* If we set the fixed cost of management to zero ($C_{k,0}$ = 0), the opportunity cost that agent d would incur from achieving the same private information for the foreign relative to the home asset would be $C(S_{d,f})/C(S_{d,d})$ = $(H_{d,d} / H_{d,f})^{\theta_3/\theta_1}$, i.e., agent *d*'s relative home-asset information advantage raised to the power (θ_3/θ_1). This represents the maximal value of the cost differential required to explain home bias as an outcome of optimal asset management. If $C_{k,0}$ >0, the required cost differential would be less than $(H_{d,d} / H_{d,f})^{\theta_3/\theta_1}$.

A partially-calibrated numerical exercise allows us to gain insight about the numerical value of the actual cost differential, based on the empirically observed pattern of home bias of the "representative investor". Applying the set of parameters used in Figures 1 an d 2, with r = 0.25, we search for ratio of specific human capital endowments $(H_{d,d} / H_{d,f})$ which produces a simulated trajectory of home bias in country d as a function of $H_{d,0}$ which closely resembles the pattern of the corresponding trajectory of home bias we observe empirically, as depicted by the regression line estimated from Table 3 for the full sample.

The representative investor's differential cost value $(H_{d,d} / H_{d,f})^{\theta_3/\theta_1}$, however, depends on the distribution of investors it represents. In a scenario in which all investors are homogeneous ("scenario 1"), we estimate the specific human capital endowment ratio $(H_{d,d} / H_{d,f})$ which produces a simulated trajectory closely resembling our empirically estimated regression line to be 6 (see the dotted line in Fig. A.1). With θ_3/θ_1 assumed to be 2, the differential cost estimate becomes 6^2 = 36. This differential, however, grossly overstates the relevant cost differential because investors are quite heterogeneous.

The US-based micro-level data used in section 6 suggest that 79% of investors with positive risky assets hold just domestic assets (group 1) while 21% hold foreign assets as well (group 2). The respective portfolio shares of groups 1 and 2 in the US portfolio of risky assets are 60% and 40%, respectively. The large size of group 1 thus reduces significantly the estimated specific human capital endowment ratio that is required to explain the average home bias exhibited by group 2. If this distribution of groups 1 and 2 is representative of all markets ("scenario 2"), our method of assessing the value of $(H_{d,d} / H_{d,f})$ that is required to explain the observed home bias trajectory across international financial markets would be 2, which makes the cost differential needed to explain the observed pattern of home bias across the observed international sample equal to $2^2 = 4$. (See Appendix C for a detailed computational account.) This exercise suggests that the cost differential which accounts for the observed level and pattern of home bias across international financial markets may be surprisingly low.

9. Concluding Remarks

The basic innovation in this paper is the treatment of private information about risky assets and the "price information content" of corresponding asset prices as endogenous variables that are influenced by human capital endowments. Our theoretical analysis and empirical findings indicate that this may be a promising approach for understanding systematic variations in portfolio choices across individuals and diversities in portfolio concentrations across markets.

Our model produces a set of testable propositions concerning the impact of measures of benefits and costs of asset management on absolute and relative demand for domestic and foreign assets. The tests we conduct using 8 annual micro-level SCF national probability samples of individual investors in the US, and 7 annual macro-level IMF and World Federation of Exchange data on international financial markets are consistent with our theoretical analysis.

Our propositions are subject to strong assumptions, especially our treatment of international financial markets as fully integrated. We are clearly aware of the existence of capital constraints, regulations, and constraints on trade which impede the openness of international financial markets, and which our analysis has not attempted to capture. Yet this is also the strength of our model and empirical analyses, which focus on the power of our basic theoretical constructs to explain systematic diversities in "home bias" while employing limited controls.

Despite the limitations of the data, our basic findings are shown to be generally robust to the introduction of various controls such as professional and occupational affiliations and self-reported attitudes toward risk at the micro level, and commonality of language and geographical proximity at the market level, in explaining systematic variations in both "individual home bias" and "macro-level home bias". This indicates that our model may indirectly contribute to the assessment of the roles of regulatory constrains and barriers to trade in financial and currency markets, and increase our understanding of the performance of these markets. In particular, our study suggests that educational attainments and opportunity costs of information acquisition need to be accounted for in attempts to assess the role of regulatory constraints and policy variables.

The analysis in this paper also offers a unifying approach to deal with other market-level characteristics we have only touched upon in this paper. For example, our model has direct implications concerning the degree to which international financial markets are “disconnected” with fundamentals such as the basic implications of CAPM, as a consequence of variations in the degree to which prices are actually “information revealing”. Indeed, we show that such “disconnect”, as indicated by variations in home bias across international markets, can be accounted for by fairly mild levels of information-cost advantage enjoyed by domestic investors concerning home, relative to foreign assets, as our illustration in section 8.2 indicates. The model can be extended to explain phenomena like “flight to quality” during times of market distress, which we can link with a decline in the price information content of risky assets. It has direct implications concerning variability in the magnitude of risk premiums across markets. It can also help explain the pattern of volatility contagion across international markets, e.g., by identifying which markets have been more susceptible to the recent financial crisis in the US. And although in this paper we have focused on the model’s ability to explain variability in “home bias”, it can be applied to address apparent diversities in asset holdings across industries and geographical units within an economy. Last but not least, our work attempts to expand the scope of issues in the “new information economy” where human capital theory can provide new insights.

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Table 1. Demand for Domestic and Foreign Risky Assets

		Total Risky Assets	Domestic Risky Assets	Foreign Risky Assets
		Salaried Workers		
Log(EDU)	Unconditional	0.577	0.555	0.268
		(6.07)	(5.82)	(0.92)
	Conditional	1.025	1.000	0.400
		(10.1)	(9.87)	(1.28)
Log(Wage)	Conditional	-0.407	-0.407	-0.086
		(-12.0)	(-11.9)	(-1.18)
Log(TASST)	Unconditional	0.834	0.836	0.741
		(75.0)	(74.8)	(28.7)
	Conditional	0.886	0.888	0.747
		(74.5)	(74.3)	(28.3)
N		3153	3112	509
		All Investors		
Log(EDU)	Unconditional	0.634	0.618	0.152
		(10.3)	(10.0)	(0.90)
	Conditional	1.085	1.059	0.358
		(16.2)	(15.8)	(1.94)
Log(Wage)	Conditional	-0.402	-0.396	-0.125
		(-17.0)	(-16.7)	(-2.75)
Log(TASST)	Unconditional	0.848	0.847	0.739
		(110.9)	(110.3)	(47.4)
	Conditional	0.896	0.896	0.748
		(110.3)	(109.5)	(46.9)
N		6444	6356	1340

Notes: The regression model is equation (11). “Unconditional” refers to the regression excluding the WAGE* regressors. “Conditional” refers to the regression including them. The numbers in parentheses are t-ratios.

Table 1A. Demand for Domestic and Foreign Risky Assets: Alternative Transformation

		Log(1+DRA) (retaining zeros)	Log(1+FRA) (retaining zeros)
		Salaried Workers	
Log(EDU)	Unconditional	0.559	0.883
		(5.90)	(6.17)
	Conditional	1.004	1.557
		(9.91)	(10.2)
Log(Wage)	Conditional	-0.407	-0.612
		(-12.0)	(-11.9)
Log(TASST)	Unconditional	0.835	0.276
		(75.2)	(16.5)
	Conditional	0.887	0.353
		(74.7)	(19.7)
N		3153	3153
		All Investors	
Log(EDU)	Unconditional	0.621	0.790
		(10.1)	(7.95)
	Conditional	1.062	1.397
		(15.9)	(12.9)
Log(Wage)	Conditional	-0.396	-0.542
		(-16.7)	(-14.1)
Log(TASST)	Unconditional	0.846	0.306
		(110.8)	(24.8)
	Conditional	0.895	0.372
		(110.0)	(28.3)
N		6444	6444

See notes to Table 1.

Table 1B. Demand for Domestic and Foreign Risky Assets: Sample Selection Model for All Investors

		Domestic Risky Assets	Foreign Risky Assests
Log(EDU)	Unconditional	0.923	3.053
		(10.2)	(2.36)
	Conditional	1.351	3.547
		(11.6)	(2.52)
Log(Wage)	Conditional	-0.368	-0.750
		(-10.6)	(-2.51)
Log(TASST)	Unconditional	0.956	1.677
		(93.9)	(4.89)
	Conditional	1.009	1.417
		(102.6)	(5.90)
N		6356	1340

See notes to Table 1.

Table 2. Portfolio Concentration (Individual "Home Bias") Regression Results

		HB = log(1+DRA/TRA)	
		All	Salaried
Log(EDU)	Unconditional	-0.022	-0.033
		(-5.77)	(-5.66)
	Conditional	-0.027	-0.0428
		(-6.39)	(-6.91)
Log(Wage)	Conditional	0.004	0.0093
		(2.74)	(4.49)
Log(TASST)	Unconditional	0.00013	0.00073
		(0.28)	(1.08)
	Conditional	-0.00036	-0.00045
		(-0.70)	(-0.62)
N		6444	3153

Notes: The regression model is equation (12). "Unconditional" refers to the regression excluding the WAGE* regressors. "Conditional" refers to the regression including them. The numbers in parentheses are t-ratios.

Table 2A. Portfolio Concentration Regression Results using Alternative HB Measure

		HB' = DRA/TRA	
		All	Salaried
Log(EDU)	Unconditional	-3.431	-6.686
		(-5.98)	(-7.18)
	Conditional	-4.255	-1.987
		(-6.81)	(-5.76)
Log(Wage)	Conditional	0.735	1.545
		(3.32)	(4.96)
Log(TASST)	Unconditional	-0.043	0.055
		(-0.61)	(0.54)
	Conditional	-0.132	-0.141
		(-1.74)	(-1.29)
N		6444	3153

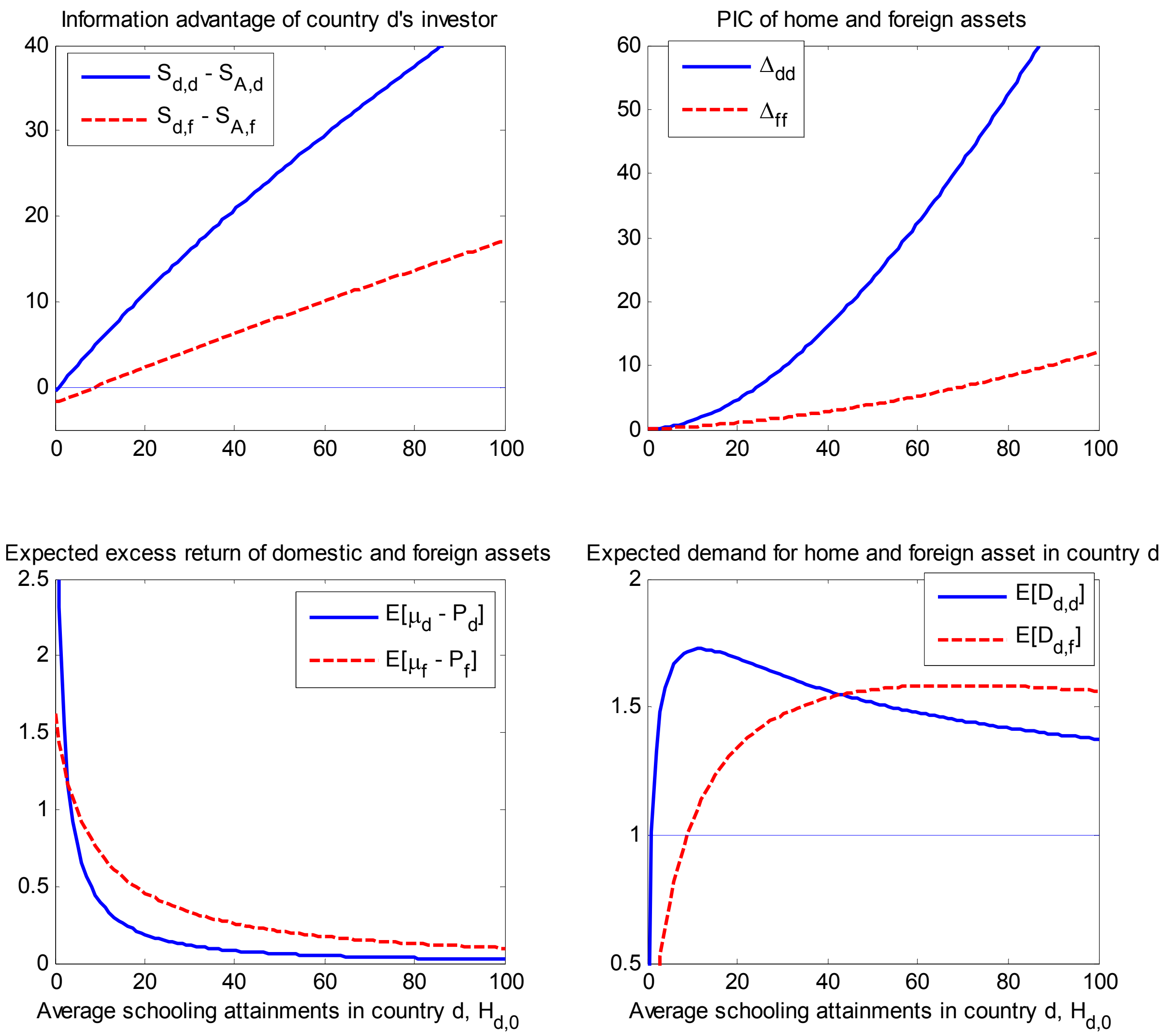
See notes to Table 2.

Table 3. Home Bias Regression at the Macro Level: Baseline Model

	Full Sample		OECD Sample	
Variable	Unconditional	Conditional	Unconditional	Conditional
$\log(EDU^d)$	-0.1805	-0.2456	-0.2518	-0.3069
	(-3.07)	(-4.40)	(-4.61)	(-6.77)
$\log(EDU^f)$	-0.0439	-0.3176	0.5802	0.4844
	(-0.04)	(-0.26)	(0.58)	(0.50)
$\log(WAGE^{*d})$		0.0802		0.0898
		(2.05)		(2.94)
$\log(WAGE^{*f})$		-1.5285		-1.5918
		(-5.63)		(-5.84)
$\log(GDPPC^d)$	-0.1314	-0.1912	-0.1807	-0.2537
	(-5.85)	(-4.80)	(-12.3)	(-9.12)
$\log(GDPPC^f)$	-0.112	1.2597	-0.7524	0.4942
	(-0.11)	(0.97)	(-0.79)	(0.49)
N	148	148	126	126
Adjusted R^2	0.4192	0.5111	0.5452	0.6620

Notes: The Baseline model is equation (13). "Unconditional" refers to the regression excluding the WAGE* regressors. "Conditional" refers to the regression including them. The numbers in parentheses are t-ratios constructed from robust standard errors.

Figure 1. Impact of the General Human Capital of Country *d*'s Investor on Relative Info. Advantage, PIC, Excess Returns, and Absolute Demands for Home and Foreign Assets

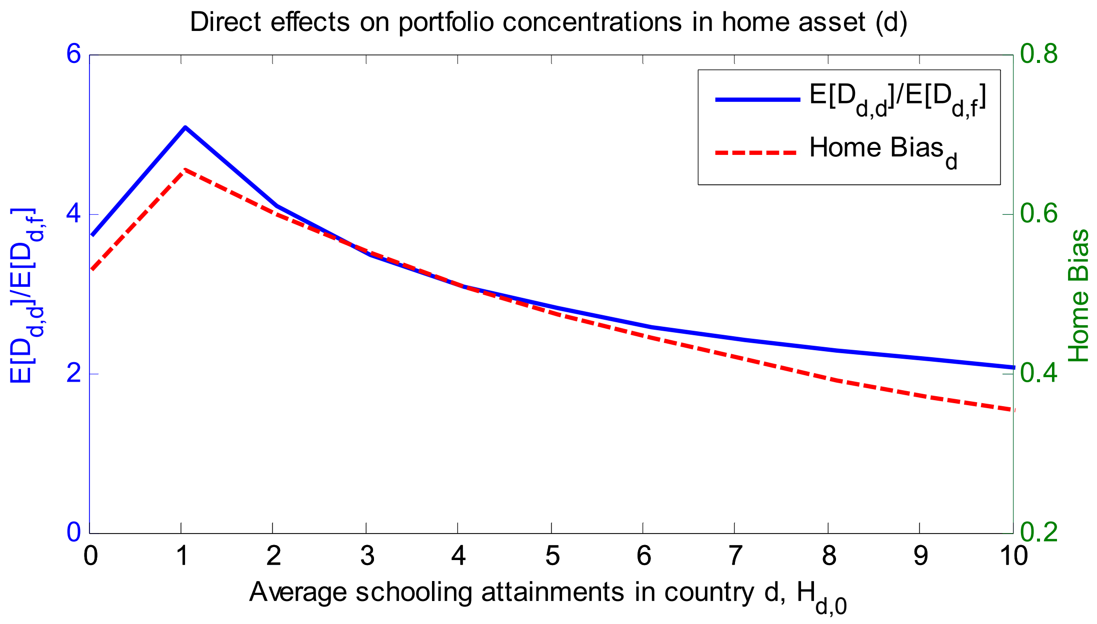


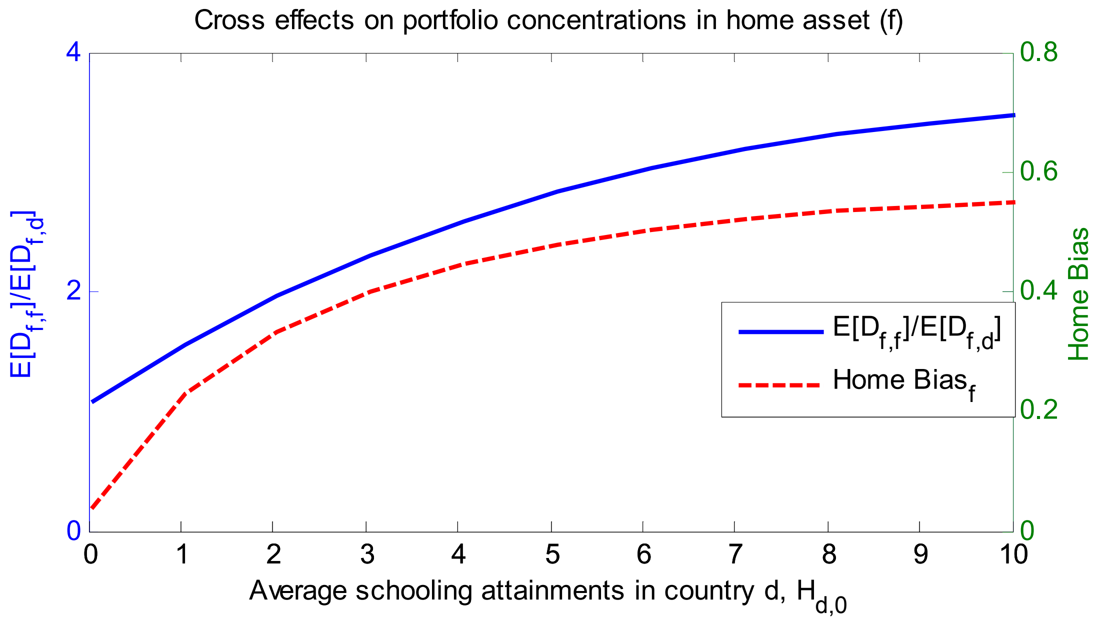
Underlying parameters: $H_{f,0}=5$, $H_{d,d}=H_{f,f}=3$, $H_{d,f}=H_{f,d}=1$, $\bar{\mu}_1=\bar{\mu}_2=10$, $\bar{x}_1=\bar{x}_2=1$,

$$\Sigma_\mu=\begin{bmatrix}10 & 5\\ 5 & 10\end{bmatrix},\quad \Sigma_x=\begin{bmatrix}3 & 0\\ 0 & 3\end{bmatrix},\quad \theta_1=0.5,\ \theta_2=\theta_3=1,$$ ***r* = 1/3 *A* = 1,**

$$N_d/N=N_f/N=0.5$$

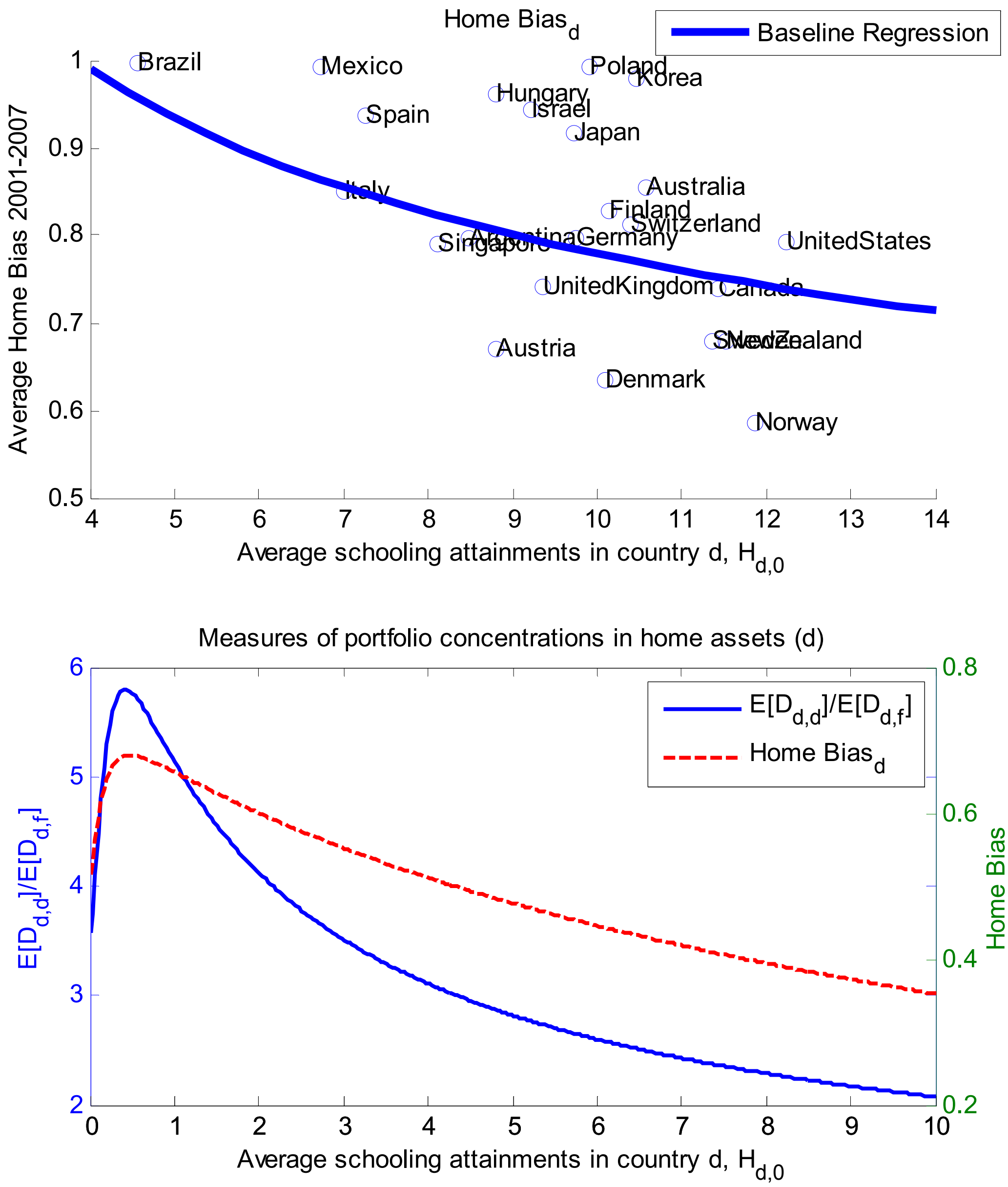
Figure 2. Impact of the General Human Capital of Country d's Investor on Measures of Relative Demand for the Home Asset and Home Bias





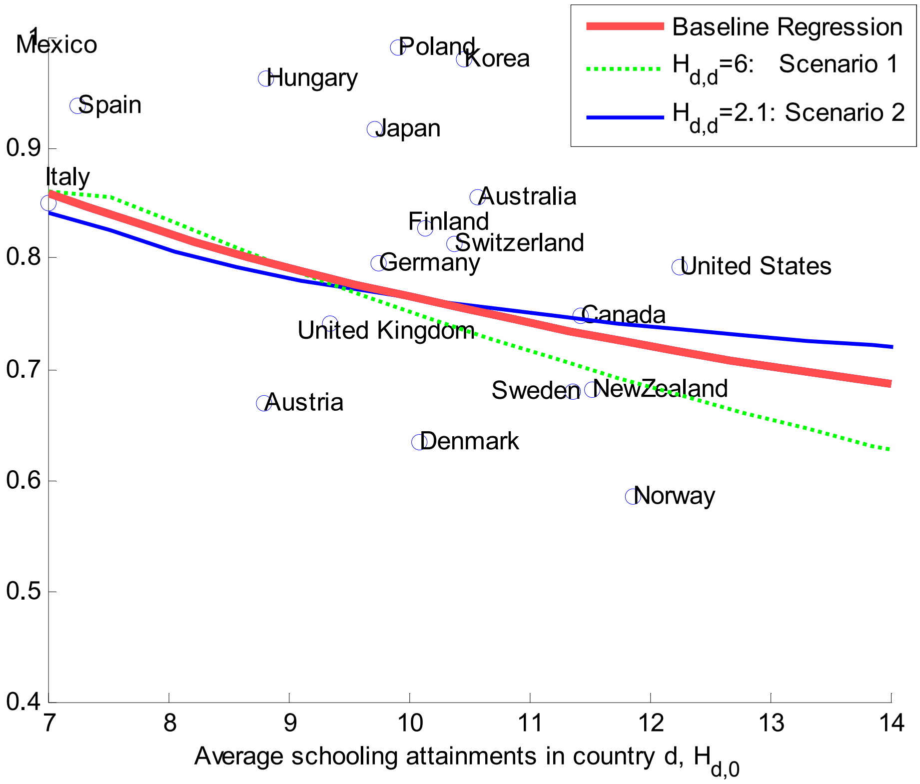
Based on the same set of parameters as in figure 1

Figure 3. Empirically Estimated, and Theoretically Simulated, Trajectories Side by Side



The lower panel is based on parameters in Figure 1

Figure A.1 The Equilibrium Cost Differential under Scenarios 1 and 2



Underlying parameters: $H_{f,0} = 5$, $H_{d,f} = H_{f,d} = 1$, $\bar{\mu}_1 = \bar{\mu}_2 = 10$, $\bar{x}_1 = \bar{x}_2 = 1$,

$$\Sigma_\mu = \begin{bmatrix} 10 & 5 \\ 5 & 10 \end{bmatrix}, \Sigma_x = \begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix}, \ \theta_1 = 0.5,\ \theta_2 = \theta_3 = 1,\ r = 1/4,\ A = 1,$$

$$N_d / N = N_f / N = 0.5$$

The simulated plots are parallel shifted by 7 to the right.

Appendix A. Mathematical Appendix

A.1 Asset Market Equilibrium

From Admati (1985), the market price has an equilibrium solution as follows:

$$\tilde{P} = \phi_0 + \phi_1\tilde{\mu} - \phi_2\tilde{x} \quad \text{almost surely,}$$

where $\phi_0 = V\left(\Sigma_\mu^{-1}\bar{\mu} + rS\Sigma_x^{-1}\bar{x}\right)$, $\phi_1 = V\left(S + r^2 S\Sigma_x^{-1}S\right)$, $\phi_2 = V\left(r^{-1}I + rS\Sigma_x^{-1}\right)$ and

$$V = \left(\Sigma_\mu^{-1} + S + r^2 S\Sigma_x^{-1}S\right)^{-1}$$

The investor *i*'s posterior forecast about the return, $\tilde{\mu}$, is normal with its mean and variance as follows:

$$E\left[\tilde{\mu}\middle|z_i, P\right] = \eta_{0i} + \eta_{1i}z_i + \eta_{2i}P \quad \text{and} \quad V_i = Var\left[\tilde{\mu}\middle|z_i, P\right] = \left(\Sigma_\mu^{-1} + S_i + r^2 S\Sigma_x^{-1}S\right)^{-1}$$

where $\eta_{0i} = V_i[I - \left\{\Sigma_x(rS)^{-1} + rI\right\}^{-1}]\left(\Sigma_\mu^{-1}\bar{\mu} + rS\Sigma_x^{-1}\bar{x}\right)$, $\eta_{1i} = V_i S_i$, and $\eta_{2i} = rV_i S\Sigma_x^{-1}\phi_2^{-1}$.

A.2 Proof of equation (6a)

By substituting the optimal conditional demand for risky assets, $D_i = rV_i^{-1}\left(\tilde{\mu}_i - \tilde{P}\right)$, into the first stage problem, we derive the following:

$$\begin{aligned}\max_{\{S_i\}} E_{\tilde{z}_i,\tilde{P}}[-\exp\{-\tfrac{1}{r}(B_0 + \tilde{P}^T x_0 + w_i - C(S_i; H_i)) \\ -\tfrac{1}{2}(E[\tilde{\mu}|\tilde{z}_i, \tilde{P}] - \tilde{P})^T V_i^{-1}(E[\tilde{\mu}|\tilde{z}_i, \tilde{P}] - \tilde{P})\}]\end{aligned} \tag{A.1}$$

where x_0 and B_0 denote investor *i*'s initial endowment of risky assets and safe bond, respectively. It can then be shown that (A.1) is equivalent to the optimizing problem:

$$\max_{\{S_i\}} -\frac{\left|\Omega_P\right|^{1/2}\left|\Omega_z\right|^{1/2}}{\left|M\right|^{1/2}}\exp\left[t_P^T\Omega_P^{-1}t_P + \frac{1}{2}\left\{\lambda_3\Omega_z\lambda_3^T - \lambda_6\right\} + \frac{C(S_i, H_i)}{r}\right] \tag{A.1)'}$$

where $M = \begin{pmatrix} \Sigma_\mu + S_i^{-1} & \Sigma_\mu \phi_1^T \\ \phi_1^T \Sigma_\mu & \phi_1^T \Sigma_\mu \phi_1 + \phi_2^T \Sigma_x \phi_2^T \end{pmatrix}$, $M^{-1} = \Omega = \begin{bmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{bmatrix}$

$\omega_{11} = \left(\Sigma_\mu + S_i^{-1}\right)^{-1} + \left(\Sigma_\mu + S_i^{-1}\right)^{-1} \Sigma_\mu \phi_1^T \omega_{22} \phi_1 \Sigma_\mu \left(\Sigma_\mu + S_i^{-1}\right)^{-1}$, $\omega_{21} = -\omega_{22} \phi_1 \Sigma_\mu \left(\Sigma_\mu + S_i^{-1}\right)^{-1} = \omega_{12}^T$

$\omega_{22} = \left[\phi_1 \left(\Sigma_\mu^{-1} + S_i\right)^{-1} \phi_1^T + \phi_2 \Sigma_x \phi_2^T\right]^{-1}$, $\lambda_1 = \eta_{1i}^T V_i^{-1} \eta_{1i}$, $\lambda_2 = \left(\eta_{2i} - I\right)^T V_i^{-1} \eta_{1i}$, $\lambda_3 = \left(\overline{\mu} - \overline{P}\right)^T V_i^{-1} \eta_{1i}$

$\lambda_4 = \left(\overline{\mu} - \overline{P}\right)^T V_i^{-1} \left(\eta_{2i} - I\right)$, $\lambda_5 = \left(\eta_{2i} - I\right)^T V_i^{-1} \left(\eta_{2i} - I\right)$, $\lambda_6 = \left(\overline{\mu} - \overline{P}\right)^T V_i^{-1} \left(\overline{\mu} - \overline{P}\right)$

$\Omega_z^{-1} = \left(\omega_{11} + \lambda_1\right)$, $t_P^T = \lambda_3 \Omega_z \left(\omega_{21} + \lambda_2\right)^T - \lambda_4 - x_0^T / r$, and

$\Omega_P^{-1} = -\left(\omega_{21} + \lambda_2\right) \Omega_z \left(\omega_{21} + \lambda_2\right)^T + \left(\omega_{22} + \lambda_5\right)$

Taking the differentiation of the object function in (A.1)' with respect to $S_{i,k}$ and using $\partial |M| |S_i| / \partial S_{i,k} = |M| |S_i| V_{i,kk}$, $\omega_{11} + \lambda_1 = \Omega_z^{-1} = S_i$, $\omega_{21} + \lambda_2 = -S_i$, $\partial t_P / \partial S_{i,k} = 0$, $\partial \Omega_P / \partial S_{i,k} = 0$, and $\partial \left\{\lambda_3 \left(\omega_{11} + \lambda_1\right)^{-1} \lambda_3^T - \lambda_6\right\} / \partial S_{i,k} = 0$, we prove the result. QED

A.3 Proof of Proposition 1

Taking partial differentiation of (6a) with respect to the general human capital, $H_{i,0}$, applying Cramer's rule on it and using (1a) ~ (1c), we derive

$$sign\left(\frac{\partial S_{i,d}}{\partial H_{i,0}}\right) = sign\left[\left(\frac{\theta_2}{\theta_1} - \varepsilon_{w_i, H_{i,0}}\right)\left\{V_{i,dd} V_{i,ff} - \left(V_{i,df}\right)^2 + \frac{V_{i,dd}}{S_{i,f}}\left(\frac{1-\theta_1}{\theta_1}\right)\right\} \frac{V_{i,ff}}{H_{i,0}}\left(\frac{r}{2}\right)^2\right] \quad \text{(A.2)}$$

where $\varepsilon_{X,Y}$ denotes the elasticity of X with respect to Y.

As V_i is covariance matrix, $V_{i,dd} V_{i,ff} - \left(V_{i,df}\right)^2 > 0$. Hence, the sign of $\partial S_{i,d} / \partial H_{i,0}$ depends on the sign of $\theta_2 / \theta_1 - \varepsilon_{w_i, H_{i,0}}$. A conditional increase in $H_{d,0}$ at a given wage level (i.e. $\varepsilon_{w_i, H_{i,0}}$=0) increases $S_{i,d}$ more than the unconditional increase in $H_{d,0}$. By equation (5a) and the large economy assumption, it is straightforward to see $sign\left(\partial \overline{D}_{i,k} / \partial H_{i,0}\right) = sign\left(\partial S_{i,k} / \partial H_{i,0}\right)$ for *k* = *d* and *f*. Finally, by (A.2) and symmetry,

$$\frac{\partial\left(S_{i,d}-S_{i,f}\right)}{\partial H_{i,0}}=\chi_0 V_{i,dd}V_{i,ff}\left[\left(\frac{1}{V_{i,dd}}-\frac{1}{V_{i,ff}}\right)D_V+\left(\frac{1}{S_{i,f}}-\frac{1}{S_{i,d}}\right)\frac{1-\theta_1}{\theta_1}\right]$$

where $\chi_0=(r/2)^2\left(\theta_2/\theta_1-\varepsilon_{w_i,H_{i,0}}\right)/H_{i,0}>0$ and $D_V=V_{i,dd}V_{i,ff}-V_{i,df}{}^2>0$.

Thus, $\partial\left(S_{i,d}-S_{i,f}\right)/\partial H_{i,0}>0$, if $V_{i,dd}<V_{i,ff}$ and $S_{i,d}>S_{i,f}$. *QED*

A.4 Proof of Proposition 4

Without loss of generality, we prove it for $H_{i,d}$. Taking differentiation of first order conditions with respect to $H_{i,1}$ and applying Cramer's rule on it, we derive the following:

$$\frac{\partial S_{i,d}}{\partial H_{i,d}}=-\left[\frac{\partial^2 C}{\partial S_{i,d}\partial H_{i,d}}\left(\frac{r}{2}V_{i,ff}^2+\frac{\partial^2 C}{\partial\left(S_{i,f}\right)^2}\right)\right]\frac{1}{\left|\frac{r}{2}V_i\circ V_i+D^2C\right|}>0$$

because the expression in the square bracket is negative given that $\partial^2 C/(\partial S_{i,d}\partial H_{i,d})$ <0 by (1a)~(1c). Similarly, it can be shown that

$$\frac{\partial S_{i,f}}{\partial H_{i,d}}=\frac{r}{2}V_{i,df}^2\frac{\partial^2 C}{\partial S_{i,d}\partial H_{i,d}}\leq 0$$

where the equality holds when $V_{i,df}=0$. Since investor *i*'s average demand for risky asset *k*, *E*[$D_{i,k}$], is proportional to $S_{i,k}$, at the individual level the concentration ratio $\left(\overline{D}_{i,d}/\overline{D}_{i,f}\right)$ increases in $H_{i,d}$. *QED*

A.5 Lemmas to Prove Proposition 5

Lemma 1: (*The impact of PIC*). The price information content (PIC) of asset *k* lowers optimal asset management and private information precision concerning this asset, i.e., $\partial S_{i,k}/\partial\Delta_{kk}<0$ for all investors. Also, $\partial S_{i,k}/\partial\Delta_{ll}\leq 0$ for $k\neq l$ where equality holds when $V_{i,df}=0$.

Proof. (WLOG, we prove it for Δ_{dd} only) Taking differentiation of (6a) with respect to PIC_d, Δ_{dd} and the application of Cramer's rule yields the following:

$$\frac{\partial S_{i,d}}{\partial \Delta_{dd}} = -\frac{1}{D}\left[\left(\frac{r}{2}\right)^2 D_{V^2} + \left(\frac{r}{2}\right) V_{i,dd}^2 C_{ff}\right] < 0 \quad \text{and} \quad \frac{\partial S_{i,f}}{\partial \Delta_{dd}} = -\frac{1}{D}\left(\frac{r}{2}\right) C_{dd} V_{i,df}^2 \leq 0$$

where $D \equiv \det\left(\frac{r}{2} V_i \circ V_i + D^2 C\right) = \left(\frac{r}{2}\right)^2 \left\{(V_{i,dd} V_{i,ff})^2 - (V_{i,df}^2)^2\right\} + \frac{r}{2}(V_{i,dd}^2 C_{ff} + V_{i,ff}^2 C_{dd}) + C_{dd} C_{ff}$,

$C_{kl} = \partial C / (\partial S_{i,k} \partial S_{i,l})$ and $D_V{}^2 = V_{i,dd}^2 V_{i,ff}^2 - V_{i,df}^4$. The result follows. QED.

Denote $F_1(H_{i,0})$ and $F_2(H_{i,d}, H_{i,f})$ as marginal distributions for specific and general human capital applied to the world investors. We place a hat to denote new distributions: $\hat{F}_1(H_{i,0})$ and $\hat{F}_2(H_{i,d}, H_{i,f})$ are first order stochastic shifts of $F_1(H_{i,0})$ and $F_2(H_{i,d}, H_{i,f})$.

Lemma 2: A first order stochastic dominance shift in the distribution of general human capital increases the PIC of at least one asset (either Δ_{dd} or Δ_{ff} or both).

Proof. Suppose otherwise. In other words, a FOSD shift in the distribution of general human capital lowers both PIC_d and PIC_f. Then, by Lemma 1, the new equilibrium functions of individual asset management $\hat{S}_{i,d}$ and $\hat{S}_{i,f}$ are higher than the initial levels, $S_{i,d}$ and $S_{i,f}$, for a given H_i. Therefore,

$$\Delta_{dd} \equiv \left[\int_{H_i} S_{i,d}(H_i) dF_2(H_{i,d}, H_{i,f}) dF_1(H_{i,0})\right]^2 (\Sigma_x^{-1})_{dd} \leq \left[\int_{H_i} \hat{S}_{i,d}(H_i) dF_2(H_{i,d}, H_{i,f}) dF_1(H_{i,0})\right]^2 (\Sigma_x^{-1})_{dd}$$
$$\leq \left[\int_{H_i} \hat{S}_{i,d}(H_i) d\hat{F}_2(H_{i,d}, H_{i,f}) d\hat{F}_1(H_{i,0})\right]^2 (\Sigma_x^{-1})_{dd} \equiv \hat{\Delta}_{dd}$$

which is a contradiction of the initial assumption, $\hat{\Delta}_{dd} < \Delta_{dd}$. QED

A.6 Proof of Proposition 5

Suppose otherwise. If both PIC_d and PIC_f fall, it is contradiction by Lemma 2 **Error! Reference source not found.**because an increase in $H_{d,0}$ is trivially a FOSD shift in the distribution of general human capital. If an increase in $H_{d,0}$ lowers PIC_d (and $S_{A,d}$) and increases PIC_f (and $S_{A,f}$), it is a contradiction too, because $H_{d,d} > H_{d,f}$. QED.

In general PIC_f also increases as $H_{d,0}$ increases because the magnitude of $\partial S_{i,f} / \partial \Delta_{dd} \leq 0$ is of second order: To see the mechanism, a rise in $H_{d,0}$ increases both $S_{d,d}$ and $S_{d,f}$, raising both PIC_d and PIC_f. This in turn erode $S_{i,d}$ and $S_{i,f}$ for all investors by Lemma 1. However, the feedback effect cannot exist without the initial rise in PICs. Therefore, PIC_f is likely to increase in equilibrium unless the negative feedback effect of $\partial S_{i,f} / \partial \Delta_{dd}$ is large.

Appendix B. Full Regression Results

Table B1. (Conditional) Demand for Risky Assets

	All Investors			Salaried Workers		
Variable	log(TRA)	log(DRA)	log(FRA)	log(TRA)	log(DRA)	log(FRA)
Constant	-0.191	-0.264	-0.211	0.372	0.291	-0.424
	(-0.74)	(-1.02)	(-0.36)	(0.98)	(0.76)	(-0.43)
lnEDU	1.085	1.059	0.358	1.025	1.000	0.400
	(16.2)	(15.8)	(1.94)	(10.1)	(9.81)	(1.28)
lnTASST	0.896	0.896	0.748	0.886	0.888	0.747
	(110.3)	(109.5)	(46.9)	(74.5)	(74.3)	(28.3)
lnWAGE*	-0.402	-0.396	-0.125	-0.407	-0.407	-0.086
	(-17.0)	(-16.7)	(-2.75)	(-12.0)	(-11.9)	(-1.18)
y95	-0.450	-0.511	1.062	-0.658	-0.717	1.500
	(-2.65)	(-2.98)	(3.75)	(-2.71)	(-2.92)	(3.10)
y98	0.128	0.148	0.333	-0.120	-0.061	0.919
	(0.79)	(0.91)	(1.08)	(-0.52)	(-0.26)	(1.80)
y01	0.211	0.483	-3.221	0.162	0.402	-3.040
	(1.29)	(2.94)	(-10.5)	(0.69)	(1.70)	(-5.70)
y04	-0.220	-0.219	-1.317	-0.315	-0.288	-1.358
	(-1.30)	(-1.27)	(-4.13)	(-1.30)	(-1.18)	(-2.81)
y07	-0.205	-0.170	1.301	-0.095	-0.017	0.887
	(-1.24)	(-1.02)	(3.90)	(-0.40)	(-0.07)	(1.76)
AGE	0.012	0.012	-0.001	0.006	0.007	-0.001
	(5.88)	(5.96)	(-0.15)	(2.22)	(2.32)	(-0.09)
y95*AGE	-0.010	-0.008	-0.021	-0.002	-0.001	-0.035
	(-3.34)	(-2.88)	(-3.89)	(-0.57)	(-0.18)	(-3.71)
y98*AGE	-0.016	-0.016	-0.007	-0.012	-0.013	-0.020
	(-5.47)	(-5.61)	(-1.19)	(-2.98)	(-3.14)	(-2.25)
y01*AGE	-0.020	-0.022	0.007	-0.019	-0.022	0.008
	(-7.05)	(-7.89)	(1.39)	(-4.70)	(-5.41)	(0.99)
y04*AGE	-0.016	-0.015	-0.008	-0.006	-0.005	-0.010
	(-5.65)	(-5.23)	(-1.40)	(-1.47)	(-1.24)	(-1.10)
y07*AGE	-0.011	-0.012	-0.013	-0.015	-0.015	-0.014
	(-3.94)	(-4.10)	(-2.27)	(-3.71)	(-3.82)	(-1.49)

See notes to Table 1.

Table B1. (Conditional) Demand for Risky Assets (Continued)

	All Investors			Salaried Workers		
Variable	log(TRA)	log(DRA)	log(FRA)	log(TRA)	log(DRA)	log(FRA)
PROF	0.122	0.137	-0.144	0.219	0.242	-0.555
	(2.53)	(2.85)	(-1.36)	(3.22)	(3.54)	(-3.43)
y95*PROF	-0.172	-0.180	-0.087	-0.342	-0.356	0.327
	(-2.54)	(-2.63)	(-0.63)	(-3.60)	(-3.73)	(1.45)
y98*PROF	-0.017	-0.049	0.506	-0.015	-0.043	0.731
	(-0.25)	(-0.73)	(3.51)	(-0.15)	(-0.45)	(3.23)
y01*PROF	0.036	-0.023	0.873	-0.055	-0.088	1.311
	(0.54)	(-0.34)	(6.06)	(-0.58)	(-0.93)	(5.85)
y04*PROF	0.083	0.041	0.265	-0.007	-0.074	0.620
	(1.23)	(0.61)	(1.73)	(-0.08)	(-0.77)	(2.79)
y07*PROF	-0.015	-0.043	0.087	-0.095	-0.127	0.439
	(-0.22)	(-0.63)	(0.56)	(-0.99)	(-1.32)	(1.90)
RAV	-0.350	-0.332	-0.066	-0.359	-0.333	-0.113
	(-11.7)	(-10.9)	(-1.17)	(-8.39)	(-7.72)	(-1.21)
y95*RAV	0.325	0.324	-0.093	0.312	0.308	-0.104
	(7.27)	(7.18)	(-1.12)	(4.90)	(4.80)	(-0.66)
y98*RAV	0.327	0.327	-0.168	0.365	0.355	-0.191
	(7.75)	(7.68)	(-2.08)	(6.05)	(5.83)	(-1.42)
y01*RAV	0.332	0.294	0.829	0.354	0.324	0.659
	(7.69)	(6.52)	(8.71)	(5.71)	(5.20)	(3.87)
y04*RAV	0.367	0.362	0.371	0.256	0.252	0.368
	(8.16)	(7.99)	(3.74)	(3.90)	(3.81)	(2.30)
y07*RAV	0.255	0.243	-0.250	0.293	0.267	-0.141
	(5.83)	(5.54)	(-2.52)	(4.74)	(4.30)	(-0.86)
SELF	-0.483	-0.502	-0.160			
	(-8.31)	(-8.56)	(-1.40)			
y95*SELF	0.352	0.377	-0.365			
	(4.05)	(4.30)	(-2.42)			
y98*SELF	0.618	0.643	0.251			
	(7.51)	(7.77)	(1.55)			
y01*SELF	0.404	0.449	-0.133			
	(4.94)	(5.44)	(-0.85)			
y04*SELF	0.454	0.473	0.435			
	(5.66)	(5.85)	(2.76)			
y07*SELF	0.410	0.444	0.164			
	(4.83)	(5.20)	(1.01)			
N	6444	6356	1340	3153	3112	509

See notes to Table 1.

Table B2. Regression Results for Home Bias

	HB = DRA/TRA		HB=log(1+DRA/TRA)	
Variable	All Investors	Salaried	All Investors	Salaried
Constant	105.7	100.7	0.733	0.702
	(43.6)	(29.0)	(45.5)	(30.4)
lnEDU	-4.255	-6.686	-0.027	-0.0428
	(-6.81)	(-7.18)	(-6.39)	(-6.91)
lnTASST	-0.132	-0.141	-0.00036	-0.00045
	(-1.74)	(-1.29)	(-0.70)	(-0.62)
lnWAGE*	0.735	1.545	0.004	0.0093
	(3.32)	(4.96)	(2.74)	(4.49)
Y95	-13.21	-14.49	-0.088	-0.0961
	(-8.32)	(-6.51)	(-8.34)	(-6.50)
Y98	-3.976	-1.751	-0.026	-0.0111
	(-2.63)	(-0.82)	(-2.60)	(-0.78)
Y01	-2.551	1.858	-0.021	0.0084
	(-1.67)	(0.87)	(-2.12)	(0.59)
Y04	3.579	6.323	0.025	0.0438
	(2.25)	(2.85)	(2.33)	(2.97)
Y07	-6.934	-4.466	-0.046	-0.0289
	(-4.47)	(-2.07)	(-4.48)	(-2.02)
AGE	-0.044	-0.061	-0.00029	-0.00039
	(-2.31)	(-2.31)	(-2.27)	(-2.24)
y95*AGE	0.108	0.107	0.00067	0.00065
	(3.97)	(2.82)	(3.70)	(2.57)
y98*AGE	0.016	0.043	0.00009	0.00026
	(0.59)	(1.15)	(0.53)	(1.05)
y01*AGE	0.017	0.008	0.00012	0.0001
	(0.65)	(0.23)	(0.72)	(0.24)
y04*AGE	-0.028	-0.041	-0.00024	-0.00031
	(-1.08)	(-1.12)	(-1.39)	(-1.28)
y07*AGE	0.033	0.034	0.00023	0.00023
	(1.26)	(0.95)	(1.32)	(0.98)

See notes to Table 2.

Table B2. Regression Results of Home Bias (Continued)

	HB = DRA/TRA		HB=log(1+DRA/TRA)	
Variable	All Investors	Salaried	All Investors	Salaried
PROF	-0.469	1.085	-0.0033	0.0069
	(-1.04)	(1.75)	(-1.11)	(1.67)
y95*PROF	-1.732	-2.526	-0.0114	-0.0165
	(-2.73)	(-2.91)	(-2.69)	(-2.86)
y98*PROF	-0.055	-0.540	-0.0005	-0.0041
	(-0.09)	(-0.62)	(-0.13)	(-0.70)
y01*PROF	0.702	-1.075	0.0050	-0.0068
	(1.12)	(-1.24)	(1.20)	(-1.18)
y04*PROF	1.756	1.321	0.0119	0.0083
	(2.79)	(1.52)	(2.84)	(1.44)
y07*PROF	-1.446	-2.243	-0.0087	-0.0145
	(-2.27)	(-2.56)	(-2.06)	(-2.48)
RAV	-0.355	0.720	-0.0035	0.0037
	(-1.26)	(1.84)	(-1.89)	(1.40)
y95*RAV	2.245	2.856	0.0158	0.0199
	(5.38)	(4.90)	(5.69)	(5.14)
y98*RAV	1.293	0.105	0.0089	0.0012
	(3.28)	(0.19)	(3.39)	(0.32)
y01*RAV	0.479	-0.763	0.0045	-0.0038
	(1.19)	(-1.35)	(1.68)	(-1.00)
y04*RAV	-1.375	-2.176	-0.0086	-0.0143
	(-3.27)	(-3.63)	(-3.06)	(-3.58)
y07*RAV	1.356	0.479	0.0092	0.0033
	(3.32)	(0.85)	(3.40)	(0.87)
SELF	-2.620		-0.0178	
	(-4.82)		(-4.92)	
y95*SELF	3.242		0.0222	
	(3.99)		(4.12)	
y98*SELF	1.850		0.0129	
	(2.40)		(2.52)	
y01*SELF	1.041		0.0065	
	(1.36)		(1.28)	
y04*SELF	1.980		0.0139	
	(2.64)		(2.78)	
y07*SELF	3.220		0.0222	
	(4.05)		(4.20)	
N	6444	3153	6444	3153

See notes to Table 2.

Table B3. Home Bias at the Macro Level: Expanded Model

Expanded Model Using Projected Wages from Baseline Mincer Regressions				
	Full Sample		OECD Sample	
Variable	Unconditional	Conditional	Unconditional	Conditional
log(EDU^d)	-0.1007	-0.1572	-0.4454	-0.4233
	(-1.40)	(-2.24)	(-8.38)	(-7.92)
log(EDU^f)	0.5444	-0.1822	0.8045	0.4788
	(0.70)	(-0.18)	(1.12)	(0.75)
log($WAGE^{*d}$)		0.0569		0.0268
		(1.49)		(1.13)
log($WAGE^{*f}$)		-1.1287		-0.7397
		(-3.85)		(-2.94)
log($GDPPC^d$)	-0.2165	-0.2496	-0.2893	-0.3050
	(-8.64)	(-7.14)	(-19.4)	(-15.8)
log($GDPPC^f$)	-0.8593	0.7086	-1.0716	-0.1838
	(-1.15)	(0.66)	(-1.55)	(-0.27)
M/G^d	0.1250	0.1089	0.1723	0.1584
	(6.61)	(5.62)	(13.1)	(10.9)
M/G^f	0.8891	0.0746	0.9665	0.5107
	(1.71)	(0.24)	(1.92)	(1.29)
LONG	0.1800	0.1470	0.1119	0.0830
	(3.54)	(3.24)	(3.53)	(3.19)
EU	0.0261	0.0477	-0.0417	-0.0248
	(1.52)	(2.88)	(-3.23)	(-1.80)
ENGLISH	-0.1180	-0.1063	-0.0969	-0.0936
	(-6.49)	(-6.29)	(-7.09)	(-6.80)
SPANISH	0.0235	0.0078	-0.0946	-0.0856
	(0.71)	(0.24)	(-3.78)	(-3.55)
N	148	148	126	126
Adjusted R^2	0.6353	0.6627	0.8591	0.8680

Notes: The expanded model includes our additional control variables. “Unconditional” refers to the regression excluding the WAGE* regressors. “Conditional” refers to the regression including them. The numbers in parentheses are t-ratios constructed from robust standard errors.

Table B4. Home Bias Regression at the Macro Level

Baseline Model Using Projected Wages from Extended Mincer Regressions				
	Full Sample		OECD Sample	
Variable	Unconditional	Conditional	Unconditional	Conditional
$\log(EDU^d)$	-0.1263	-0.2092	-0.2347	-0.3279
	(-2.04)	(-2.96)	(-4.35)	(-6.05)
$\log(EDU^f)$	0.8719	0.7796	0.6148	0.4228
	(0.91)	(0.78)	(0.62)	(0.41)
$\log(WAGE^{*d})$		0.1291		0.1266
		(5.35)		(5.32)
$\log(WAGE^{*f})$		-1.2152		-1.2798
		(-5.51)		(-5.38)
$\log(GDPPC^d)$	-0.1783	-0.2894	-0.1836	-0.2966
	(-11.8)	(-13.1)	(-12.7)	(-14.4)
$\log(GDPPC^f)$	-0.9846	-0.2537	-0.7792	0.088
	(-1.08)	(-0.25)	(-0.82)	(0.08)
N	133	133	123	123
Adjusted R^2	0.5148	0.6441	0.5471	0.6887

Notes: The Baseline model is equation (13). The extended Mincer regression includes sex ratios and infant mortality risks in addition to the basic Mincer regression. “Unconditional” refers to the regression excluding the WAGE* regressors. “Conditional” refers to the regression including them. The numbers in parentheses are t-ratios constructed from robust standard errors.

Table B5. Home Bias Regression at the Macro Level

Extended Model Using Projected Wages from Extended Mincer Regressions				
	Full Sample		OECD Sample	
Variable	Unconditional	Conditional	Unconditional	Conditional
log(EDU^d)	-0.1075	-0.1041	-0.4391	-0.4330
	(-1.26)	(-1.24)	(-8.47)	(-7.55)
log(EDU^f)	1.8582	1.3108	0.9917	0.7267
	(2.48)	(2.04)	(1.41)	(1.17)
log($WAGE^{*d}$)		0.0590		0.0551
		(2.15)		(2.27)
log($WAGE^{*f}$)		-0.7912		-0.5336
		(-3.93)		(-2.67)
log($GDPPC^d$)	-0.2479	-0.2886	-0.2858	-0.3233
	(-12.7)	(-14.4)	(-18.4)	(-17.7)
log($GDPPC^f$)	-2.1093	-1.0756	-1.2682	-0.6768
	(-2.93)	(-1.61)	(-1.88)	(-1.06)
M/G^d	0.1323	0.1081	0.1677	0.1482
	(7.43)	(5.14)	(12.1)	(8.80)
M/G^f	0.6513	0.0315	0.8485	0.4155
	(1.41)	(0.10)	(1.74)	(1.08)
LONG	0.2518	0.1731	0.1489	0.0848
	(4.38)	(3.40)	(3.46)	(2.31)
EU	0.0165	0.0137	-0.0350	-0.0388
	(0.97)	(0.85)	(-2.52)	(-2.97)
ENGLISH	-0.0956	-0.0975	-0.0969	-0.0998
	(-5.15)	(-5.75)	(-6.81)	(-7.10)
SPANISH	0.0756	0.0875	-0.0833	-0.0701
	(2.20)	(2.65)	(-3.31)	(-2.98)
N	133	133	123	123
Adjusted R^2	0.7635	0.7804	0.8622	0.8728

Notes: The expanded model includes our additional control variables. The extended Mincer regression includes sex ratios and infant mortality risks in addition to the basic Mincer regression. “Unconditional” refers to the regression excluding the WAGE* regressors. “Conditional” refers to the regression including them. The numbers in parentheses are t-ratios constructed from robust standard errors.

Appendix C. Determining the Equilibrium Cost Differential under Scenario 2

To gain insight about the equilibrium cost differential $(H_{d,d} / H_{d,f})^{\theta_3/\theta_1}$ which is consistent with the observed trajectory of home bias as a function of general human capital ($H_{d,0}$) proxied by schooling, we pursue the following exercise, based the on micro-level US data used in section 6. These data show that groups 1 and 2, as defined in section 8.1, account for 60% and 40% of the dollar value of US's risky portfolio. In this case the share of domestic assets in the risky portfolio of the representative investor in the US (SR), and thus the US home bias measure, can be computed as

$$HB_d = 0.6\ HB_1 + 0.4\ HB_2 \tag{C.1}$$

where HB_j (j=1,2) represents the share of domestic assets in the risky asset portfolio of groups 1 and 2, respectively. In the following exercise, we assume that the US shares of groups 1 and 2 in the risky portfolio are the same across all countries (thus country d).

Since group 1 specializes in the domestic asset, the trajectory of the home-bias level of group 1 as a function of schooling is thus a flat curve at a value HB=1. To determine the corresponding home-bias trajectory of group 2, we pursue the same method discussed in Section 8.1 under "scenario 1". That is, we assume that group 2 consists of homogeneous investors, all holding equal shares of assets d and f. We then simulate our model numerically to derive trajectories of the home bias of group 2's representative investor under alternative values the investor's endowed information advantage ($H_{d,d} / H_{d,f}$). For each trial value, we compute the home bias trajectory of the average investor in country d using equation (C.1). We then determine the equilibrium value of $H_{d,d} / H_{d,f}$ as the one producing the trajectory which most resembles the empirically observed trajectory in Figure (A.1), i.e., the estimated regression line based on Table 3 for the full sample. This produces an equilibrium value of $H_{d,d} / H_{d,f}$ = 2.1. The maximal equilibrium cost differential explaining the observed trajectory of home bias is thus 4.4.