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THE ROLE OF HUMAN CAPITAL IN IMPERFECTLY INFORMED INTERNATIONAL FINANCIAL MARKETS

Isaac Ehrlich and Jong Kook Shin

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Isaac Ehrlich*

State University of New York at Buffalo

National Bureau of Economic Research

Hong Kong Institute for Monetary Research

and

Jong Kook Shin

State University of New York at Buffalo

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* Corresponding author: Ehrlich: State University of New York at Buffalo, Buffalo NY 14260, (email: mgtehrl@buffalo.edu);

Shin: State University of New York at Buffalo, Buffalo NY 14260, (email: jongshin@buffalo.edu)

This paper was presented at the American Economic Association's meetings in the session titled *New Directions in the Economic Analysis of Human Capital* on January 5, 2010. A related paper on the same topic is available as NBER Working Paper 15668 "Human Capital, Endogenous Information Acquisition and Home Bias in Financial Markets" by Isaac Ehrlich, Jong Kook Shin and Yong Yin. An earlier version of this study was authored by Isaac Ehrlich and Jong Kook Shin when Ehrlich was a visiting scholar at the Hong Kong Institute for Monetary Research in spring 2009.

Deviating from conventional models in financial economics which maintain that markets are perfectly informed, more recent work has relied on the role of private information to explain observed portfolio choices or their impact on market outcomes in financial and currency markets (see, e.g., Philippe Bacchetta and Eric Van Wincoop 2006, and Stijin Van Nieuwerburgh and Laura Veldkamp 2009). These studies have not offered, however, a testable model of endogenous information acquisition. Following Isaac Ehrlich, William A. Hamlen Jr. and Yong Yin (2008), we here pursue such a model, based on the role of human capital in information production, and test its power to explain variations in “home bias” – the holding of home, relative to foreign stocks – across international markets.

There is an extensive literature in financial economics that offers various explanations for “home bias”. What we add to these studies is the role of prior knowledge and private information acquisition in imperfectly-informed markets. Our model of endogenous information acquisition, or “asset management” (cf. Isaac Ehrlich and Uri Ben-Zion, 1976), relies on heterogeneity in individuals’ human capital endowments – both “general” and “specific” – to explain evidence on diversity in home bias at both the micro and macro levels in a multi-asset framework. Our model predicts that while a conditional increase in general human capital, proxied by schooling, increases the expected absolute demand for both home and foreign stocks, “home bias” at the market level is an inverted-U function of schooling. This prediction is confirmed in our empirical investigation.

1. The Basic Model

For the sake of a simple exposition, consider an exchange economy with two countries, a risk-free bond and two risky assets or mutual funds, domestic (*d*) and foreign (*f*), supplied by firms from their respective countries (*d* and *f*). These assets are traded in a fully integrated, competitive world exchange, i.e., there are no capital controls. Investors share identical priors about the distribution of returns per asset, $\tilde{\mu} \sim N(\bar{\mu}, \Sigma_\mu)$ where $\tilde{\mu} = [\tilde{\mu}_d, \tilde{\mu}_f]'$. The distribution of asset supplies *per investor* is given by $\tilde{x} \sim N(\bar{x}, \Sigma_x)$, where $\tilde{x} = [\tilde{x}_d, \tilde{x}_f]'$ and Σ_x is a diagonal matrix. The random supplies of assets inject uncertainty concerning the market valuation of the underlying assets, so asset prices cannot be fully revealing of the assets’ future returns.

There is a large number of investors (*i*) in countries *d* and *f*, N_d and N_f, respectively, all indigenous to their countries (for simplicity we abstract from migration). Investors live over two periods. In the first they search for information signals and make portfolio allocation decisions, and in the second they realize portfolio returns, which are used to finance consumption. Search for private information amounts to generating a forecast of second period returns: $\tilde{z}_i = \tilde{\mu} + \tilde{\varepsilon}_i$, where $\tilde{\varepsilon}_i \sim N(0, S_i^{-1})$ is a forecast error, and S_i is the error’s inverse variance serving as an index of *private information precision*. We assume, for simplicity, that S_i is a diagonal matrix.

Search for information signals is costly, involving time and direct inputs by investors. Direct inputs may include purchase of informational services from analysts or brokers in a competitive information market, 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 thus part of what we call asset management, and the effectiveness of search is dictated by investors' prior knowledge and ability we identify as "human capital endowments". We distinguish two kinds: "general" and "specific". Investor *i*'s "general human capital" ($H_{i,0}$) raises his efficiency in managing both domestic and foreign stocks. The empirical counterpart would be one's formal schooling level. Investor *i*'s "specific human capital" ($H_{i,k}$, $k = d, f$), in contrast, is comprised of specific country attributes like language and culture, and is thus shared by all investors in their respective countries. An essential assumption in our model is that one always has more "specific human capital" about one's own country than a foreign country, i.e., $H_{i,d} > H_{i,f}$. Investors are heterogeneous, however, in their "general human capital", or schooling endowments, both within and across countries.

The production function of information precision is given by the Cobb-Douglass function $S_{i,k} = Aq_{i,k}^{\theta_1} H_{i,0}^{\theta_2} H_{i,k}^{\theta_3}$ where $q_{i,k}$ denotes time spent on the management of asset *k* by investor *i*, and *A* denotes external technology (or impact of purchased inputs). The asset management direct and opportunity costs are thus given by $C_i=C_{i,d}+ C_{i,f}$ where $C_{i,k} =C(S_{i,k}) = w_i q_{i,k}+C_{k,0}$, $w_i = w_i(H_{i,0}, \lambda_i)$ denotes one's wage rate as a function of schooling and labor market experience, with $\partial w_i / \partial H_{i,0} \geq 0$, and $C_{k,0}$ denotes fixed information costs, including brokerage and trading costs.

The investor's 2-period optimization problem is to maximize an expected utility function $E[-\exp(-W_{i1}/r)]$ of final wealth W_{i1} and risk tolerance *r* with respect to his choice variables: information precision, S_i, a demand vector for domestic and foreign stocks, D_i, and a zero coupon bond B_{i1}, taken as a numeraire. (Note that the exponential utility function precludes any pure wealth effects in our model). The maximization is subject to the budget constraint $W_{i0} = \tilde{P}' D_i + B_{i1} + C_i$ where W_{i0} denotes initial wealth. Final wealth includes the returns on the stocks and bonds purchased in the first period: $W_{i1} = \tilde{\mu}' D_i + B_{i1}$

The complex maximization problem can be described heuristically as a two-stage simultaneous optimization problem. In the second stage we solve for portfolio choice and equilibrium in the asset market, conditional on a given distribution of investors' private information. In the first stage, we use the portfolio allocation solution from the second stage to solve for optimal information acquisition, or asset management, and arrive at a full solution.

2. Optimal Demand and Testable Propositions

Expected individual demand for asset *k* over its endowed supply $\bar{x}_k$ is found to be

$$E[D_{i,k}] = r(S_{i,k} - S_{A,k})\, E[\tilde{\mu}_k - \tilde{P}_k] + \bar{x}_k \text{ for all } i,\, k \tag{1}$$

Expected demand for domestic (*d*) and foreign (*f*) stocks is thus a product of investor *i*'s information precision relative to the world's average investor's, $(S_{i,k} - S_{A,k})$, and the expected excess return on asset *k*, $E[\tilde{\mu}_k - \tilde{P}_k]$. While $(S_{i,k} - S_{A,k})$ can be negative or positive, $E[\tilde{\mu}_k - \tilde{P}_k]$ is always positive for risky assets. Specified in matrix form, it can be shown equal to

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

where $S = \frac{1}{N}\sum_{i=1}^{N} S_i$ denotes the average private information level and $r^2 S\Sigma_x^{-1} S$ represents what we term "Price Information Content" (PIC). The term acts like a public signal for all investors, as it reflects the degree to which observed market prices reveal information. Equation (2) indicates that excess return on asset *k*, $E[\tilde{\mu}_k - \tilde{P}_k]$, falls with both average information precision $S_{A,k}$ and $PIC_{k,}$, (the k^{th} diagonal entries in *S* and PIC, respectively) because higher levels of these variables reduce the posterior variance of returns on asset *k*, $V_{i,kk}$, thus increasing the average investor's demand for and market price of *k*, P_k. This, in turn, lowers the excess return on *k*.

Given the optimal portfolio choice in equations (1) and (2), we can now complete our analysis by deriving the conditions for optimal information precision S_{ik}^* and asset management:

$$MR_{i,k} = \tfrac{r}{2} V_{i,kk} = w_i(\partial q_{i,k} / \partial S_{i,k}) = \theta_1^{-1} w_i S_{i,k}^{\frac{1-\theta_1}{\theta_1}} \left(A H_{i,0}^{\theta_2} H_{i,k}^{\theta_3}\right)^{-1/\theta_1} = MC_{i,k} \quad for\ k = d, f \tag{3}$$

where the marginal revenue of S_{ik}, $MR_{i,k}$, is proportional to the posterior variance of returns on asset *k*, $V_{i,kk}$ which is a decreasing function of $S_{i,k}$ (see Isaac Ehrlich, Jong Kook Shin and Yong Yin, 2010), and the marginal cost of S_{ik}, $MC_{i,k}$, is an increasing function of $S_{i,k}$. Based on equations (1), (2) and (3) we can derive testable implications concerning the demand for domestic and foreign assets.

2.1 Implications for Assets Demand at the Micro Level

Investors take the market solutions, hence $S_{A,k}$ and PIC_k as given. We can thus derive testable implications from equations (1) and (3). These imply that a. A rise in general human capital $H_{i,0}$ (schooling) and the wage rate w_i always have *opposite effects*: a conditional rise in $H_{i,0}$ (given w_i) *increases* *i*'s expected demand for both domestic and foreign assets, *d* and, *f,* while a conditional rise in w_i *lowers* both; b. An unconditional increment in $H_{i,0}$ thus has a smaller impact on demand relative to a conditional rise; c. Portfolio size, or other technological variables that lower the fixed asset management costs, or raise its efficiency, also increase demand for both domestic and foreign assets. We actually verify these predictions using micro data (See Ehrlich, Shin and Yin, 2010). These effects hold for the representative investor as well. The basic difference, however, is that at the market level, *S* and PIC are endogenously determined.

2.2 Implications for Assets Demand at the Macro Level

By equation (1), the expected demand for risky assets by country *d*'s average investor is $E[D_{d,k}] = r(S_{d,k} - S_{A,k})E[\tilde{\mu}_k - \tilde{P}_k] + \bar{x}_k$, *k*= (*d*, *f*). To derive testable implications at the market level, we differentiate equation (4) with respect to a *conditional* increases in average schooling ($H_{d,0}$), holding constant the wage rate w_d. The results are given by equation (4), and graphically by the trajectory of agent *d*'s expected demand for the domestic and foreign assets in **Figure 1A**:

$$\partial E[D_{d,k}]/\partial H_{d,0} = r\{E[\tilde{\mu}_k - \tilde{P}_k]\partial(S_{d,k} - S_{A,k})/\partial H_{d,0} + (S_{d,k} - S_{A,k})\partial E[\tilde{\mu}_k - \tilde{P}_k]/\partial H_{d,0}\} \quad (4)$$

Note that a similar analysis with the same or reverse signs applies to the impact of portfolio size, or conditional increments in the wage rate $w_{i.}$, respectively.

a. ***Direct effects of $H_{d,0}$ on E[$D_{d,d}$]*** : An incremental increase in schooling ($H_{d,0}$) always increases agent *d*'s information precision about asset *d* and her information advantage over the world's average investor: $\partial(S_{d,d}-S_{A,d})/\partial H_{d,0} > 0$. Such an increase, however, can be shown to also raise the price information content of asset *d*'s price, PIC_d, hence the total demand and price of asset *d*, P_d, which lowers the expected return on asset *d*. The net effect is ambiguous, but traceable, since it depends on the interaction between the change in the expected excess return and the level of agent *d*'s information advantage. If $(S_{d,d}-S_{A,d}) < 0$, which would be the case when agent *d*'s schooling level ($H_{d,0}$) is very low relative to that of the average world investor (and agent *f*, $H_{f,0}$), the decline in the perceived riskiness of asset *d* brought about by the rise in PIC_d would reinforce the impact of the higher information advantage brought about by the higher schooling level, $H_{d,0}$. The expected demand for the domestic asset could then rise sharply. As agent *d*'s schooling level keeps rising from nil, however, her information advantage will first become nil (at which point her expected demand will equal the asset's per-capita supply, $\overline{x}_d$), then positive ($S_{d,d}$−$S_{A,d}$) ≥0, and the dominant effect of PIC_d would be its adverse impact on expected excess demand on asset *d*. This would erode the increase in demand for asset *d* until it reaches a peak and starts falling (see our numerical simulation in **Figure 1A**). Note that as $H_{d,0}$ rises toward an infinite value, $S_{A,d}$ and PIC_d likewise rise and the asset price P_d tends to become fully revealing. At that point, the optimal demand for asset *d* will again reach its expected supply per investor, $\overline{x}_d$.

b. ***Direct effects of $H_{d,0}$ on $E[D_{d,f}]$***: the same analysis applies to agent *d*'s demand for the foreign asset *f* – its trajectory is also an inverted-U function of $H_{d,0}$, except that $E[D_{d,f}]$ rises more slowly with $H_{d,0}$, peaking at a higher schooling level because $H_{d,d}>H_{d,f} << H_{A,f}$ (see **Figure 1A**).

c. ***Cross effects of $H_{d,0}$* on *$E[D_{f,d}]$***: Here the trajectory (not shown in Fig 1) is simply a mirror image of that of $E[D_{d,d}]$ by the market clearing condition $(N_f/ \Sigma N_k)E[D_{f,d}]+(N_d/ \Sigma N_k)E[D_{d,d}]= \overline{x}_d$.

2.3 Implications for "Home Bias" at the Market Level

We use two definitions of home bias. The first is simply $HB_{d1} = E[D_{d,d}] / E[D_{d,f}]$, or the ratio of expected demand for the home relative to the foreign asset. The other is the conventional measure in the literature, which transforms the relative demands into the deviation of the actual percentage of home assets in the portfolio (ACT) from that predicted by CAPM, the share of the home country's market capitalization in the world portfolio, denoted CAPM, and normalized to account for difference in total market capitalization: $HB_{d2} = (ACT_d – CAPM_d)/(1 – CAPM_d)$

a. *Direct effects of conditional increment in $H_{d,0}$ on home bias in country d*: It can easily be verified that the trajectories of the two HB_d measures, as functions of $H_{d,0}$, are monotonically related. The trajectory of $E[D_{d,d}] / E[D_{d,f}]$ as a home bias measure is easily inferred from **Figure 1B**. Since $E[D_{d,f}]$ rises more slowly than $E[D_{d,d}]$ and peaks at a higher level of $H_{d,0}$, HB_{d1} rises more sharply than $E[D_{d,d}]$ and starts declining at a very low level of $H_{d,0}$. The upward segment of the HB_{d1} trajectory is thus not likely to be observed empirically since even stock exchanges in emerging markets are associated with at least modest average schooling levels of the population.

b. *Cross effects of conditional increments in $H_{d,0}$ on home bias in country f*: Like HB_{d1}, the trajectory of home bias in country *f*, $HB_{f1} = E[D_{f,f}]/E[D_{f,d}]$, as a function of $H_{d,0}$ can be derived as the ratio $E[D_{f,f}]$ to $E[D_{f,d}]$. Both $E[D_{f,f}]$ to $E[D_{f,d}]$ would be decreasing with $H_{d,0}$, but the latter would be falling more sharply. Hence, the trajectories of the home bias measures, HB_{f1} and HB_{f2}, also assume an inverted-U shape. As our numerical analysis indicates, however, the upward-sloping segment of the trajectories rises more slowly and becomes flat before turning south. Most empirical observations are likely to locate on this segment (see **Figure 1C**).

3. Empirical Implementation

We test our model's implications concerning direct and cross effects, as well as our hypotheses concerning the effects of determinants of demand, against pooled data on home bias in 23 countries over a 7-year period (2001-07). The baseline regression model we implement is:

$$\ln(HB_{d2}) = a_0+a_1\ln(EDU_d)+a_2\ln(EDU_f)+|a_3\ln(Wage^*_d)|+|a_4\ln(Wage^*_f)|+a_5\ln(gdp_d)+ a_6\ln(gdp_f) \quad (5)$$

Note that our model requires using both "home country" and corresponding "foreign countries" variables to implement our testable hypotheses of direct and cross effects on home bias. Since our dependent variable is home bias in the home country (*d*) all "foreign" variables are constructed as averages of all countries weighted by market capitalization, excluding the home country. The empirically relevant home-bias measure, HB_{d2}, is constructed with data from the IMF's Coordinated Portfolio Investment Survey and the World Federation of Exchanges; data on average schooling attainments is taken from the most recent Barro and Lee's index. Note that since we have just one reliable year of data on education we run our regressions as a pooled cross-section with year dummies; hourly earnings are taken from the Bureau of Labor Statistics; and per-capita GDP, gdp, a proxy for portfolio size, are taken from the World Bank. The wage variable we use, Wage*, is *projected* from a Mincer model where log (wage) is regressed on schooling, experience, and experience-squared for two reasons: being based on earnings data, it may be affected by time allocated to work. Also, the wage data include total compensations which may vary across countries. A projected wage may minimize measurement errors.

The results in **Table 1** and **Figure 1D** strongly support our basic hypotheses. EDU_d and $Wage_d^*$ have opposite signs: home-country schooling lowers home-bias while the projected home wage rate increases it, and the home portfolio size proxy works in the same direction as schooling. All these effects are statistically significant. The cross effects are found to work in opposite direction to the direct effects or are statistically insignificant, consistent with the expectation that they are located on the upward-sloping or flat segments of the trajectory in **Figure 1C.** As a robustness test we have also implemented an expanded regression model (not reported) where we added to the equation (5) a set of variables often used in the literature: the ratio of market capitalization to GDP in the home and foreign markets; the longitudinal (time-zone) difference between the home and foreign market; a dummy for EU membership; a dummy variable for English-speaking countries; a dummy variable for Spanish-speaking countries; and trade openness. The qualitative results remain generally quite similar to those reported in Table 1.

4. Conclusion

Our propositions concerning the role of private information and asset management as determinants of diversity in portfolio concentrations across imperfectly informed international financial markets are subject to strong assumptions, especially treating the markets as fully integrated. There clearly exist constraints on trade and exchange which impede the openness of international markets. Yet our model and empirical analysis appear to have significant power to explain observed diversities in “home bias”, even without accounting for these constraints.

The explanation rests on asymmetries in endogenous private information and “price information content”, or the degree to which market prices actually reveal information. In our model, these asymmetries stem from unequal information costs, coming from differences in endowed knowledge or “specific human capital” investors have concerning their home relative to foreign risky assets. In a separate analysis (see Ehrlich, Shin and Yin, 2010), we show that the asset management cost differences accounting for the observed pattern of home bias are of the order of at most 4 to 1, since they include differences in fixed information or trading costs as well.

Our model has important applications beyond home bias concerning observed “disconnect with fundamentals” in currency markets, the pattern of volatility contagion following financial shocks, and variations in market risk premiums. These are left for future work. More generally, the analysis points to the scope of issues in the “new information economy” where human capital theory can provide new insights.

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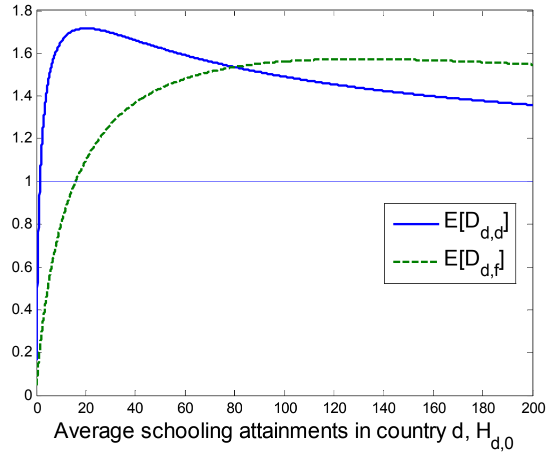
Table 1. Home Bias Regression at the Macro Level: Dependent Variable is ln(HB_{d2})

	Full Sample		OECD Sample	
Variable	Unconditional	Conditional	Unconditional	Conditional
ln(EDU_d)	-0.1805***	-0.2456***	-0.2518***	-0.3069***
	(0.0588)	(0.0558)	(0.0546)	(0.0453)
ln(EDU_f)	-0.0439	-0.3176	0.5802	0.4844
	(1.0993)	(1.2425)	(0.9985)	(0.9623)
ln($Wage^*_d$)		0.0802**		0.0898***
		(0.0391)		(0.0306)
ln($Wage^*_f$)		-1.5285***		-1.5918***
		(0.2716)		(0.2724)
ln(gdp_d)	-0.1314***	-0.1912***	-0.1807***	-0.2537***
	(0.0225)	(0.0399)	(0.0147)	(0.0278)
ln(gdp_f)	-0.1120	1.2597	-0.7524	0.4942
	(1.0457)	(1.2964)	(0.9500)	(1.0010)
Adjusted R^2	0.4192	0.5111	0.5452	0.6620
N	148	148	126	126

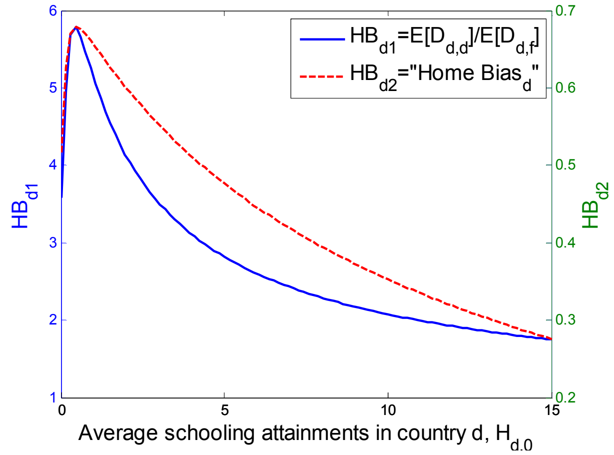
Notes: "Unconditional" refers to the regression excluding the Wage regressors. "Conditional" refers to the regression including them. The numbers in parentheses are White's robust standard errors. *, **, *** denote the statistical significance at 10%, 5% and 1%, respectively. Time dummies are used to control for the year fixed effect.

Figure 1. Impact of Country *d*'s Schooling on Demand and Home Bias

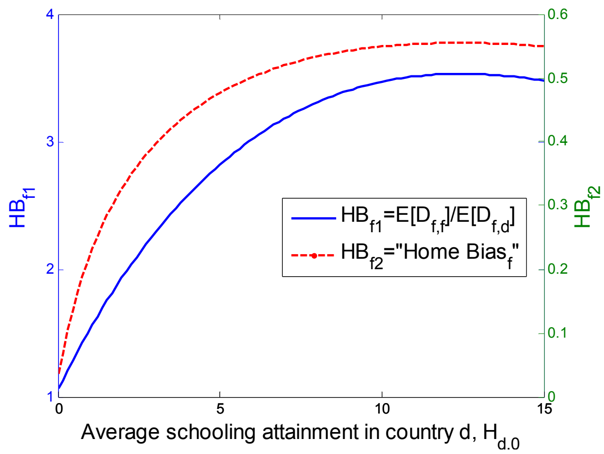
A: Direct effects on demand for *d* and *f*



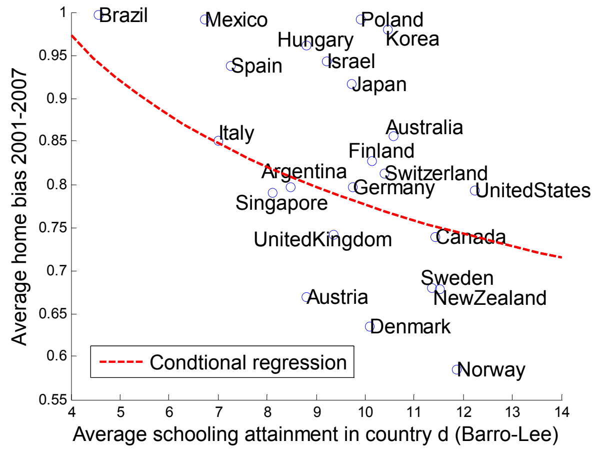
B: Direct effects on country *d*'s home bias



C: Cross effects on country *f*'s home bias



D: Partial regression coefficient effect - full sample



$H_{d,d}$=$H_{f,f}$=3, $H_{d,f}$=$H_{f,d}$=1, $\bar{\mu}_d = \bar{\mu}_f$ =10, $\bar{x}_d = \bar{x}_f$ =1, r=1/3, A=1, N_d/N=N_f/N=0.5, θ_1=0.5,

$\theta_2 = \theta_3$=1, $Var(\tilde{\mu}_d)$=$Var(\tilde{\mu}_f)$=10, $Cov(\tilde{\mu}_d, \tilde{\mu}_f)$=5, $Var(\tilde{x}_d)$=$Var(\tilde{x}_f)$=3, $Cov(\tilde{x}_d, \tilde{x}_f)$=0