International Trade and Portfolio Diversification: the Role of Information*

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Abstract

I show that information choice can explain the puzzling positive relation between bilateral investment and trade across countries. I present a model of endogenous information with both investment in assets and income from trade. While standard model of risk-hedging would require agents to invest in non-trading countries to diversify income risk, I show that limited information capacity and preferences for early resolution of uncertainty reverse this result. The intuition is that investors collect more information on trading partners to reduce income uncertainty, and therefore perceive their equity as less risky. I find that allowing for information choice reduce the role of risk hedging on portfolio decisions. I test my model's implied relation between trade and attention in the data and find robust empirical support.

JEL Codes: F3, F4, G11, G15, D8, D83

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1 Introduction

A long standing puzzle in the international finance literature is the empirical positive relation between bilateral trade in goods and portfolio investment between countries (Portes and Rey, 2005; Aviat and Coeurdacier, 2007; Lane and Milesi-Ferretti, 2008; Galstyan et al., 2016). While this finding is hard to reconcile with risk hedging motives, in this paper I show that it can be rationalized in an endogenous information setting..

According to a standard risk-hedging view, agents should diversify the positive correlation between financial and non-financial income by holding a higher share of foreign asset (Baxter and Jermann, 1997). Since trade makes domestic non-financial income more affected by trading partner's risk factors, agents should diversify their income by holding fewer trade partner's equities as trade increases. This basic result is in stark contrast with the empirical positive relation between bilateral investment and trade across country pairs.

I show that allowing investors to collect information before their investment decision helps rationalize the empirical evidence. I follow the literature in introducing investors with preferences for early resolution of uncertainty (Van Nieuwerburgh and Veldkamp, 2009). I show that investors decide to collect information on trading partner's country risk factors to decrease the perceived riskiness of their non-financial income. The resulting higher information and lower perceived riskiness of the foreign country increases desired bilateral investment. I show that information choice decrease the magnitude of risk-hedging motives and can offset diversification incentives, leading to higher investment in trading country's asset. To the best of my knowledge, this is the first paper to investigate theoretically the relation the impact of information choice on on investment and trade.[1]

Model I consider a two-country static investment model, where investors receive (i) financial income from their asset portfolio and (ii) non-financial income from wages. They decide the composition of their portfolio between a domestic asset, a foreign asset and a risk-free asset. They receive a wage from a local firm selling domestic goods in both countries. Preferences for domestic and foreign goods in each country determines the amount of trade and therefore firm's (and wage's) exposure to domestic and foreign demand. Demand for goods and asset return in each country depend on a country-specific risk factor

[1] While also Dasgupta and Mondria (2018) applies the endogenous information approach to a trade model, they do not study investment, but jut trade flows.

and therefore are positively correlated.

I show that this simple setting can not match the empirical finding. In this model, the higher is trade with the foreign country, the more correlated is domestic investor's non financial income with foreign asset return, and therefore higher the incentive to not invest abroad to diversify income. Bilateral trade and portfolio investment are negatively correlated, contrary to the data.

I extend this basic setting by assuming that investors are limited in their capacity to process information. Before investing, they choose the quantity of information to acquire on domestic and foreign countries with the intent to decrease perceived uncertainty of future financial and non-financial income.[2] While trade is given by preferences, investment decision depends on asset's perceived riskiness and therefore on information choice.

I show that a model with information choice leads to an opposite outcome with respect to the standard model. In absence of trade, domestic agent's non-financial income is affected only by domestic risk. Thus he collects information only on domestic risk factor and invest mostly on domestic country since he perceives it as less risky. When the amount of trade is larger, domestic agent's non-financial income is more exposed to foreign risk. Thus he collects information also on the foreign risk factor and increases investment in foreign asset since he perceives it as less risk. While the risk-hedging motives of the standard model are still present, I show that information choice decreases their importance in agent's portfolio allocation. Bilateral trade and portfolio investment are positively correlated, consistently with the data.

My model relies on the assumption that financial and non-financial returns are correlated, but it does not rely on a particular correlation sign.[3] If the correlation is positive, the mechanism works against risk hedging; if it is negative, it provides an amplification mechanism. Importantly, while a risk-hedging explanation always implies optimal risk sharing, the friction introduced by cognitive limitation makes the final allocation inefficient.

Empirical analysis The main implication of my model is that trade increases investment in assets through attention allocation. I test this implication in the data. I follow the financial literature in measuring attention using Google search queries from *GoogleTrend*:[4]

[2] I follow Van Nieuwerburgh and Veldkamp (2009) in using an Shannon (1948) entropy constraint to limit attention.

[3] One can think of it as a reduced form of country specific supply or demand shocks.

[4] Da et al. (2011) and Andrei and Hasler (2014), while Mondria et al. (2010) use a different but similar proxy.

I proxy the attention of some country H to another country F with an index measuring the volume of Google researches in country H with the keyword "F" in category "finance". I regress this proxy for attention on bilateral trade (export plus import), equity holding by households in origin country and other standard bilateral controls.[5] I have a panel of nearly 40 origin and 130 destination countries, from 2004 to 2015. Observations are at the country-pair level, and I include origin and destination country-time fixed effect.

My model implies that, controlling for equity holdings, trade affects positively attention allocation. The empirical test confirms my result: the impact of trade on the attention index is meaningful and strongly significant. I run some robustness tests using instrumental variables for trade and total assets to measure portfolio holdings, with the same result.

Contribution to the literature This paper contributes to different strands of the international macroeconomic and financial literature. First, it relates to the works on portfolio under-diversification and risk-hedging. Some papers explain observed equity home bias with real exchange rate risk hedging (Obstfeld and Rogoff, 2000; Coeurdacier, 2009; Benigno and Nistico, 2012)[6], while others argue that non-financial income and domestic equity returns are actually negatively correlated (Bottazzi et al., 1996; Julliard, 2002; Heathcote and Perri, 2013; Coeurdacier and Gourinchas, 2016). The most related to my paper is Heathcote and Perri (2013), which provides a model where domestic equity return are negatively correlated with non-financial income, but this covariance is less negative the more is the country's openness to trade. Therefore higher trade leads to higher diversification. This paper provide a mechanism matching the same empirical finding without relying on particular correlation sign between financial and non-financial income, but with very different implication in terms of risk sharing efficiency.

Second, this paper relates to the empirical literature on international capital flows, documenting the positive relation between trade in goods and equity investment at the cross country level (Lane, 2000; Heathcote and Perri, 2013) and at the paired countries level (Portes and Rey, 2005; Aviat and Coeurdacier, 2007; Lane and Milesi-Ferretti, 2008; Galstyan et al., 2016). My contribution is to provide a theoretical model to rationalize this

[5] I consider only households and not total holdings in order to address the objection that information frictions might not result from endogenous attention choices but they might be caused by private information that trading firms obtain with personal and business contacts in the foreign country.

[6] However, Van Wincoop and Warnock (2010) documents that the empirical correlation between exchange rate and equity return is too low to justify the observed home bias in equity.

pattern. This paper is also consistent with Massa and Simonov (2006), which uses Swedish micro-data to argue that investment pattern does not seem to be explained by hedging risk, but by a "familiarity" effect.

Third, this paper relates to the works on portfolio home bias and information frictions (Merton, 1987; Gehrig, 1993; Brennan and Cao, 1997), and in particular later models of endogenous information (Van Nieuwerburgh and Veldkamp, 2009; Mondria et al., 2010; Valchev, 2017). I extend the investment model with endogenous information to incorporate non-financial income from trade and show that the structure of non-financial income affect final attention and portfolio allocation. Moreover, I show that the importance of the risk-hedging term depends on information choice.

The paper is organized as follows. Section 2 present some motivational evidence documenting the positive causal relation between trade in goods and portfolio investment between countries; section 3 develops an endogenous information model of investment with trade between two countries; section 4 presents the model solution; section 5 explains the results; section 6 brings the model's implications to the data; finally, section 7 concludes.

2 Motivating Evidence

This paper investigate the puzzling positive correlation between portfolio investment and trade between country pairs. The literature has widely documented this positive correlation using gravity-like equations (Portes and Rey, 2005; Aviat and Coeurdacier, 2007; Lane and Milesi-Ferretti, 2008; Galstyan et al., 2016). Moreover, the model presented here is consistent with two additional findings. First, Aviat and Coeurdacier (2007) document a strong positive causal relation from trade in goods to equity flows, but not the reverse direction. In line with this result, in my model trade will originate from consumers' preferences and affect portfolio investment.[7] Second, Galstyan et al. (2016) break down the results by holding sectors and find that gravity patterns in equity investment are weaker for professional investors than for retail ones. This finding is consistent with a model of cognitive limitations where professional investors are less cognitively bounded than retail investors.

[7] Even though Aviat and Coeurdacier (2007) do not take a stand on why trade in goods causes equity investment, they mention the role of trade in decreasing information asymmetry as one possible explanation.

I document empirically the positive relation between trade and portfolio investment as motivational fact for my theoretical contribution. First, I isolate the impact of trade on equity in the aggregate sample. Then, I consider only a subset of holders, the households.

My main regression is the following:

$$ln(Equity_{ijt}) = \phi_{it} + \phi_{jt} + \beta_1 ln(Trade_{ijt}) + \beta_3 X_{ijt} + \epsilon_{ijt} \tag{1}$$

The dependent variable is the total amount of country j equity in country i's portfolio *(IMF Coordinate Portfolio Investment Survey)*; the independent variable is the total amount fo trade between the two countries, measures as export plus import *(IMF Direction of Trade Statistics)*; all time varying country-specific characteristics are controlled by source country-time fixed effect ϕ_{jt} and destination country-time fixed effect ϕ_{it}; In line with the literature, I add a number of bilteral controls: cultural (common language, colonial relationship), distance between capitals, common monetary union, free trade area, GDP correlation *(CEPII)*. The sample cover the period 2005-2015 for around 50 source and 150 destination countries. I exclude small financial centers and countries with less than one million inhabitants. The appendix reports a complete list of variables description and countries in the sample. The errors are clustered at the country-time level.

Column (1) of Table 1 reports the result using a simple OLS estimator. Trade has a positive and statistically significant impact on equity holding: a one percent increase in the bilateral amount of trade raises the bilateral equity holding of around 0.8 percent. This is the finding motivating this paper. The overall results is consistent with the previous literature.

In order to address a concern of possible reverse direction of causality, namely from asset holding to trade, I use a IV approach to isolate the exogenous effect of trade on portfolio investment. I again follow the literature (Aviat and Coeurdacier, 2007) in instrumenting trade with (i) dummy for free trade area, and (ii) bilateral trade costs. Column (2) reports the result. The test of weak identification, under-identification and the Hansen test ensures the instruments' validity. Trade's impact on equity holding is still positive, even if a bit lower in magnitude, confirming the previous results.

Column (3) and (4) repeats the same exercise but substituting equity holding with total holdings, meaning equity plus bond. The results are again confirmed. Table 2 reports an additional robustness check where I substitute trade with export from country i to country j, yielding the same results.

In the next section, I shed light on this finding by proposing a endogenous information model where trading agent optimally decide to be more informed about each other. However, a simpler explanation could be the following: if firms are trading with a foreign country, they might have access to information at a lower cost with respect to firms in non-trading countries, by physically being abroad or through business contacts. In order to address this concern, I run the same regression but now considering only the direct equity holding of households, which are less likely to have any information advantage.[8]

Table 3 mirrors the analysis of Table 1, but only considering household's holdings. The sample decreases considerably, but the impact of trade is pretty stable with respect to the previous tables. Table 4 reports the same results but substituting trade with export. The results are robust to this specification as well.

Motivated by this empirical fact, in the next section I develop a theoretical model able to formalize the link between trade and portfolio diversification through an information channel.

3 Model

In this section, I present a model in which trading agents jointly decide investment and amount of information. I show how the presence of trade affects investor's optimal choices: information and portfolio investment on foreign assets depends positively on the share of foreign good in agent's consumption.

My contribution extends the baseline two-countries model of investment and endogenous information (Van Nieuwerburgh and Veldkamp, 2009, 2010). Preferences for early resolution of uncertainty in this model lead to increasing returns to information and large amount of portfolio specialization with a even small initial information advantage. A simple intuition is that agents can expose most of their consumption to one of the two assets while decreasing its perceived volatility as much as possible, increasing by consequence its risk-adjusted return.

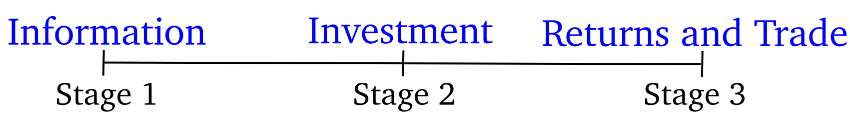
I extend this setting by including non-financial income and trade between countries.

[8] The IMF Coordinated Portfolio investment Survey provide the data disaggregated by issuer and holder. Here I am keeping the aggregate level of issuer, but restricting the holder to household, therefore excluding firms, banks, government, mutual funds, et cetera.

The new risk hedging component in the optimal portfolio would require to invest less in trading partner's asset to diversify risk. However, I show that investors want also to collect more information on trade partner's country to decrease non-financial income risk, and therefore want to invest more in its asset. Under certain parametrizations, the latter force is stronger than the former and the model implies higher portfolio investment in trading partner's asset.

3.1 Model structure

The model feature two countries, Home and Foreign, each one with a continuum of investors of measure ½. They face an investment choice between three assets: (i) a domestic risky asset h, (ii) a foreign risky asset f and (iii) a risk-free asset b. The model is static and divided in three stages:



1. **Information acquisition:** Agents face an attention allocation problem subject to a Shannon entropy contraint. [9] Each investor has a limited amount of attention they use to increase the precision of two signals they will receive in the second stage. These signals convey information on country-specific risk factors.

2. **Investment choice:** Each agent receives the signals and forms posteriors about domestic and foreign country risk factors. They choose how to allocate their initial resources to domestic, foreign and risk free assets.

3. **Portfolio returns and trade:** All shocks realize, agents receive the returns from portfolio investment and non-financial income. The latter is a wage compensation from working for a firm selling to domestic and foreign consumers.

I describe now each stage of the model backwards.

3.2 Third stage

In the third stage all shocks are realized and agents receive the returns from portfolio investment allocated in the second stage and their non-financial income. Final wealth is

[9] The information choice problem is in the spirit of the rational inattention literature (Sims, 2003)

the sum of financial and non-financial wealth:

$$W_k = W_k^{NONFIN} + W_k^{FIN} \tag{2}$$

for $k \in \{h, f\}$. I describe each component of this income separately.

3.2.1 Non-financial income and trade

I model non-financial income as compensation from working for a firm selling domestic good domestically an abroad. Trade affect non-financial income by its impact on firm's aggregate demand's composition.

I assume that domestic and foreign demand for tradables are stochastic and depend on some country-specific risk factor. The implication is that investors receive income from tradable production, but do not consume tradables themselves. I make this assumption to maintain the model tractable and with the intent to take trade as given and study the impact on portfolio choices. Therefore in each countries there are three agents.

Investors In each country $k \in \{h, f\}$,, there is a continuum of investors with measure 1 that provides inelastically one unit of labor $L_k^{(i)}$ and receive a nominal wage $w_k^{(i)} L_k^{(i)} \equiv W^{NONFIN}$. Differently from the investment decision, labor supply is identical for each investor in the country, and they can be aggregated to a representative agent.

Firm In each country $k \in \{h, f\}$, a representative firm uses labor to produce a tradable good,with a production function $f(L)$ is linear in labor

$$Y_k = L_k \tag{3}$$

This firm face a domestic and a foreign demand for its good.

Consumers Total demand for tradables in each country is modeled as exogenous, while its composition between domestic and foreign good depend on a preference parameter. In particular, domestic consumers' problem is

$$\begin{aligned} &max\ C_h = (a_h^{\alpha} b_h^{1-\alpha}) \\ &st\ D_h = q_h a_h + q_f b_h \end{aligned} \tag{4}$$

where a is the domestic good and q_h its price, while b is the foreign good and q_f its price. D_h is the total consumption expenditure and it is an exogenous random variable. Consumption is a Cobb-Douglas bundle of domestic and foreign good, where α is the share of domestic consumption in domestic good. Similarly for foreign country, $C_f = (b_f^{\alpha} b_h^{1-\alpha})$, α is the share of foreign consumption in foreign good.

Market solution The market clearing conditions are

$$\begin{aligned} Y_h &= a_h + a_f \\ Y_f &= b_h + b_f \end{aligned} \tag{5}$$

Equation 5 equates supply and demand for domestic and foreign goods. Combining the consumer problem solution with the clearing condition gives

$$\begin{aligned} q_h Y_h &= \alpha D_h + (1-\alpha) D_f \\ q_f Y_f &= \alpha D_f + (1-\alpha) D_h \end{aligned} \tag{6}$$

Because of the simplifying assumption on the production function, in each country nominal output equates nominal labor income.

$$\begin{aligned} W_h^{NONFIN} &= \alpha D_h + (1-\alpha) D_f \\ W_f^{NONFIN} &= \alpha D_f + (1-\alpha) D_h \end{aligned} \tag{7}$$

As a result, non-financial income in each country is a linear function of domestic and foreign consumption expenditure in tradables, depending on the preference parameter α. Higher is α, higher is the share of domestic consumption of domestic good and therefore lower the trade between the two countries. With no trade, $\alpha = 1$, agents' labor income depend only on domestic demand. With complete trade, $\alpha = 0.5$, agents' labor income depend equally on domestic and foreign demand.

Tradable consumption demand are exogenous random variable. In particular, for each country $k \in \{h, f\}$ they follow the process

$$D_k = \bar{D}_k + c_k M_k + \epsilon_{D_k} \tag{8}$$

with $\epsilon_{D_k} \sim N(0, \sigma^2_{D_k})$. M_k is a country specific risk factor, distributed $M_k \sim N(0, \sigma^2_{M_k})$.

Therefore, domestic demand for domestic and foreign good depends on domestic country risk factor (and similarly for foreign demand).[10] I normalize c_k to be positive, meaning that the country risk factor positively affect non-financial income.

3.2.2 Financial income

Income from portfolio investment is standard. When shocks realize in third stage, the agent receives the payoff from his portfolio of domestic and foreign asset, plus the returns on his saving in risk-free asset.

$$W_k^{FIN} = x_h f_h + x_f f_f + (W_0 - p_h - p_f)R \tag{9}$$

where x_h and x_f are the portfolios of home and foreign asset chosen in the previous stage; f_h and f_f are their realized returns; p_h and p_f are their prices; R is the risk free rate and W_0 the initial wealth. Similarly for foreign agents.

Similarly to domestic and foreign tradables demand, I assume that domestic and foreign asset payoffs depend on the respective country-specific risk factor and a idiosyncratic term. For $k \in \{h, f\}$,

$$f_k = \bar{f}_k + b_k M_k + \epsilon_{fk} \tag{10}$$

with $\epsilon_{fk} \sim N(0, \sigma_{fk}^2)$. M_k is again the country-specific risk factor and ϵ_{fk} is a idiosyncratic term.[11]

Equations 7 and 9 shows that the two component of financial wealth are both affected by domestic and foreign risk factors M_k, respectively by tradables demands D_k and asset returns f_k. However, while the exposure of non-financial income to risk factors is exogenous and given by the preference parameter α, agents can decide how to form their financial portfolio in terms of domestic and foreign risk. I use the model to investigate how the portfolio choices respond to exogenous changes in the trade parameter α.

Throughout the paper I assume $b_k > 0$, meaning that country risk factor positively affect asset return. Since I also normalize $c_k > 0$, it means that non financial and financial income are positively correlated, as first shown by Baxter and Jermann (1997). In Section 5 I consider the case in which the correlation is negative.

[10] The iid error terms ϵ_{D_k} can be normalized to zero, they do not affect the model solution in any way.

[11] Differently from the tradable demand shocks, here the iid term is important for result. It corresponds to the ”unlearnable” component of asset return similarly to Valchev (2017).

3.3 Second stage: investment choice

In this stage agents receive signals about the country-specific risk factors and maximize their mean variance utility by allocating their resources on domestic and foreign assets. In order to compute expected value and variance of consumption, they form posterior about the risk factors using the information available: priors, asset prices and private signals.

The problem for the domestic agent is[12]

$$\max_{x_h, x_f} \qquad U_2 = E(W|I^{(i)}) - \frac{\gamma}{2} Var(W|I^{(i)}) \tag{11}$$

where $W = \underbrace{x_h f_h + x_f f_f + (W_0 - p_h - p_f)R}_{W^{FIN}} + \underbrace{\alpha D_h + (1-\alpha) D_f}_{W^{NONFIN}}$

His information set contains their prior, $M_k \sim N(0, \sigma^2_{Mk})$, $k \in \{h, f\}$, the market price for each asset and two private unbiased signals about the risk factors value

$$\begin{aligned} \eta_h^{(i)} &= M_h + \epsilon_h^{(i)} \qquad && \epsilon_h \sim N(0, \sigma^2_{\eta h}) \\ \eta_f^{(i)} &= M_f + \epsilon_f^{(i)} \qquad && \epsilon_f \sim N(0, \sigma^2_{\eta_f}) \end{aligned} \tag{12}$$

The agent observes the signal, forms posteriors and decides his portfolio allocation. Similarly for the foreign agent.

3.4 First Stage: information acquisition

In this stage agents maximize their expected mean variance utility by choosing the distribution from which to draw the two private signals in the next stage. In other words, they use their attention to decrease signals variance given the information set available at this stage, which contains only the priors.

$$\begin{gathered} \max_{\sigma^2_{\eta_h}, \sigma^2_{\eta_f}} \qquad U_1 = E[E(W|I^{(i)}) - \frac{\gamma}{2} Var(W|I^{(i)})] \\ st \qquad \underbrace{\frac{1}{2}\left(ln(Var(M_h|I^p)) - ln(Var(M_h|I^{(i)}))\right)}_{\kappa_h} + \underbrace{\frac{1}{2}\left(ln(Var(M_f|I^p)) - ln(Var(M_f|I^{(i)}))\right)}_{\kappa_f} \leq \kappa \\ \kappa_k \geq 0 \end{gathered} \tag{13}$$

[12] Since I consider only domestic investors, I drop the pedix notation for simplicity.

The implication of the utility function in equation 13 is a *preference for early resolution of uncertainty*: agents want to minimize the perceived variance of final wealth.[13]

Agents choose attention allocation subject to two constraints: (i) the *capacity constraint* limits the amount of information they can learn, measured as the distance between posterior variance conditional on the private information $I^{(i)} = \{\eta_h^{(i)}, \eta_f^{(i)}, p_h, p_f\}$ and posterior variance conditional on only public signals $I^p = \{p_h, p_f\}$;[14] (ii) the *no-negative-learning constraint* rules out the possibility of increasing initial uncertainty (forgetting information). The intuition is that agents are rational but limited in their capacity of processing information. As a result, they have to decide whether to focus on domestic risk factor, foreign risk factor or a combination of both. However, they can not "forget" information they already know.

4 Model Solution

The model is solved backwards: first I show the optimal investment allocation for a given signal precision, then how attention choice interacts with the optimal portfolio.

4.1 Optimal portoflio

From stage 2's investment maximization problem, the optimal portfolio of domestic agent is

$$\begin{aligned} x_h &= \frac{\bar{f}_h + b_h \hat{M}_h^{(i)} - p_h R}{\gamma(b_h^2 \hat{\sigma}_h^2 + \sigma_{fh}^2)} - \alpha c_h b_h \frac{\hat{\sigma}_h^2}{b_h^2 \hat{\sigma}_h^2 + \sigma_{fh}^2} \\ x_f &= \frac{\bar{f}_f + b_f \hat{M}_f^{(i)} - p_f R}{\gamma(b_f^2 \hat{\sigma}_f^2 + \sigma_{ff}^2)} - (1-\alpha) c_f b_f \frac{\hat{\sigma}_f^2}{b_f^2 \hat{\sigma}_f^2 + \sigma_{ff}^2} \end{aligned} \tag{14}$$

where $\hat{M}_k \equiv E(M_k|I^{(i)})$ is the country risk factor posterior mean and $\hat{\sigma}_k^2 \equiv Var(M_k|I^{(i)})$ is the country risk factor posterior variance.[15] Similarly for the foreign agent.

The first term in each portfolio is the Sharpe Ratio and the second term is the risk-hedging term. In particular, the Sharpe Ratio is increasing in asset return's posterior mean (numerator) and decreases in its posterior variance (denominator). The risk hedging term

[13] The increasing return to information in absence of trade relies on this particular utility function form. The technical details in Van Nieuwerburgh and Veldkamp (2010).
[14] By increasing the signal precision, agents increase the posterior precision.
[15] The resulting optimal allocation in the standard form $x_k = \frac{E(f_k|I) - p_k R}{\gamma Var(f_k|I)} - \frac{Cov(f_k, z|I)}{Var(f_k|I)}$ where z is a source of income correlated with the asset return.

depends on the posterior covariance between financial and non-financial income (numerator) and asset return's posterior variance (denominator).

No information choice Consider a domestic agent and ignore first any information choice. Suppose $\alpha = 1$ (no trade): since non-financial income is positively correlated with financial income (b_h, $c_h > 0$), the agent should hedge it by investing proportionally more abroad than domestically. When $\alpha < 1$, his non-financial income becomes affected also by foreign risk, and it becomes optimal to gradually invest more domestically and less abroad. When $\alpha = 0.5$ (maximum trade), it is optimal to completely diversify the portfolio. As a result, absent any information choice, the more domestic country is trading with foreign country, the less domestic agent should invest abroad. This theoretical results is in sharp contrast with the evidence of Section 2.

With information choice The previous result relies on the assumption that posterior variance of domestic and foreign country risk factor are equal. This will not be the case anymore when one allows for information choice. In particular, lower is the domestic posterior variance $\hat{\sigma}_h^2$, higher is the Sharpe Ratio of domestic asset and lower the risk-hedging term. As a result, for the same level of trade, the resulting proportional holding of domestic asset increases.

Importantly, the decrease in the risk heding term depends on the presence of the "unlearnable" risk component σ_{fk}^2 in the asset return, that makes the posterior hedging power of the asset lower when information increases.[16] If in equilibrium information increases with trade, as I show in the next sections, then the role of risk-hedging in determining portfolio allocation is downsized.

4.2 Equilibrium Price

In order to preserve private information in equilibrium, I make the standard assumption that in each market the supply of asset consists in a constant term plus a noisy component (noise traders) $z_k \in N(0, \sigma_z^2)$. As a result, the equilibrium market conditions are

$$\overline{z}_k + z_k = \int^H x_k^{(i)} di + \int^F x_k^{*(i)} di \qquad k \in \{h, f\} \tag{15}$$

[16] The role fo the "unlearnable" risk component has been explored by Valchev (2017).

The resulting price depends on the posterior distribution of the country risk factors, which in turn depend on prices as unbiased signals of country risk factor realizations. I solved this fixed point problem with a guess and verify technique: the appendix shows that a linear solution of this problem has the form[17]

$$p_k = \overline{\lambda}_k + \lambda_{M_k} M_k + \lambda_{z_k} z_k \tag{16}$$

As a result, price $\tilde{p}_k$ is an unbiased signal of the country risk factor M_k

$$\frac{\tilde{p}_k - \overline{\lambda}_k}{\lambda_{M_k}} = M_k + \frac{\lambda_{z_k}}{\lambda_{M_k}} z_k \tag{17}$$

Agents use public (price) and private (priors and signals) information to form posteriors about country risk factors' variance and mean:

$$\begin{aligned} \hat{\sigma}_k^2 &\equiv Var(M_k|I^{(i)}) = \left(\frac{1}{\sigma_k^2} + \frac{\lambda_{Mk}^2}{\lambda_{z_k}^2 \sigma_k^2} + \frac{1}{\sigma_{\eta k}^2} \right)^{-1} \\ \hat{M}_k &\equiv E(M_k|I^{(i)}) = \hat{\sigma}_k^2 \left(\frac{\lambda_{Mk}^2}{\lambda_{z_k}^2 \sigma_k^2} \tilde{p}_k + \frac{1}{\sigma_{\eta k}^2} \eta_k^{(i)} \right) \end{aligned} \tag{18}$$

4.3 Attention allocation

Substituting for the optimal portfolio allocation and taking expectation conditional on first stage information set, the domestic agent's attention allocation problem becomes

[17] Note that, differently from traditional information cost paper (Adamanti, 1985) the price is not a function of asset return, but country risk factor.

$$
\begin{aligned}
\max_{\sigma^2_{\eta_h},\sigma^2_{\eta_f}} E^1(U_2) = & \frac{B_h^2 + A_h}{2\gamma(b_h^2\hat{\sigma}_h^2 + \sigma_{fh}^2)} - \frac{b_h^2\hat{\sigma}_h^2}{2\gamma(b_h^2\hat{\sigma}_h^2 + \sigma_{fh}^2)} \\
& + \frac{B_f^2 + A_f}{2\gamma(b_f^2\hat{\sigma}_f^2 + \sigma_{ff}^2)} - \frac{b_f^2\hat{\sigma}_f^2}{2\gamma(b_f^2\hat{\sigma}_f^2 + \sigma_{ff}^2)} \\
& -\alpha\left[b_h c_h \frac{\hat{\sigma}_h^2}{b_h^2\hat{\sigma}_h^2 + \sigma_{fh}^2} B_h + \frac{\gamma}{2}(c_h)^2 \frac{\hat{\sigma}_h^2\sigma_{fh}^2}{b_h^2\hat{\sigma}_h^2 + \sigma_{fh}^2}\right] \\
& -(1-\alpha)\left[b_f c_f \frac{\hat{\sigma}_f^2}{b_f^2\hat{\sigma}_f^2 + \sigma_{ff}^2} B_f + \frac{\gamma}{2}(c_f)^2 \frac{\hat{\sigma}_f^2\sigma_{ff}^2}{b_f^2\hat{\sigma}_f^2 + \sigma_{ff}^2}\right] \\
& -\frac{\gamma^2}{2}\sigma_y^2\left[\alpha^2 + (1-\alpha)^2\right] + \bar{Y}_h \\
st \quad & \kappa_h + \kappa_f \leq \kappa \\
& \kappa_k \geq 0 \qquad k \in \{h, f\}
\end{aligned} \tag{19}
$$

The terms B_k and A_k are functions of priors (assumed equal across countries), prices and other terms taken as given by agents. They are defined in Appendix B.

The first two rows of (19) derive from the risk-adjusted posterior mean return of, respectively, domestic and foreign asset (they do not depend on the hedging term). Utility in the first (second) row decreases in home (foreign) country risk posterior variance, and therefore increases in attention to it.

The third and fourth rows of (19) derive from the hedging term of the optimal portfolio (first term) and from the volatility of trade consumption (second term). Under the assumption of positive covariance between country's good demand and asset return ($b_k, c_k > 0$), utility in the third (fourth) row decreases in home (foreign) country risk posterior variance, and therefore increases attention to it. In the case of negative covariance ($b_k > 0, c_k < 0$ or $b_k < 0, c_k > 0$), the opposite is true.

The fifth row of (19) derives from tradables consumption variance caused by the endowment idiosyncratic shock plus a constant, and it does not affected by information choice.

The interaction between trade and investment makes the information problem less convex with respect to the baseline in Van Nieuwerburgh and Veldkamp (2009). The corner solution is only a particular case in a range of different possibilities depending on the parameter values. In the next section I explain in details this result.

5 Results

In the following sections I perform a comparative statics analysis and highlight the impact of trade on portfolio allocation. From now on I assume symmetry between the two countries in terms of parameters and idiosyncratic shocks.

5.1 Financial and non-financial income non correlated

Suppose that non-financial income is not correlated with asset return ($c_k = 0$). Hence, there is no hedging term in portfolio allocation and signals are informative only about asset payoffs. Formally, the attention allocation problem consists in only the first two lines of (19). The problem reduces to the standard endogenous information model, where the feedback between information and investment choice leads to increasing return to attention. As in the baseline case, the information problem is convex in posteriors and there are two corner solutions: complete attention to domestic or foreign asset. Agents allocate attention to only one asset, which is perceived with higher risk-adjust return and overweight in the optimal portfolio.

Figure 1 illustrates the information choice problem faced by the domestic agent. The red dotted line is the capacity constraint, the black solid lines the prior variances. Because of the no negative learning constraint, posterior variances can not be increased above the priors: the feasible choices are below the priors and above the capacity constraint. The blue solid line represent the highest achievable utility (it increases in indifference curves closer to the origin). The orange dotted line shows one of the two corner solutions. This particular case of my model is similar to Van Nieuwerburgh and Veldkamp (2009). I now show how trade leads to different implications.

5.2 Financial and non-financial income positively correlated

Allow now country risk factors to affect positively not only asset return but also non-financial income ($c_k, b_k > 0$). There are two implications: first, optimal portfolios present a hedging term; second, by decreasing posterior variance, attention lowers both the hedging term ad perceived non-financial income volatility. Formally, rows three and four in the information problem (19) are different from zero.

The following results depend on my calibration of the model, which I discuss in the next section.

5.2.1 No trade

First, suppose there is no trade ($\alpha = 1$). Non-financial income depends only on domestic factors (fourth row of (19) is zero). Without any attention choice, domestic agents should hold a larger share of portfolio in foreign asset, in order to hedge non-financial risk (as in Baxter and Jermann (1997)). However, they also have incentive to specialize attention in domestic risk to decrease non financial income uncertainty. Because of the increasing return to information, they end up allocating all attention to domestic asset, which becomes perceived as less risky. As a result, contrary to the risk hedging prediction, they end up overweight their own asset in their portfolio. There are two forces at work to offset the risk hedging: (i) the lower posterior risk makes the asset more attractive; (ii) the lower posterior covariance makes the asset less suitable for risk-hedging.

Figure 2 illustrate the information choice problem faced by the domestic agent. The indifference curve has higher slope than in the standard case, and the optimal choice is to decrease domestic posterior variance by allocating all attention to ”domestic” signal and no attention to ”foreign” signal.[18]

5.2.2 Maximum trade

Now suppose there is maximum trade ($\alpha = 0.5$). Non-financial income is equally exposed to domestic and foreign factor and agents hedge against both. Without information choice, portfolios should be perfectly diversified. Information choice does not change this result: domestic agent has no incentive to pay more attention to the domestic asset than to the foreign asset, since they are equally exposed to both.[19] Formally, the indifference curve is symmetric. Figure 3 illustrate this problem.

The intuition is the following: learning problem’s convexity in the baseline model derives from the possibility of contemporaneously decreasing both attention and investment to one asset while focusing on the other. As a result, we have a portfolio specialization on one country risk factor. Here, by imposing final wealth to be exposed to both risk factors through trade, the increasing return to information is considerably weakened.

[18] Figure 2 does not show an exact corner solution, it depends on the calibration.

[19] This is a necessary but not sufficient condition to get this result. The size of the non-learnable risk component of asset payoff plays a crucial role in weaking the increasing return to information.

5.2.3 General case

While for $\alpha = 1$ (no trade) the model predicts home bias in investment and for $\alpha = 0.5$ (maximum trade) it predicts full diversification, for values $\alpha \in (0.5, 1)$ we have gradual opening of portfolio and attention to foreign equities: higher the trade openness, higher the portfolio diversification.

This result in shown in Figure 4. The horizontal axis measures the trade parameter α and the vertical axis the posterior variance of the two assets. Higher the α, lower the trade, higher the specialization of attention in domestic equities. A similar pattern is shown is Figure 5, that relates trade and portfolio holdings: higher the α, lower the trade, higher the specialization on home equities.

Figure 4 and 5 show the main result of the paper: information choice creates a positive link between trade in goods and equity investment. The model can explain both the lack of diversification in presence of trade and the equity home bias when trade is low. In the latter case, it does not relies on heterogeneous priors and it reverses the risk hedging diversification prediction.

Appendix C discussed model's results with alternative parametrizations.

6 Trade, investment and attention in the data

The main implication of my model is that international trade affects portfolio diversification by increasing attention allocation to foreign country. I test this prediction in the data.

In order to study the impact of trade on information choice, I need to measure attention allocation. However, attention is not directly observable. I follow the financial literature (Da et al., 2011; Andrei and Hasler, 2014) in using the volume of research queries from GoogleTrend as a proxy.[20] I measure the attention allocation of country H to country F financial assets with the index of Google research frequencies in country H with the keyword "F" in the category "finance".[21] The index has values 0-100, where 100 is the highest value in the sample downloaded.[22] I only have a limited sample of around 30

[20] Mondria et al. (2010) measure the international investors' attention allocation in a similar way, but only for the US and with a slightly different proxy.

[21] For example, the attention allocated by Italy to Germany is measured as the number of researches on Google in Italy with the keyword "Germany" in the finance section, relative to the total number of researches in Italy.

[22] To keep the normalization consistent across observations, i always use the same highest normalizing observation.

source and 110 destination countries, from 2005 to 2015.[23] I aggregate the monthly data to an annual frequency, and use it as a dependent variable in the following regression.

$$ln(Att_{ijt}) = \phi_{it} + \phi_{jt} + \beta_1 ln(Trade_{ijt}) + \beta_2 ln(Equity_{ijt}) + \beta_3 X_{ijt} + \epsilon_{ijt} \tag{20}$$

The dependent variable is the logarithm of the volume research index, while the independent variables are (i) trade, measured as export plus import; (ii) the amount of country j equity in country i household's portfolio, and (iii) a the bilateral controls: cultural linkages (common language, colonial relationship, common religion), distance between capitals, common monetary union, GDP correlation. I include again source and destination-time fixed effect, which captures every country-specific determinants of attention. I consider only households' portfolio instead of total holding for two reason: first, to address the concern that the information set of trading firms might have other determinants, as explained in Section 2; (ii) because the google search volume index is typically indicated as a proxy for attention allocation of retail investors, not big financial companies.

The hypothesis I am testing is that, for a given amount of equity, higher trade between countries leads to higher attention allocated: $\beta_1 > 0$. Table 5 confirm this prediction. Column (1) show that simple OLS coefficient for trade is positive and significant: even controlling for portoflio investment, higher trade with the foreign country increases the attention allocated to its financial characteristic. Column (2) show that this result is robust when instrumenting trade similarly to Section 2 while columns (3) and (4) show that the results hold when using total asset instead of only equity. Table 6 consider only export instead of total trade, but the result is unaffected.

7 Conclusions

This paper provides an answer to a common puzzle in the international economic literature: the empirical positive correlation between trade in goods and portfolio investment across countries. I present a theoretical model to rationalize the impact of trade on equity investment through information choice, and provide empirical support for my model's predictions in the data.

The model extends the baseline framework of the endogenous information literature to

[23] It is not possible to download them all in one time, I could only get the data on this countries.

include income from trade. I show how the model can rationalize the positive relation between trade and portfolio diversification: trading countries optimally chose to acquire more information about each other with respect to less trading countries, thus perceiving partner's asset as less risky and more profitable. In general, higher the trade between countries, higher is their bilateral portfolio investment.

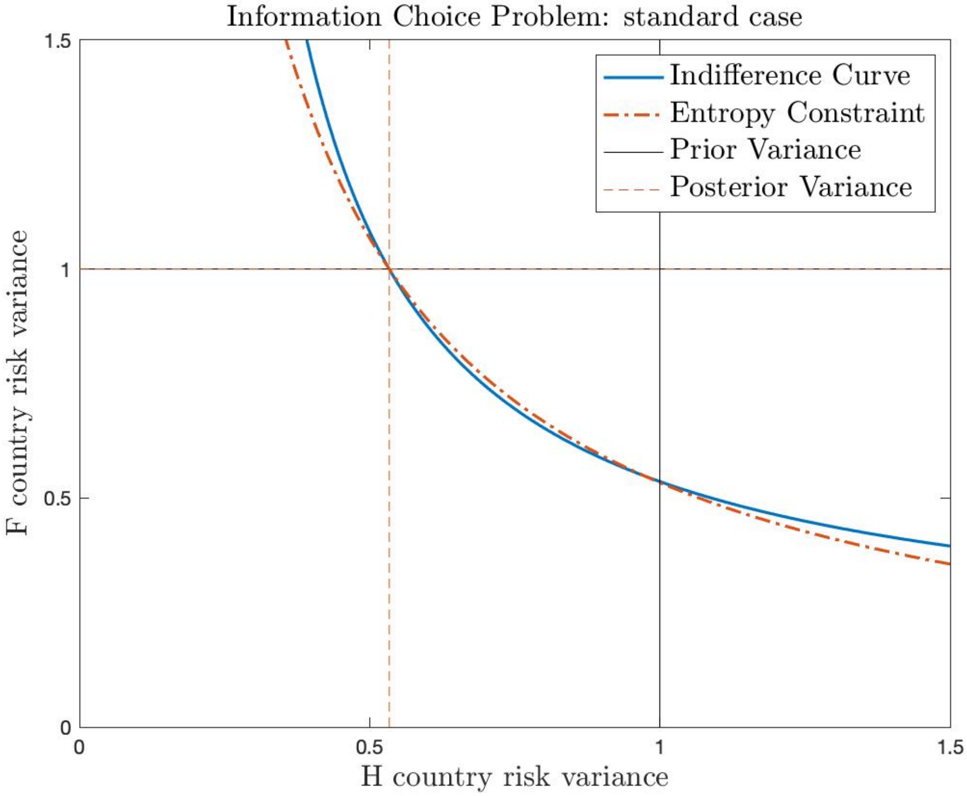


Figure 1: Information Stage maximization problem: standard case ($c = 0$)

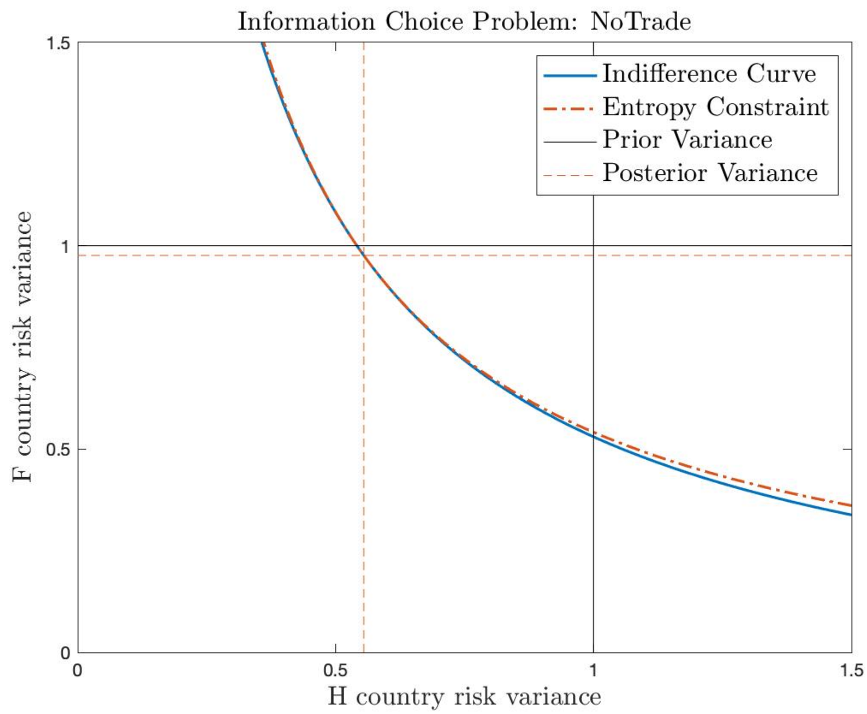


Figure 2: Information Stage maximization problem: no trade case ($\alpha = 1$)

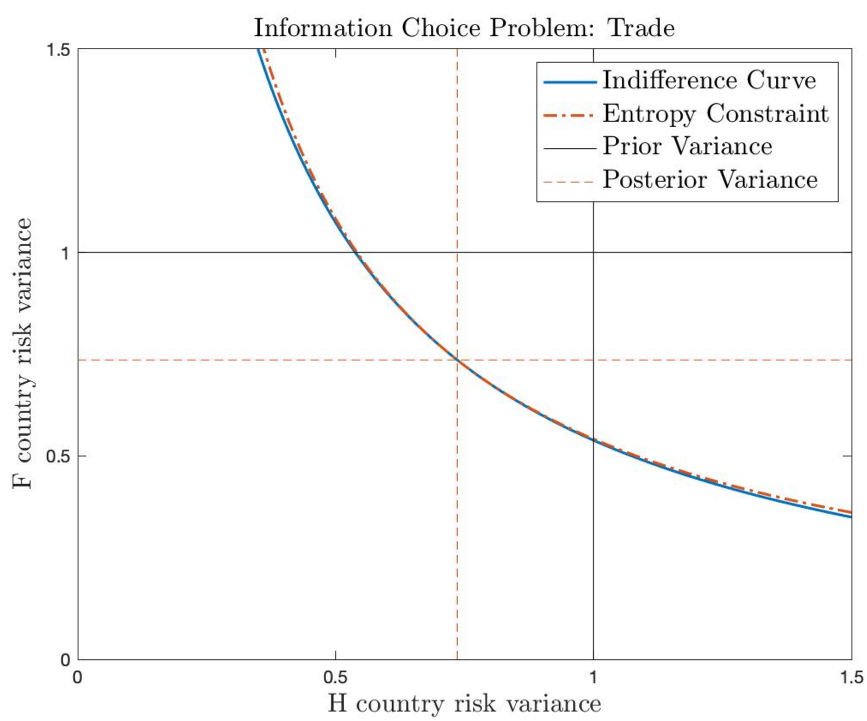


Figure 3: Information Stage maximization problem: trade case ($\alpha = 0.5$)

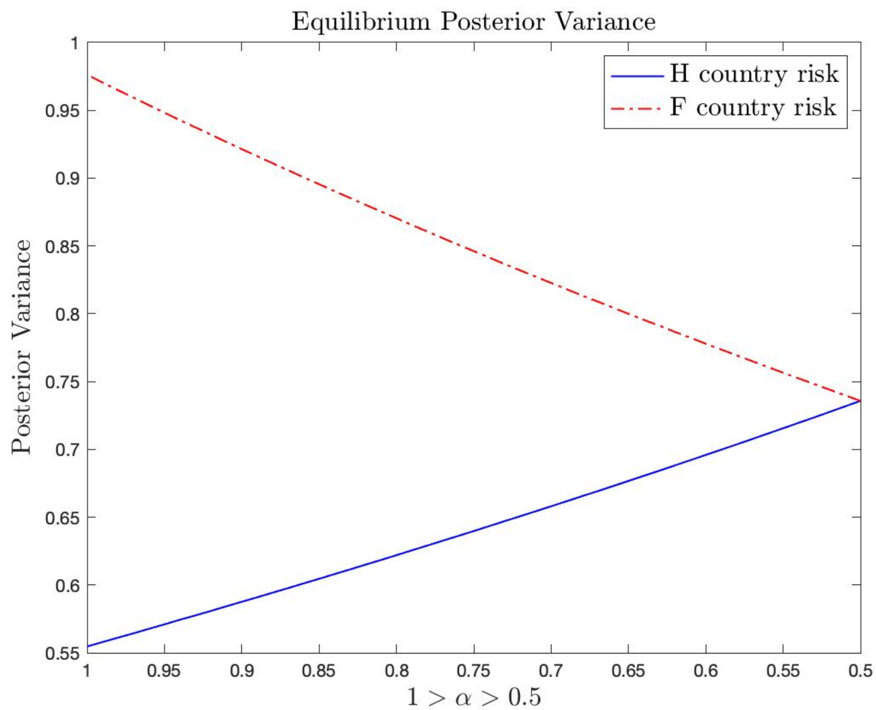


Figure 4: Equilibrium posterior variance for values $\alpha \in [0.5, 1]$

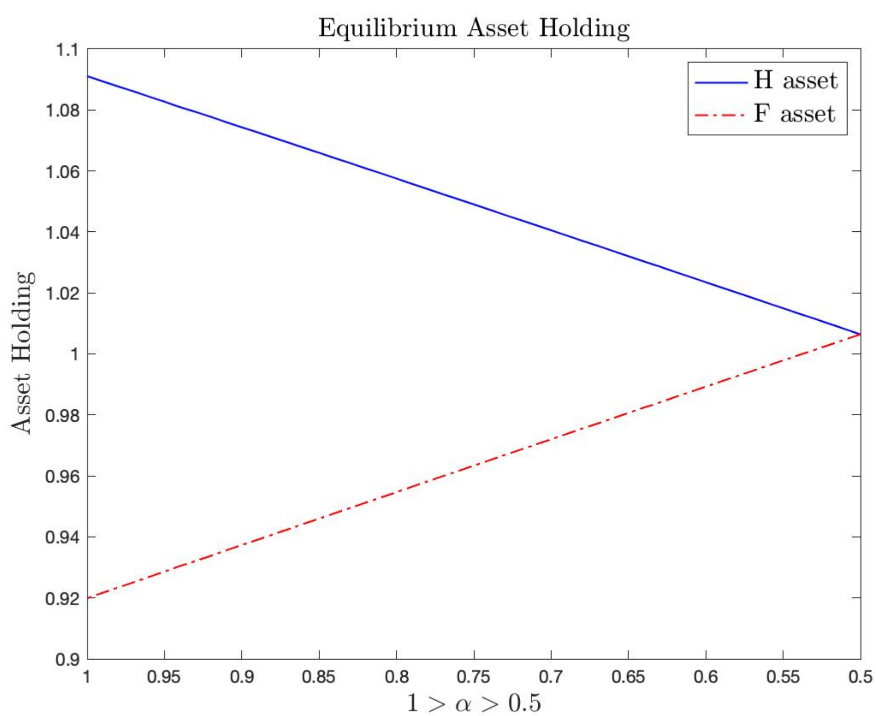


Figure 5: Equilibrium portfolio allocation for values $\alpha \in [0.5, 1]$

	(1) logEquity OLS	(2) logEquity IV	(3) logTotinv OLS	(4) logTotinv IV
logDistance	-0.232***	-0.392***	-0.0967	-0.404***
	(0.0735)	(0.0906)	(0.0603)	(0.0717)
logTrade	0.760***	0.677***	0.751***	0.523***
	(0.0438)	(0.0729)	(0.0313)	(0.0500)
CommonLanguage	0.311*	0.463***	0.296**	0.455***
	(0.165)	(0.161)	(0.135)	(0.134)
Colony	0.0848	0.0384	0.0188	0.0589
	(0.164)	(0.164)	(0.153)	(0.145)
CommonLegalSystem	0.472***	0.407***	0.298***	0.293***
	(0.105)	(0.103)	(0.0844)	(0.0855)
CommunCurrency	0.718***	0.466***	1.576***	1.151***
	(0.151)	(0.153)	(0.126)	(0.132)
CorrGDP	-0.438**	-0.493**	0.402**	0.490***
	(0.200)	(0.202)	(0.165)	(0.169)
CommonBorder	0.0292	0.142	-0.342**	-0.179
	(0.177)	(0.173)	(0.162)	(0.165)
R-squared	0.735	0.171	0.729	0.211
N	18863	17127	25630	23182
Weakid F		229		374
Underid p		0.000		0.000
Hansen p		0.244		0.087

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 1: Impact of trade on portoflio (total holders)

	(1) logEquity OLS	(2) logEquity IV	(3) logTotinv OLS	(4) logTotinv IV
logDistance	-0.360***	-0.463***	-0.194***	-0.433***
	(0.0718)	(0.0866)	(0.0601)	(0.0715)
logExport	0.602***	0.566***	0.617***	0.457***
	(0.0376)	(0.0639)	(0.0288)	(0.0461)
CommonLanguage	0.253	0.453***	0.228*	0.435***
	(0.166)	(0.161)	(0.136)	(0.134)
Colony	0.155	0.0805	0.0533	0.0646
	(0.170)	(0.164)	(0.157)	(0.146)
CommonLegalSystem	0.525***	0.429***	0.361***	0.311***
	(0.107)	(0.103)	(0.0862)	(0.0862)
CommunCurrency	0.688***	0.442***	1.554***	1.132***
	(0.153)	(0.150)	(0.129)	(0.131)
CorrGDP	-0.327	-0.438**	0.466***	0.508***
	(0.199)	(0.201)	(0.163)	(0.167)
CommonBorder	0.0349	0.141	-0.322*	-0.170
	(0.182)	(0.176)	(0.166)	(0.166)
R-squared	0.729	0.161	0.723	0.202
N	18895	17147	25696	23216
Weakid F		207		343
Underid p		0.000		0.000
Hansen p		0.194		0.092

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 2: Impact of export on portoflio (total holders)

	(1) logEquity OLS	(2) logEquity IV	(3) logTotinv OLS	(4) logTotinv IV
logDistance	-0.489***	-0.751***	-0.489***	-0.648***
	(0.137)	(0.136)	(0.137)	(0.152)
logTrade	0.655***	0.319***	0.655***	0.540***
	(0.0716)	(0.107)	(0.0716)	(0.133)
CommonLanguage	0.273	0.202	0.273	0.516*
	(0.318)	(0.247)	(0.318)	(0.285)
Colony	0.687**	0.794***	0.687**	0.482*
	(0.267)	(0.273)	(0.267)	(0.265)
CommonLegalSystem	0.863***	0.770***	0.863***	0.806***
	(0.155)	(0.137)	(0.155)	(0.158)
CommunCurrency	1.391***	0.720***	1.391***	0.958***
	(0.231)	(0.196)	(0.231)	(0.216)
CorrGDP	-0.635*	-0.781**	-0.635*	-1.001***
	(0.334)	(0.325)	(0.334)	(0.344)
CommonBorder	-0.163	0.459**	-0.163	0.156
	(0.274)	(0.212)	(0.274)	(0.246)
R-squared	0.707	0.101	0.707	0.097
N	6766	5161	6766	5964
Weakid F		118		90
Underid p		0.000		0.000
Hansen p		0.776		0.040

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 3: Impact of trade on portoflio (HH holders)

	(1) logEquity OLS	(2) logEquity IV	(3) logTotinv OLS	(4) logTotinv IV
logDistance	-0.621***	-0.798***	-0.621***	-0.764***
	(0.137)	(0.125)	(0.137)	(0.130)
logExport	0.527***	0.279***	0.527***	0.408***
	(0.0633)	(0.0932)	(0.0633)	(0.0942)
CommonLanguage	0.218	0.190	0.218	0.498*
	(0.322)	(0.247)	(0.322)	(0.286)
Colony	0.798***	0.825***	0.798***	0.571**
	(0.273)	(0.272)	(0.273)	(0.262)
CommonLegalSystem	0.901***	0.785***	0.901***	0.833***
	(0.159)	(0.137)	(0.159)	(0.157)
CommunCurrency	1.380***	0.737***	1.380***	0.920***
	(0.235)	(0.198)	(0.235)	(0.211)
CorrGDP	-0.565*	-0.808**	-0.565*	-0.908***
	(0.331)	(0.325)	(0.331)	(0.328)
CommonBorder	-0.182	0.447**	-0.182	0.172
	(0.282)	(0.214)	(0.282)	(0.251)
R-squared	0.703	0.094	0.703	0.101
N	6776	5164	6776	5968
Weakid F		68		114
Underid p		0.000		0.000
Hansen p		0.662		0.036

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 4: Impact of export on portoflio (HH holders)

	(1) LogAttention OLS	(2) LogAttention IV	(3) LogAttention OLS	(4) LogAttention IV
logDistance	-0.175***	-0.114*	-0.109**	-0.0690
	(0.0549)	(0.0621)	(0.0425)	(0.0531)
logTrade	0.123***	0.282***	0.108***	0.266***
	(0.0194)	(0.0349)	(0.0170)	(0.0353)
LogEquity	0.0216***	0.0230***		
	(0.00824)	(0.00758)		
logAsset			0.0327***	0.0326***
			(0.00819)	(0.00843)
CommonLanguage	0.437***	0.347***	0.605***	0.461***
	(0.109)	(0.0980)	(0.102)	(0.0872)
Colony	0.204**	0.147	0.112	0.0717
	(0.103)	(0.104)	(0.0914)	(0.0921)
CommonLegalSystem	0.0202	-0.0264	0.0270	-0.0655
	(0.0454)	(0.0464)	(0.0396)	(0.0426)
CommunCurrency	-0.169**	-0.196***	-0.211***	-0.224***
	(0.0690)	(0.0614)	(0.0649)	(0.0605)
CorrGDP	0.229*	0.230*	0.00653	0.164*
	(0.125)	(0.125)	(0.0989)	(0.0921)
CommonBorder	-0.107	-0.204***	0.0136	-0.139*
	(0.0797)	(0.0763)	(0.0770)	(0.0747)
CommonRelig	0.00603	-0.00496	0.0853	0.110
	(0.0838)	(0.0752)	(0.0740)	(0.0677)
R2	0.654	0.124	0.625	0.153
N	5535	4328	6957	5319
Weakid F		296		77
Underid p		0.000		0.000
Hansen p		0.291		0.674

Standard errors in parentheses

Errors clustered at the country-pair level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 5: Impact of trade on attention (HH holders)

	(1) LogAttention OLS	(2) LogAttention IV	(3) LogAttention OLS	(4) LogAttention IV
logDistance	-0.160***	-0.128**	-0.102**	-0.0751
	(0.0534)	(0.0593)	(0.0418)	(0.0524)
logExport	0.139***	0.262***	0.116***	0.251***
	(0.0179)	(0.0343)	(0.0163)	(0.0349)
LogEquity	0.0204***	0.0247***		
	(0.00790)	(0.00742)		
logAsset			0.0314***	0.0301***
			(0.00782)	(0.00832)
CommonLanguage	0.427***	0.334***	0.600***	0.459***
	(0.106)	(0.0948)	(0.102)	(0.0874)
Colony	0.214**	0.171*	0.115	0.0859
	(0.101)	(0.103)	(0.0908)	(0.0925)
CommonLegalSystem	0.0165	-0.0172	0.0286	-0.0543
	(0.0449)	(0.0453)	(0.0391)	(0.0416)
CommunCurrency	-0.159**	-0.183***	-0.207***	-0.223***
	(0.0686)	(0.0605)	(0.0648)	(0.0609)
CorrGDP	0.211*	0.194	0.00655	0.171*
	(0.123)	(0.123)	(0.0996)	(0.0934)
CommonBorder	-0.116	-0.210***	0.00267	-0.147**
	(0.0779)	(0.0721)	(0.0757)	(0.0717)
CommonRelig	0.00786	0.00461	0.0917	0.131*
	(0.0819)	(0.0739)	(0.0729)	(0.0671)
R2	0.660	0.139	0.628	0.148
N	5537	4329	6964	5321
Weakid F		118		66
Underid p		0.000		0.000
Hansen p		0.537		0.990

Standard errors in parentheses
Errors clustered at the country-pair level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 6: Impact of export on attention (HH holders)

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Appendix

A. Fixed point problem

Substituting optimal portfolios 14 for domestic and foreign agent in the equilibrium condition 15 one can find the price for asset $k \in \{h, f\}$

$$p_k = \frac{1}{R}\bar{\sigma}_k^2 \left[\bar{E}(f_k) - \gamma(\bar{z}_k + z_k) - \gamma\frac{1}{2}\left(\alpha c_k V_k + (1-\alpha)c_k V_k^*\right)\right] \tag{21}$$

where

$$\bar{\sigma}_k^2 = \left[\frac{1}{2}\left(\frac{1}{b_k^2\hat{\sigma}_k^2 + \sigma_{fk}^2} + \frac{1}{b_k^2\hat{\sigma}_k^{2*} + \sigma_{fk}^2}\right)\right]^{-1} \tag{22}$$

is the average posterior variance, and

$$\bar{E}(f_k) = \left[\frac{1}{2}\left(\frac{1}{b_k^2\hat{\sigma}_k^2 + \sigma_{fk}^2}\int^H (\bar{f}_k + b_k\hat{M}_k^{(i)})di + \frac{1}{b_k^2\hat{\sigma}_k^{2*} + \sigma_{fk}^2}\int^F (\bar{f}_k + b_k\hat{M}_k^{(i)*})di\right)\right] \tag{23}$$

is the average posterior mean. For notational convenience, define

$$\begin{aligned} V_k &= \frac{b_k\hat{\sigma}_k^2}{b_k^2\hat{\sigma}_k^2 + \sigma_{fk}^2} \\ V_k^* &= \frac{b_k\hat{\sigma}_k^2}{b_k^2\hat{\sigma}_k^2 + \sigma_{fk}^2} \end{aligned} \tag{24}$$

and

$$\bar{q}_k = \left(V\frac{1}{2\sigma_{\eta k}^2} + V^*\frac{1}{2\sigma_{\eta k}^{2*}}\right) \tag{25}$$

The solution to the fixed point problem is of the form (15) with

$$\begin{aligned} \bar{\lambda}_k &= \frac{1}{R}\bar{\sigma}_k^2\left[\frac{\bar{f}_k}{\bar{\sigma}_k^2} - \gamma\bar{z}_k - \gamma\frac{1}{2}(\alpha c_k V_k + (1-\alpha)c_k V_k^*)\right] \\ \lambda_{zk} &= -\frac{1}{\gamma R}\bar{\sigma}_k^2\left(1 + \frac{\bar{q}_k}{\gamma^2\sigma_z^2}\frac{1}{2}(V + V^*)\right) \\ \lambda_{Mk} &= \frac{1}{R}\bar{\sigma}_k^2\bar{q}_k\left(1 + \frac{\bar{q}_k}{\gamma^2\sigma_z^2}\frac{1}{2}(V + V^*)\right) \end{aligned} \tag{26}$$

B. First stage problem

The coefficients A_k and B_k for $k \in \{h, f\}$ in 19 are the following:

$$\begin{aligned} A_k &= b_k^2\sigma_k^2 + R^2\lambda_{M_k}^2\sigma_k^2 + R^2\lambda_{z_k}^2\sigma_z^2 - 2b_kR\lambda_{M_k}\sigma_k^2 \\ B_k &= \bar{\sigma}_k^2\bar{z}_k\gamma + \bar{\sigma}_k^2\gamma\frac{1}{2}\left(\alpha c_kV + (1-\alpha)c_kV^*\right) \end{aligned} \tag{27}$$

These two terms are taken as given in the attention allocation problem by each agents, but in equilibrium they depend and affect their choices.

C. Alternative parametrizations

C.1. Asset return and production negatively correlated

Suppose country risk factors affect positively non-financial income but negatively asset's return ($c_k > 0$ and $b_k < 0$). Optimal portfolios present a hedging term with opposite sign as in the previous case, but attention can still decrease non-financial income perceived volatility.

Even without information choice, the risk hedging term by itself is able to yield the prediction that higher trade openness leads to higher portfolio diversification. However, one would need this risk hedging term to be too large to justify the amount of home bias in data. My model provide an endogenous mechanism to amplify portfolio specialization in this case. Nevertheless, the main intuition is still valid: higher the amount of trade, lower the portfolio home bias.

C.2. Calibration discussion

The results showed in the previous section relies on a particular calibration. In particular: (P1) in the no trade case ($\alpha = 1$) the benefit from information specialization has to offset the risk hedging term; (P2) in the full trade case ($\alpha = 0.5$) the consumption volatility due to trade has to make the information problem less convex to avoid corner solutions. I now discuss how each parameter is involved in these issues.

First, the "unlearnable variance" σ_{fh}^2: higher is this term in the asset return variance, lower is the increasing return to information. The intuition is that the signal agents pay attention to becomes less informative about the total asset return variance. Therefore higher is this term, lower is the return to information. If it is too high, information specialization in the no trade case is not enough to offset risk hedging (P1). If it is too low, there is information (and portfolio) specialization even with trade (P2).

Second, the correlation between country risk factor and endowment shock c: it drives the benefit of information on consumption volatility, but it also increases the portfolio risk hedging term. If it is too high, the model still predict specialization in attention but domestic portfolio is biased to foreign asset because of risk hedging (P1). If it is too low, the model is not able to yield information (and portfolio) diversification with full trade (P2).

Third, the correlation between asset return and country risk factor b: it increases the benefit of information on asset return (converse of σ^2_{fh}), but it also increases the portfolio risk hedging term (similar to c). If it is too low,the benefit from information is not enough to offset risk hedging in the no trade case (P1). If it is too high, there is information (and portfolio) specialization even with trade (P2).

Moreover, the amount of attention available κ and priors σ_k also affect the problem's convexity in information.

Finally, in the baseline calibration attention allocation does not reach a corner solution for values lower than $\alpha = 1$. If it happens, increasing further α does not increase the investment home bias, since it is not possible to increase attention to domestic factor. Conversely, there is an increase in the hedging term, and therefore a increase in the holding of foreign asset.

Figure 6 and 7 show information and portfolio allocations under a calibration leading to the first problem: information allocation is not enough to have portfolio home bias in no trade case ($\alpha = 1$). It embed the case of high σ^2_{fh}, high c_k and low b_k.

Figure 8 and 9 show information and portfolio allocations under a calibration leading to the second problem: the information problem is too convex and there is no information diversification in trade case ($\alpha = 0.5$). It embed the case of low σ^2_{fh}, low c_k and high b_k.

Figure 10 and 11 show information and portfolio allocations under a calibration leading to the third problem: information allocation is completely specialized for $\alpha < 1$. Therefore, higher α does not increase attention to domestic asset: it increases only risk hedging term. From then on, the share of domestic asset in home agent portfolio decreases instead of increasing.

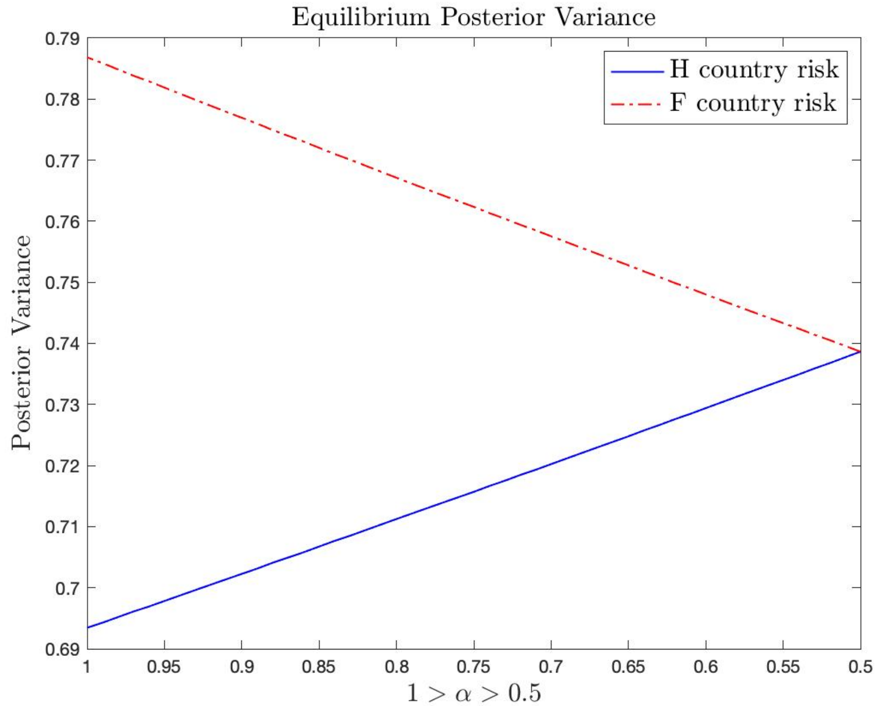

Figure 6: Equilibrium posterior variance: P1 case (high σ^2_{fh})

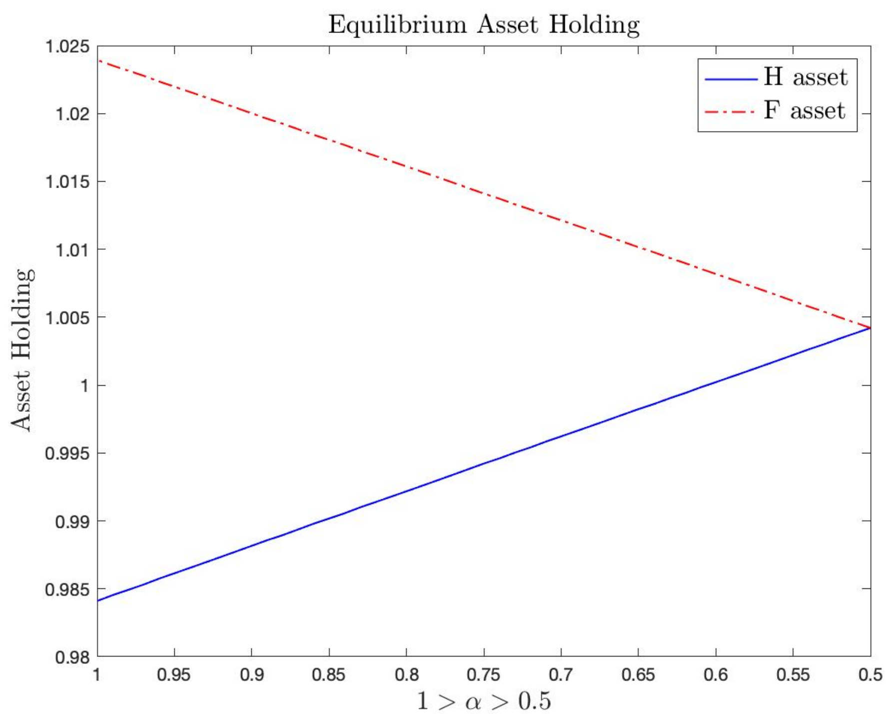

Figure 7: Equilibrium portfolio allocation: P1 case (high σ^2_{fh})

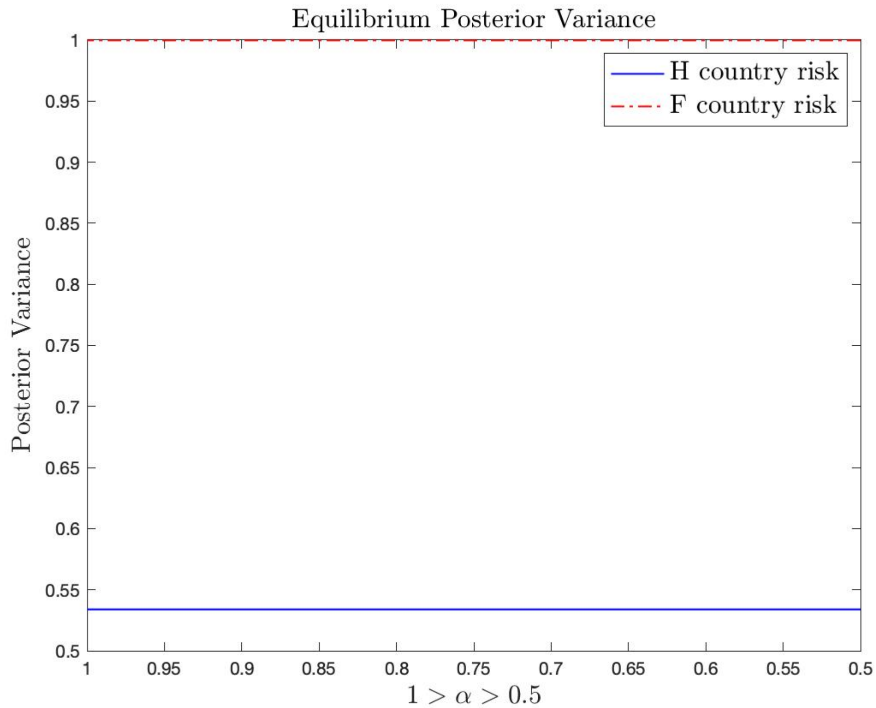

Figure 8: Equilibrium posterior variance: P1 case (low σ^2_{fh})

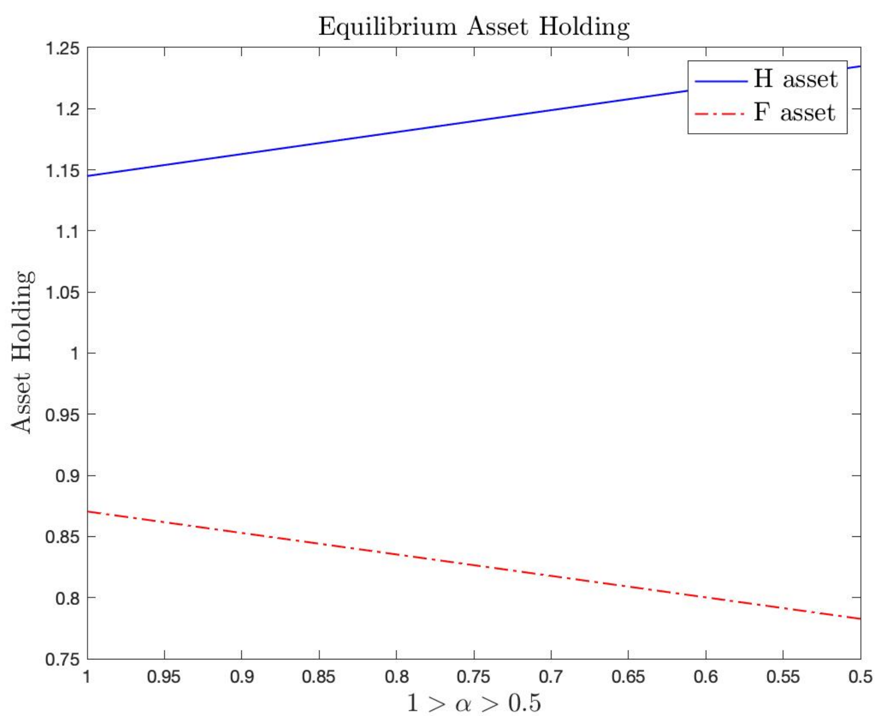

Figure 9: Equilibrium portfolio allocation: P1 case (low σ^2_{fh})

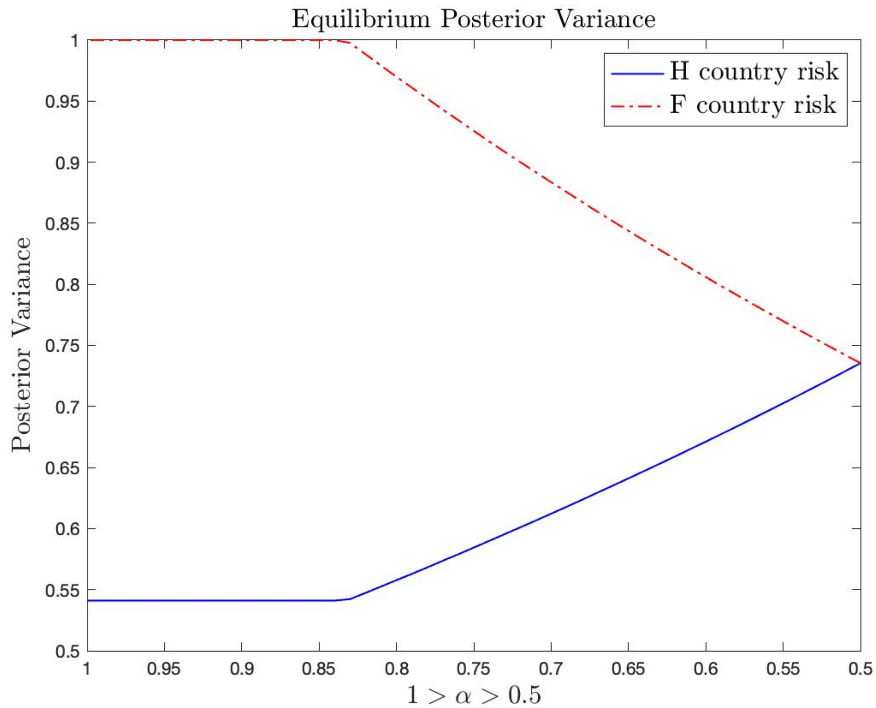

Figure 10: Equilibrium posterior variance with boundary cases

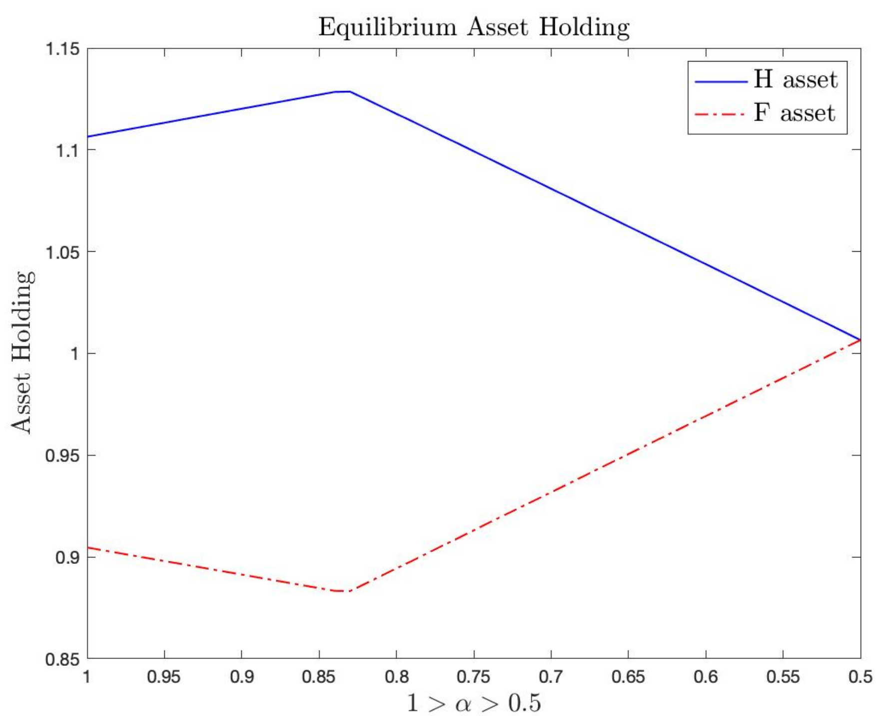

Figure 11: Equilibrium portfolio allocation with boundary cases