# International portfolio diversification and macroeconomic fluctuations when preferences are time-varying

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**Abstract**

We propose a 2-country asset pricing model where agents' preferences change endogenously as a function of the popularity of internationally traded goods. When agents are more sensitive to changes in the popularity of domestic goods than to changes in the popularity of foreign goods, the local stock market reacts more to changes in preferences of local agents than to changes in preferences of foreign agents. Therefore, the home bias arises because the home-country stock represents a better investment opportunity to hedge against future preference fluctuations. We test our model and find that preference evolution is a plausible driver of key macroeconomic variables and stock returns.

**Keywords:** Asset pricing, general equilibrium, heterogeneous agents, interdependent preferences, portfolio choice.

**JEL Classification Numbers:** D51-53; E20-21; F21; G11-12.

# 1 Introduction

Since the seminal paper of French and Poterba (1991) many researchers have tried to explain why investors allocate more wealth to domestic assets than to foreign assets and thus, why they ignore the potential benefits of international diversification. The debate on the home bias is still open nowadays because despite the enhanced financial integration across countries, international investors seem still to favour domestic assets (for a review of the recent home bias literature see Lin and Viswanathan (2015), Coeurdacier and Rey (2013), Mishra and Ratti (2013), Hamberg et al. (2013), Daly and Vo (2013) and Sercu and Vanpée (2012)). Therefore, despite a number of different explanations for the home bias have been proposed, the reason why international investors prefer domestic assets still remains a puzzle.

In this paper we offer a preference-based explanation of the home bias puzzle which builds on the idea of endogenous preference evolution. We embed preference evolution in an otherwise standard two-country (home and foreign) endowment economy. Our main assumption is that, in each country, agents' preferences evolve in favor of goods with the highest demand across agents. Since the demand of consumption goods is an endogenous quantity, the evolution of preferences is also endogenous in our model. Changes in preferences determine changes in the agents' desired consumption plan and, since agents finance their desired level of consumption by trading in financial assets, also determines portfolio decisions. More precisely, agents show a bias toward the stock market of the country that produces the most popular good. Although intuitive, this basic mechanism does not generate a complete home bias unless we assume heterogeneity across agents. In fact when agents located in different countries react in the same way to changes in the popularity of consumption goods, they show a bias toward the equity of the country that produces the most popular good independently on where they are located. For instance, if the consumption good produced by the home country becomes the most popular, home and foreign investors will show a bias toward the equity of the home country. To obtain a complete home bias in portfolios we assume that in each country agents are more sensitive to changes in the popularity of the domestic good rather to changes in the popularity of the foreign good. Under this assumption, the domestic equity market reacts more to changes in preferences of local agents than to changes in preferences of the foreign agents for the local consumption good. As a result the home bias arises because, in each country, the domestic equity represents a better investment opportunity to hedge against the future changes in preferences.

Then, we ask ourselves whether the mechanism of preference evolution is empirically plausible. To answer this question we interpret our model as a latent factor model for the dynamics of stock prices and exchange rates. Using our equilibrium equations in conjunction with empirical data we back out the factors driving our economy, namely supply shocks and preference shocks. We show that the data support a link between supply shocks and preference shocks in line with the theoretical link suggested by our model and that preference shocks are important drivers of international capital market fluctuations. To show that our factors are economically meaningful we investigate their predictive power for several macroeconomic variables. We find that our factors have significant explanatory power for important variables such as industrial production and different measures of business and consumers confidence in the United States, United Kingdom and Germany. Our test relies on empirical measures of the popularity of internationally traded goods. We use two measures of goods popularity. The first measure is derived by our model that suggests that in a two-country economy the popularity of goods produced by a given country is a function of the country's consumption share. Consistently, we back out our first measure of popularity using its equilibrium dynamics in conjunction with consumption data. For the sake of robustness we also construct a broader and more direct measure of the popularity of internationally traded goods using Google trends: for each country we consider firms that operate internationally and we measure the internet search volume of their products. The predictive power of our model is not affected by the measure of popularity of internationally traded goods and the previous results continue to hold even when we measure popularity using internet data. Finally, we verify empirically the economic mechanism that leads to the equity home bias in our model. In our model the home bias arises because in each country the equity market is more affected by changes in the local popularity of the home consumption goods than by changes in the foreign popularity of the home consumption goods. Using Google trends we can measure the popularity of consumption goods among local investors and among foreign investors and we show that in all Countries we consider (US, UK and Germany) the aggregate price dividend ratio is indeed more sensitive to changes in local popularity of the home consumption goods than to change in the foreign popularity of the home consumption goods, consistent with the predictions of our model.

Taken together these results support the role of preference evolution as a plausible driver of asset prices and macroeconomic fluctuations. To the best of our knowledge we are the first to propose and test the hypothesis of an economic link between preference evolution and the dynamics of capital markets. The idea of endogenous preference evolution is not new in the economic literature (see for instance Krackhardt (1998), Bell (2002) and references therein), however its implications for financial markets and, most importantly, its empirical plausibility have not been verified so far.

The rest of the paper is organized as follows. Section 2 describes the model and characterizes the equilibrium. Section 3 presents the results of our empirical analysis. Section 4 concludes.

# 2 The Economy

We consider a continuous-time pure exchange economy in the spirit of Lucas (1978). The horizon is infinite and the uncertainty is represented by a filtered probability space $(\Omega, \mathbb{F}, \mathbb{P})$ on which we define a two-dimensional Brownian motion $B = (B_1, B_2)$. There are two countries, Home and Foreign. Each country produces a consumption good according to the production technology

$$dY^H(t) = Y^H(t)\nu_H dt + Y^H(t)\phi_H dB_1$$
$$dY^F(t) = Y^F(t)\nu_F dt + Y^F(t)\phi_F dB_2 \tag{1}$$

where: $Y^H$ and $Y^F$ represent the total production (or total dividend) of country $H$ and $F$, $\nu_H, \nu_F, \phi_H, \phi_F$ are positive constants, $H$ refers to the Home country and $F$ refers to the Foreign country. We assume that the consumption good of the Home country represents the numeraire of the economy and we define $p$ to be the relative price of the foreign good in terms of the home good.

Each country is populated with a representative investor who can consume the home and foreign goods and, at the same time, can invest in international financial markets. There are three investment opportunities: two risky assets in positive supply of one unity and a risk-less asset in zero net supply. The risky assets represent the claim to the total production of each country and their prices follow

$$dS^H(t) + Y^H(t) = S^H(t)\mu_H(t)dt + S^H(t)\sigma_{H,1}(t)dB_1 + S^H(t)\sigma_{H,2}(t)dB_2 \tag{2}$$

$$dS^F(t) + pY^F(t) = S^F(t)\mu_F(t)dt + S^F(t)\sigma_{F,1}(t)dB_1 + S^F(t)\sigma_{F,2}(t)dB_2 \tag{3}$$

where $\mu_H, \mu_F, \sigma_{H,1}, \sigma_{H,2}, \sigma_{F,1}$ and $\sigma_{F,2}$ have to be determined endogenously in equilibrium. The risk-less asset, whose price is denoted by $B(t)$ evolves as

$$dB(t) = r(t)B(t)dt \tag{4}$$

where the risk free rate $r$ is determined endogenously in equilibrium. The two representative agents derive utility from both the home and foreign goods and maximize

$$\mathbb{E}\int_0^\infty \left[\alpha^H(t)\log c_H^H(t) + \beta^H(t)\log c_F^H(t)\right] dt \quad \text{Home agent} \tag{5}$$

$$\mathbb{E}\int_0^\infty \left[\alpha^F(t)\log c_H^F(t) + \beta^F(t)\log c_F^F(t)\right] dt \quad \text{Foreign agent} \tag{6}$$

where $c_i^j$ represents consumption of the good produced in country $j$ of the investor located in country $i$. $\alpha^H$ ($\beta^H$) and $\alpha^F$ ($\beta^F$) represent the weights attached to the local (foreign) good by the home agent and the foreign agent, respectively. Traditional international finance models assume that the weights that agents attach to the home and foreign goods are exogenously given and that $\alpha^H > \alpha^F$ to capture the home bias in consumption. The home bias in portfolios then typically follows as a consequence of the home bias in consumption (Pavlova and Rigobon (2007)). Differently, we assume that $\alpha^H(t)$, $\alpha^F(t)$, $\beta^H(t)$ and $\beta^F(t)$ evolve endogenously as a function of the popularity of internationally traded goods. This choice is motivated by the recent empirical evidence of Frieder and Subrahmanyan (2005) and Hwang (2011) who find that portfolio decisions are significantly influenced by the popularity of commercial products and, in case of international investments, by the popularity of the country issuing the foreign security. We argue that if the country/product popularity affects portfolio decisions, it should also naturally affect the dynamics of relevant asset pricing and macro quantities. Put it differently, if there exist a link between product popularity and portfolio decisions there should also be an economic link between product popularity and the dynamic behavior of asset prices and exchange rates. In search for this link we build a model where agents' preferences change over time in reaction to changes in the popularity of internationally traded goods and analyze the implications of time variation in preferences for portfolio choices, the dynamics of international capital markets and that of exchange rates.

Our mechanics of preference evolution is motivated by the work of Bell (2002) extended to dynamic economies by Curatola (2016). We explain below the mechanism of preference evolution with an emphasis on the home investor but the mechanism is exactly the same for the foreign investor. First we have to specify our measure of popularity of traded goods. We assume that the popularity of the home good among local agents is given by $s^H(t) = \frac{c_H^H(t)}{c_H^H(t)+c_F^H(t)}$. This quantity represents the share of the home good in the consumption basket of the home agent and, thus, we believe it is a natural measure of how popular is the home good in the home country. Accordingly, we call $s^H$ popularity ratio. Second, we have to specify how preferences react to changes in the popularity of traded goods. We assume that

$$\begin{cases} \alpha^H(t) = \bar{\alpha} + k_H^H(s^H(t) - \bar{s}), \\ \beta^H(t) = \bar{\beta} - k_F^H(s^H(t) - \bar{s}) \end{cases} \tag{7}$$

where $\bar{\alpha}$, $\bar{\beta}$, $k_H^H$ and $k_F^H$ are positive parameters. $k_H^H \in [0, 1]$ and $k_F^H \in [0, 1]$ capture the sensitivity of agents' preferences to changes in the popularity of consumption goods. Given that $k_H^H$ and $k_F^H$ are positive coefficients, agents' preferences evolve in favor of popular goods: an increase in the popularity of the home good (i.e., an increase in $s^H$) increases the preference for the home good (i.e. increases $\alpha^H(t)$) and, at the same time, decreases the preference for the foreign good (i.e. decreases $\beta^H(t)$). The bigger are $k_H^H$ and $k_F^H$ the stronger is the previous effect. The economic mechanism we want to capture is the following: preferences for a good increase because other agents in the same country purchase the same good. Similarly, agents dislike goods that they do not observe in their country. Accordingly, when the popularity of the home good decreases, agents move their preferences away from the home good and toward the foreign good.

Note that the popularity of the home and foreign goods is symmetrical in the sense that $s^H(t) = 1 - \frac{c_F^H(t)}{c_H^H(t)+c_F^H(t)}$ and the ratio $\frac{c_F^H(t)}{c_H^H(t)+c_F^H(t)}$ represents the popularity of the foreign good in the home country. Using this relationship we can rewrite the preference for foreign goods as

$$\beta^H(t) = \bar{\beta} - k_F^H + k_F^H \left( \frac{c_F^H(t)}{c_H^H(t) + c_F^H(t)} - \bar{s} \right) \tag{8}$$

which makes it clear that $\beta^H(t)$ is a function of the popularity of the foreign good in the home country. In this way, we can interpret $k_H^H$ as the sensitivity of the home agent to change in the popularity of the home good and $k_F^H$ as the sensitivity of the home agent to changes in the popularity of the foreign good. $k_H^H$ and $k_F^H$ can have different value to capture different sensitivity to the popularity of local and foreign goods. For instance if $k_H^H > k_F^H$ then the home agent in our economy is more sensitive to changes in the popularity of the home good rather than to changes in the popularity of the foreign good.

$\bar{\alpha}$ and $\bar{\beta}$ represent intrinsic preferences, that is those preferences that are not dependent on changes in the popularity of consumption goods. The parameter $\bar{s}$ controls the degree of preference polarization: the higher is $\bar{s}$ the higher has to be the popularity of the home good to convince the home investor to prefer the home good more than the foreign good[1]. This captures the idea that agents may have some arguments against the home good and therefore they want to observe substantial changes in its popularity before moving their

[1]Formally, $\alpha^H(t) > \beta^H(t) \Leftrightarrow s^H(t) > \bar{s} - \frac{\bar{\alpha}-\bar{\beta}}{k_H^H+k_F^H}$.

preferences away from the other good. Similarly, for the foreign investor we have

$$\begin{cases} \alpha^F(t) = \bar{\alpha} + k_H^F(s^F(t) - \bar{s}), \\ \beta^F(t) = \bar{\beta} - k_F^F(s^F(t) - \bar{s}) \end{cases} \tag{9}$$

and $s^F(t) = \frac{c_H^F(t)}{c_H^F(t)+c_F^F(t)}$ represents the popularity of the home in the foreign country. The interpretation is exactly the same as before[2].

In summary, the main behavioral mechanism behind our rule of preference evolution is the following. Agents make consumption choices based on the local popularity of traded good. For instance, before deciding her optimal consumption basket, the home agent looks at the popularity of the home good in the home country: if the popularity of the home good is high then the home agent increases her preferences for the home good, decreases her preferences for the foreign good and modifies her consumption basket accordingly. The agent will then select her optimal portfolio to finance the desired consumption plan which implies that product popularity will affect portfolio choices and, in this way, the equilibrium dynamics of asset prices and exchange rates.

Our representation of preference evolution may appear similar to the demand shocks (see for instance Pavlova and Rigobon (2007)). We stress that preference evolution differs considerably from demand shocks in two important aspects. First, demand shocks are typically exogenous processes while the popularity of traded goods is endogenous because it depends on the agents' optimal consumption choice. Second, demand shocks affect agents' demand of both domestic and local consumption goods thus causing a parallel shift of the aggregate demand function of a given country. Differently, the popularity of traded goods affects the relative preference for domestic and foreign goods thus causing a reallocation of the aggregate demand from the domestic to the foreign good, or from the foreign to the domestic good depending on the direction of change of the popularity ratio.

[2]Parameters $k_j^i, \bar{\alpha}, \bar{\beta}$ and $\bar{s}$ are chosen so that $\alpha^i(t)$ and $\beta^i(t)$ are always positive, ensuring that utility functions 5 and 6 are well defined. For instance, in Section 2.2 below we assume that $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$ which, in conjunction with the assumption $k_j^i \in [0, 1]$ implies that $\alpha^H(t), \alpha^F(t), \beta^H(t), \beta^F(t) \in [0, 1] \quad \forall t$.

To fully describe the agents' decision problem we have to specify their initial endowment and the budget constraint. At time 0 the representative agents are endowed with the total supply of the national stock market, that is the initial allocation of wealth is $w^H(0) = S^H(0)$ and $w^F(0) = S^F(0)$. Given the initial endowment of wealth the representative consumers choose consumption and a portfolio of assets to maximize their expected utility subject to the budget constraint

$$\frac{dw^H(t)}{w^H(t)} = \pi_b^i(t)\frac{dB(t)}{B(t)} + \pi_1^i(t)\frac{dS^H(t) + Y^H(t)}{S^H(t)} + \pi_2^i(t)\frac{dS^F(t) + p(t)Y^F(t)}{S^H(t)} - \frac{c_H^H + p(t)c_F^H}{w^H(t)}dt \tag{10}$$

where $i \in \{H, F\}$ and $\pi_b^i, \pi_1^i, \pi_2^i$ denote the fraction of wealth allocated to the bond, the risky asset of country $H$ and the risky asset of country $F$, respectively.

## 2.1 The competitive equilibrium

Since there are 2 assets and 2 sources of risk, financial markets are potentially dynamically complete and the equilibrium can be characterized by solving the social planner's problem [3]. The social planner chooses consumption of home and foreign agents to maximizes the weighted sum of utilities using weights $\lambda^H$ and $\lambda^F$:

$$\max_{c_H^H, c_F^H, c_H^F, c_F^F} \mathbb{E}\int_0^\infty e^{-\rho t}\left[\lambda^H\left(\alpha^H(t)\log c_H^H(t) + \beta^H(t)\log c_F^H(t)\right) + \lambda^F\left(\alpha^F(t)\log c_H^F(t) + \beta^F(t)\log c_F^F(t)\right)\right]dt \tag{11}$$

subject to he resource constraint

$$c_H^H(t) + c_H^F(t) = Y^H(t) \tag{12}$$

$$c_F^H(t) + c_F^F(t) = Y^F(t). \tag{13}$$

[3] More precisely, Cass and Pavlova (2004) show that for a special case of our economy where $\alpha^i$ and $\beta^i$ are constant, any equilibrium of this economy is Pareto optimal and thus can be obtained by solving the social planner problem. Moreover, Curatola (2016) shows that when preferences depend on the popularity of traded good and the agents are equipped with log utility, the equilibrium obtained by solving the decentralized economy and the equilibrium obtained by solving the social planner problem are equivalent.

Taking the FOC of the previous problem we obtain the sharing rules[4]

$$\begin{aligned} c_H^H(t) &= e^{-\rho t}\frac{\lambda^H \alpha^H(t)}{m(t)}, \quad c_F^H(t) = e^{-\rho t}\frac{\lambda^H \beta^H(t)}{m(t)p(t)} \\ c_H^F(t) &= e^{-\rho t}\frac{\lambda^F \alpha^F(t)}{m(t)}, \quad c_F^F(t) = e^{-\rho t}\frac{\lambda^F \beta^F(t)}{m(t)p(t)} \end{aligned} \tag{14}$$

where $m(t)$ is the Lagrange multiplier attached to 11 and represents the price of one unit of the numeraire to be delivered at time $t$ is state $\omega \in \Omega$. Similarly $m(t)p(t)$ is the multiplier attached to 12 and represents the price of a unit of the foreign consumption good to be delivered at time $t$ is state $\omega \in \Omega$.

Imposing the clearing conditions of international consumption markets we obtain the equilibrium values of the term of trade (i.e. the relative price of the two consumption goods) $p(t)$:

$$p(t) = \underbrace{\frac{\lambda^H \beta^H(t) + \lambda^F \beta^F(t)}{\lambda^H \alpha^H(t) + \lambda^F \alpha^F(t)}}_{\text{Preference Effect}} \times \underbrace{\frac{Y^H(t)}{Y^F(t)}}_{\text{Ricardian Effect}} \tag{15}$$

The second term on the right hand side of 13 captures the traditional Ricardian effect: when the home consumption good becomes relatively abundant (i.e. the ratio $\frac{Y^H(t)}{Y^F(t)}$ increases) the foreign good becomes more expensive in order to stimulate the consumption of the home good, and viceversa. The first component of the term of trade depends on the evolution of agents' preferences. When the foreign good becomes relatively more popular (i.e. the ratio $\frac{\lambda^H \beta^H(t)+\lambda^F \beta^F(t)}{\lambda^F+\alpha^H(t)+\lambda^F \alpha^F(t)}$ increases) the demand for the foreign good rises and, therefore, its price increases. Similarly, when the popularity of the home good rises, the demand for this good and its price increase. So far, the traditional international finance literature has ignored the effect of time variation in preferences on the term of trade by assuming that that $\alpha^H, \alpha^F, \beta^H$ and $\beta^F$ are constant over time. Time variation in preferences has important effects for the equilibrium consumption sharing rules. In fact

[4]We use the standard martingale method of Karatzas et al. (1987)

using 13 we see that

$$\frac{c_H^H(t) + p(t)c_F^H(t)}{Y^H(t) + p(t)Y^F(t)} = \frac{\lambda^H(\alpha^H(t) + \beta^H(t))}{\lambda^H(\alpha^H(t) + \beta^H(t)) + \lambda^F(\alpha^F(t) + \beta^F(t))}. \tag{16}$$

As a result, when preferences are constant the Country H's share of world consumption (and consequently also the Country F's share of world consumption) is constant. The standard case of constant preferences therefore leads to perfect risk sharing that implies that consumption growth is perfectly correlated across countries, contrary to the empirical evidence suggesting that cross-country correlations of consumption growth are typically below 1 (see for example Backus et al. (1994)). When preferences are time-varying $\alpha^H(t)$, $\beta^H(t)$ and $\beta^F(t)$ are stochastic and therefore the evolution of consumption shares depends on the country-specific evolution of preferences. This mechanism makes the cross-country consumption correlation below 1 and helps to reconcile the model's predictions with the empirical evidence.

Using optimal consumption choices the equilibrium values of the popularity ratios $s^H$ and $s^F$ are then obtained as the unique solution to the system of equations

$$\begin{cases} s^H(t) = \frac{c_H^H(t)}{c_H^H(t)+c_F^H(t)} = \frac{p(t)\alpha^H(t)}{p(t)\alpha^H(t)+\beta^H(t)}, \\ s^F(t) = \frac{c_H^F(t)}{c_H^F(t)+c_F^F(t)} = \frac{p(t)\alpha^F(t)}{p(t)\alpha^F(t)+\beta^F(t)} \end{cases} \tag{17}$$

where $\alpha^H(t)$, $\alpha^F(t)$, $\beta^H(t)$ and $\beta^F(t)$ also depend on $s^H(t)$ and $s^F(t)$ according to Eq 7 and 8. Even if $s^H(t)$ and $s^F(t)$ have to be obtained numerically, the link between supply shocks, changes in the popularity ratios and agents' preferences can be established analytically. In the Appendix 5 we show that $\frac{\partial s^H}{\partial(Y^H/Y^F)}, \frac{\partial s^F}{\partial(Y^H/Y^F)} > 0$ which means that the popularity of a good increases with its relative supply: in our economy fashionable goods are abundant goods. The mechanism works as follows. Assume for instance that the home country experiences a positive supply shock. After the shock, the aggregate consumption of the home goods has to increase to ensure that markets clear. The increase in consumption implies that home goods becomes more visible and, thus, its popularity increases. Given that agents in the economy like popular goods their preferences will move toward the home good and away from the foreign goods. The magnitude of change in preferences depends on the agents' sensitivity to the popularity of traded goods which is captured by the parameters $k_H^H$ and $k_F^H$ for the home agents and $k_F^F$ and $k_H^F$ for the foreign agent.

Agents smooth consumption over time by using the assets traded in the international capital markets. Thus the value of traded assets is affected by preference evolution. The value of the home and foreign stock markets is given by the present discounted value of the country' total output:

$$S^H(t) = \frac{Y^H(t)}{\underbrace{\lambda^H \alpha^H(t) + \lambda^F \alpha^F(t)}_{\text{Current preference for the home good}}} \overbrace{\left[\lambda^H \mathbb{E} \int_t^\infty e^{-\rho(u-t)} \alpha^H(u) du + \lambda^F \mathbb{E} \int_t^\infty e^{-\rho(u-t)} \alpha^F(u) du\right]}^{\text{Future preference for the home good}} \tag{18}$$

$$S^F(t) = \frac{Y^F(t)p(t)}{\underbrace{\lambda^H \beta^H(t) + \lambda^F \beta^F(t)}_{\text{Current preference for the foreign good}}} \overbrace{\left[\lambda^H \mathbb{E} \int_t^\infty e^{-\rho(u-t)} \beta^H(u) du + \lambda^F \mathbb{E} \int_t^\infty e^{-\rho(u-t)} \beta^F(u) du\right]}^{\text{Future preference for the foreign good}} \tag{19}$$

By inspection of Eq 15 and 16 we see that the value of each country stock market positively depends on the national output and is also related to the evolution of agents' preferences. Note that current and future preferences for the national output have different impact on the value of the national stock market. Consider for instance the home stock market. If the current preference of home and foreign agents for the home good increases their current marginal utility from consuming the home good tend to increase as compared to the future one. As a result from the perspective of home and foreign agents the marginal cost of investing in the home market increases, thus depressing the current value of the home stock market. Differently, if the future popularity of the home consumption good is expected to increase, the future marginal utility from consuming the home good increases as compared to the current one and agents desire to postpone the consumption of the home good. Given that the home equity gives the right to obtain future dividends in the unit of the home consumption good, its value increases in reaction to an increase in the future popularity of the home consumption good. The dependence of price dividend ratios on the preferences of agents located in the two countries implies that stock returns in each country depend on both home and foreign factors. As a result stock returns are correlated across countries despite the absence of correlation between fundamentals.

The mechanism described above implies that international capital markets depend on the evolution of agents' preferences for internationally traded goods. The more the agents' preferences react to changes in the popularity of traded goods, the stronger will be the consequent reaction of equity markets and the strength of this mechanism is determined by the sensitivity parameters $k_H^H, k_F^H, k_F^F, k_H^F$. To understand the intuition, consider an extreme case in which agents preferences are only sensitive to the popularity of the domestic good. That is $\alpha^H$ and $\beta^F$ change over time while $\alpha^F$ and $\beta^H$ remain constant (this happens if $k_H^H > k_F^H = 0$ and $k_F^F > k_H^F = 0$). In this case, the stock market of each country reacts to changes of local agents' preferences but is insensitive to changes in preferences of foreign agents. This mechanism is important to explain the composition of equity portfolios because the reaction of stock prices to preferences shocks determines the hedging properties of international stock markets (see Section 2.2 below).

Finally note that in the standard case without preference evolution, the price-dividend ratios are deterministic functions of time (see also (Pavlova and Rigobon, 2007)), contrary to the data. By inspection of Eq. 15 and 16 we observe that, although we use log utility, the time variation in agents' preference makes price-dividend ratios stochastic consistent with findings in the empirical asset pricing literature.

## 2.2 Preference evolution and portfolio diversification

The objective of this section is to illustrate the implications of preference evolution for international portfolio diversification. Note that, in principle, log linear preferences over multiple consumption goods leads to market incompleteness. When financial markets are incomplete, portfolio holdings that implement optimal consumption plans are indeterminate and, thus, it is impossible to pin down the fraction of wealth an investor allocates to domestic and foreign assets[5]. For this reason the implications of preference evolution for portfolio holdings are not straightforward because one has to first determine whether financial markets are complete or not. One of the contributions of time variation in preferences is to make financial markets complete even when agents are equipped with log linear preferences. As a result the equilibrium portfolio is unique and we can study the implications of time variation in preferences for the home bias puzzle[6].

To determine portfolio holdings we first have to compute the wealth of the representative agents along their optimal strategy:

$$w^H(t) = \frac{\lambda^H}{\lambda^H \alpha^H(t) + \lambda^F \alpha^F(t)} \left[ \mathbb{E}_t \int_t^\infty e^{-\rho(u-t)} \alpha^H(u) du + \mathbb{E}_t \int_t^\infty e^{-\rho(u-t)} \beta^H(u) du \right] \quad (20)$$

$$w^F(t) = \frac{\lambda^F}{\lambda^H \alpha^H(t) + \lambda^F \alpha_F(t)} \left[ \mathbb{E}_t \int_t^\infty e^{-\rho(u-t)} \alpha^F(u) du + \mathbb{E}_t \int_t^\infty e^{-\rho(u-t)} \beta^F(u) du \right] \quad (21)$$

From Eq 17 and 18 we see the impact of preference evolution of wealth fluctuation across countries. If the agent's expected preferences for the consumption goods of either the home country or the foreign country increase, the agent's financial wealth will increase as well. This is so because after an increase in the expected preferences for consumption goods agents postpone consumption to the future and therefore accumulate more wealth today. Differently, an increase in the current preference for the home good rises its current prices and, other things being equal, forces agents to decumulate wealth in order to maintain the desired level of consumption. This mechanism implies that preference shocks spill over from one country to the other: if the foreign agent increases his/her preference for the home consumption good, the price of the home consumption good increases and, and as a consequence, the financial wealth of the home agent decreases[7].

[5]The implications of log linear preferences for market (in)completeness are studied by Cass and Pavlova (2004). For a generalization to different utility functions see ? and ?. The issues of using Cobb-Douglas preferences over multiple consumption goods to explain the home bias puzzle are illustrated by the discussion in ? and ?.

[6]Constant log linear preferences over multiple consumption goods imply the agent's optimal consumption is a linear function of the exogenous dividends. As a result the prices of different assets (when expressed in the same unit of measure) are all linear functions of the same exogenous dividend and, as a result, they are collinear. Differently, in our framework optimal consumption also depends on the popularity of internationally traded goods. This dependence breaks the linearity between asset prices and dividends and makes financial markets complete. A theoretical characterization of the implications of time varying preferences for individual portfolios can be found in Curatola (2016).

[7]Note that in Eq 17 and 18 we express agents' wealth in units of the home consumption good and,

To determine agents' portfolios we apply the Ito's lemma on Eq 17 and 18 and compare coefficients with Eq 9. Details of this computations are given in the Appendix 5 and optimal portfolios are plotted in Figures 1 and 2 below. First we analyze the case of symmetric preference evolution, that is we assume that $\bar{\alpha} = \bar{\beta} = \bar{s}$ and $k_H^H = k_F^H = k_H^F = k_F^F > 0$. We recall that in our economy equity investment serves two purposes, financing the desired consumption plan as well as hedging future changes in preferences which are driven by changes in the supply of consumption goods. Figure 1 makes it clear how the supply of consumption goods affects their popularity and in turn, the agents' portfolios. When the supply share of the home consumption good is small, the foreign good is more popular among agents and their portfolio is biased toward the foreign asset. As the popularity of the home good increases the agents re-balance their consumption basket toward the home consumption good and their portfolio toward the home stock. In

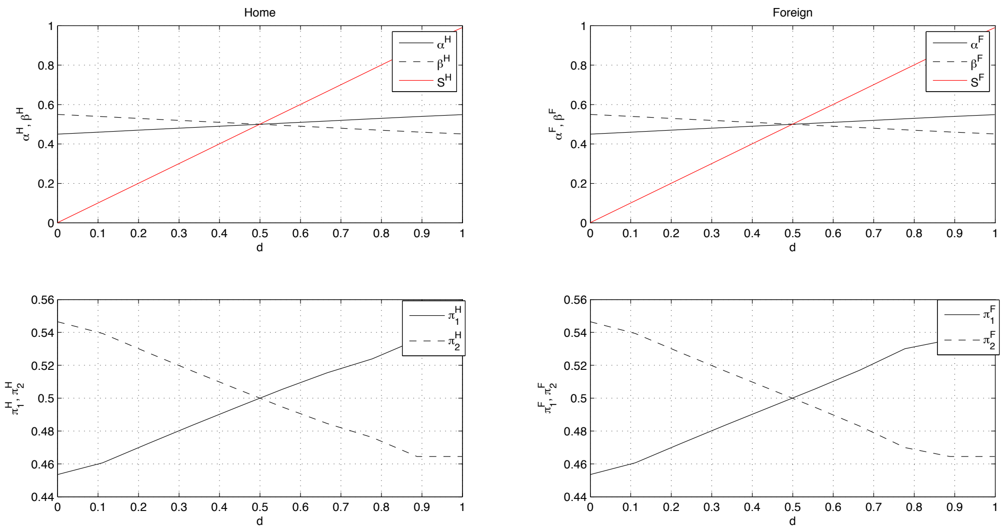


Figure 1: Agents' preference (upper panels) and portfolios as a function of the supply share of the home consumption good in the case of symmetric preference evolution. $\rho = 0.3$, $\mu_H = \mu_F = 0.02$, $\phi_H = \phi_F = .03$, $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^H = k_H^F = k_F^F = 0.1$

other words, our model suggests that consumption and portfolio diversification are related to each others via the mechanism of preferences evolution. When preferences change the consumption basket is re-balanced in favour of the preferred good and the stock portfolio

consistently, we describe the spillover effect in terms of the price of the home consumption good. One can equivalently express agents' wealth in unit of the foreign consumption good and discuss spill over effects induced by shocks to the preferences of the home agent on the financial wealth of the foreign agent.

is re-balanced in favour of the country producing the preferred good. This is consistent with the recent empirical evidence that country portfolios portfolios are biased in favour of countries with stronger trade linkages[8] (Lane and Milesi-Feretti (2008), Aviat and Coeurdacier (2007) and Porter and Rey (2005)). Moreover, Hwang (2011) shows that foreign investments of US investors are positively related to the popularity of foreign countries. In our model, the country popularity affects investment decisions because it changes the preferences for international traded goods. Thus our model provides a theoretical justification for the empirical results of Hwang (2011).

Even if the simple economy described above can reproduce several stylized facts about international markets, it cannot explain the observed bias for local stocks because the agents' portfolios are symmetric. Therefore we make the additional assumption that agents are more sensitive to changes in the popularity of local goods than they are to changes in the popularity of foreign goods, that is we assume that $k_H^H > k_F^H$ and $k_F^F > k_H^F$. This assumption seems natural in this framework and may be the result of the fact that, historically, home investors are more frequently exposed to the home consumption goods than to the foreign consumption goods, for instance, through more frequent advertising campaigns. Under this assumption (Figure 2) preferences for the domestic goods are more sensitive to supply shocks than preferences for the foreign goods in each country (that is, $\alpha^H$ is steeper than $\beta^H$ and $\beta^F$ is steeper than $\alpha^F$). This result, in conjunction with the expressions for stock prices given in Eq 15 and 16 implies that, in each country, the stock market is more sensitive to changes in preferences of domestic agents rather than to changes in preferences of foreign agents. As a result, the domestic equity is a better investment opportunity to protect against future preference fluctuations and is thus preferred relative to foreign equity. Intuitively, agents prefer to tie the fluctuations of their wealth to the local stock because this allows them to smooth consumption over time taking into account that the desire of consumption smoothing is time varying. Under the home bias portfolio strategy, time periods where the local market has high value (because of high dividend payments) are also periods where the agents' preferences are biased

[8]This of course under the assumption that a stronger trade linkages reflects high popularity of goods produced by the trading partner.

toward the local consumption good. The high desire to consume the home consumption good can be satisfied given that an important fraction of wealth comes in the form of payments in units of the local consumption good. Similarly, time periods when the value of the local market is low are also periods where agents do not want to consume high levels of the local consumption good. At the same time, given that preferences for the foreign good are relatively flat over time, agents can satisfy their time-varying necessity to smooth consumption of the foreign good by investing a relatively low fraction of wealth into the foreign asset. Quantitatively, this mechanism succeeds in generating a high degree of home bias: local investor hold between 60% and 90% of their portfolio in local assets.

In summary, our model provides a unified explanation for the home bias in consumption and the home bias in equity portfolios. This explanation is based the endogenous popularity of traded goods, which drives the evolution of preferences: agents purchase the most popular good because it carries higher marginal utility and prefer the home equity because it provides the best hedge against changes in preferences.

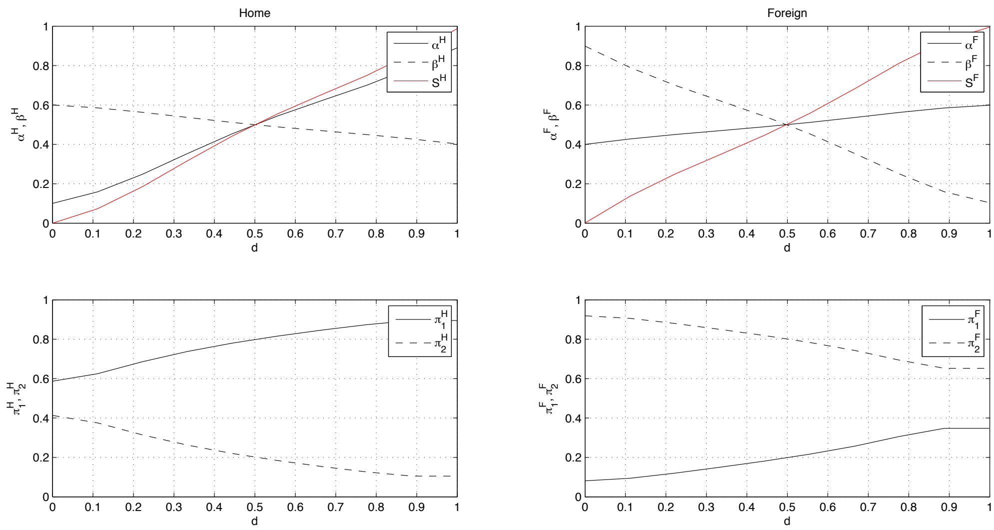


Figure 2: Agents' preference (upper panels) and portfolios as a function of the supply share of the home consumption good in the case of asymmetric preference evolution. $\rho = 0.3$, $\mu_H = \mu_F = 0.02$, $\phi_H = \phi_F = .03$, $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^F = 0.8$, $k_F^H = k_H^F = 0.4$

## 2.3 Discussion and alternative explanations

Since the seminal paper of French and Poterba (1991), several explanations for the home bias puzzle have been proposed. **?** show that the home bias can be explained by the disagreement of international investors about the country-specific expected output growth rates. Hatchondo (2008), Brennan and Cao (1997) and Gehrig (1993) explore the role of information asymmetry between local and foreign stocks as a possible explanation for the home bias in international portfolios. The implications of trading costs are studied by Coeurdacier (2009) and Uppal (1993). Baxter and Jermann (1997) suggest that the portfolio biases can be explained by labor income while Engel and Matsumoto (2009) emphasize the role of sticky prices. A branch of the international finance literature focuses on behavioral and preference-based explanations: for instance, Magi (2009) suggests that the home bias can be explained by loss aversion while Lauterbach and Reisman (2004) argue that home bias can be rationalized in a model where agents are equipped with "keeping up with the Joneses" preferences. Barber and Odean (2001), Korniotis and Kumar (2011) and Bailey et al. (2011) point to the role of over-confidence while Gtinblatt and Keloharju (2001) and Huberman (2001) argue in favor of emotional factors driven by common language or familiarity[9].

Our paper belongs to the category of preference-based explanations for the home bias puzzle. We suggest that the home bias in portfolios can be rationalized in a model where agents' preferences evolve over time in response to the popularity of internationally traded goods and agents are more sensitive to changes in popularity of the local good than to changes in popularity of the foreign goods. Note that our explanation does not rely on any kind of market imperfections and transactions costs and therefore our mechanism would still predict the home bias even in a world with perfectly integrated consumption and financial markets. Whether the data support the view of preference evolution is ultimately an empirical question that we address in Section 3 below.

[9]The literature on the equity home bias is huge, thus the list of papers above is not meant to be exhaustive. Our goal is to isolate some important strands of this literature looking at different possible explanations of the home bias. A comprehensive review of this literature can be found in Coeurdacier and Rey (2013).

# 3 Empirical analysis

To examine the empirical predictions of our model we use the methodology suggested by Pavlova and Rigobon (2007). First note that our model can be written as a factor model where the dynamics of Home and Foreign stock markets and that of the exchange rate are given by

$$\begin{pmatrix} \frac{dS^H(t)}{S^H(t)} \\ \frac{dS^F(t)}{S^F(t)} \\ \frac{dq(t)}{q(t)} \end{pmatrix} = I(t)dt + \Gamma(t) \times \begin{pmatrix} f^H(t) \\ f^F(t) \\ f^s(t) \end{pmatrix} \tag{22}$$

where $q(t) = \frac{1}{p(t)}$, $I$ is a $3 \times 1$ vector of intercepts, $\Gamma$ is $3 \times 3$ factor loading matrix and $f^H$, $f^F$ and $f^s$ are latent factors. The system 19 is derived by applying Ito's formula to 13, 15 and 16 (see the Appendix 5 for more details). This procedure yields the equilibrium dynamics of international stock markets and that of the exchange rate. Our empirical strategy is based on the following steps. First we use data on stock returns and exchange rates to estimate the latent factors $f^H$, $f^F$ and $f^s$[10]. Second, our model suggests that those factors should be linked to macroeconomic innovation and therefore we test the predictive power of the factors for macroeconomic variables. To do so, after estimating $f^H$, $f^F$ and $f^s$ we run regressions of macro variables on the estimated factors. We use data for 3 countries, Unites States United Kingdom and Germany (indexed by US, UK and GER), and we repeat the procedure described above for all pairs of countries.

## 3.1 Estimation of the latent factor model and popularity ratio

A crucial aspect when estimating Eq 19 is the availability of closed form solutions for the matrices $I$ and $\Gamma$ at any point in time. In the Appendix 5 we prove that under the assumptions $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^H = k_H^F = k_F^F$ and $\lambda^H = \lambda^F = 0.5$ it exists a unique popularity ratio given by $s = s^H = s^F = \frac{Y^H}{Y^H + Y^F}$. Admittedly these assumptions are made for tractability but they also have intuitive and reasonable economic implications. First, $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$ implies that hat the equilibrium popularity ratio equals 50% when the

[10]The left-hand side of Eq 19 is obtained from empirical data, $I$ and $\Gamma$ are given by our equilibrium model, thus the only thing we need to to is to invert Eq 19 and solve for $f^H$, $f^F$ and $f^s$ at any point in time

supply of the two consumption goods is the same (this can be verified by looking at Figures 1 and 2). Thus, if one assumes that $Y^H(0) = Y^F(0)$ then at the starting date agents have the same preferences for the two goods. After the initial date international preferences evolve in reaction to changes in the supply of the goods. Assuming that agents have the same social weight ($\lambda^H = \lambda^F = 0.5$) implies that the two representative agents have the same initial wealth[11], i.e. $w^H(0) = w^F(0)$. Clearly the assumption $k_H^H = k_F^H = k_H^F = k_F^F$ implies that international portfolios react symmetrically to changes in the popularity of traded goods. However, we stress that it is not our purpose here to test whether agents exhibit different sensitivity to changes in the popularity of local and foreign goods. Instead our goal is to show that the economic mechanism that links popularity of traded goods to agents' preference offers a plausible explanation for the dynamics of important macroeconomic variables [12]. All together the assumptions described above ensure that the dynamics of asset prices in our model are driven by changes in popularity of traded goods only and are not affected by differences in the primitives of the economy such as different endowment of initial wealth or different initial preferences for the two consumption goods.

Quantitatively, the assumptions $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^H = k_H^F = k_F^F$ and $\lambda_H^H = \lambda_H = 0.5$ imply that asset prices simplify to (see Appendix 5 for more details)

$$\frac{S_H(t)}{Y^H(t)} = \frac{\frac{0.5(1-k)}{\rho} + k\mathbb{E}_t\left[\int_t^\infty e^{-\rho(u-t)} s(u)\right] du}{0.5 + k\,(s(t) - 0.5)} \tag{23}$$

$$\frac{S_F(t)}{p_{2,t} Y^F(t)} = \frac{\frac{0.5(1+k)}{\rho} - k\mathbb{E}_t\left[\int_t^\infty e^{-\rho(s-t)} s(u)\right] du}{0.5 - k\,(s(t) - 0.5)}. \tag{24}$$

The advantage of 20 and 21 with respect to 15 and 16 is the availability of a closed form solution for the popularity ratio $s$ that, in this case, coincides with the supply share $\frac{Y^H}{Y^H+Y^F}$. As a result, the expected value of the future popularity ratio can be computed

[11] Exogenous weight are also used by Chan and Kogan (2002) in a model where agents differ in their risk aversion

[12] Note that in this way we test a restricted version of our original model and therefore this assumption clearly works against us finding evidence in favour of the mechanism of preference evolution, thus making the results described in this Section stronger.

using the hypergeometric function as follows[13]

$$F \equiv \mathbb{E}_t\left[\int_t^{\infty} e^{-\rho(\tau-t)}s(\tau)d\tau\right] = \frac{s}{\psi(1-\gamma)(1-s)}V\left(1;1-\gamma;2-\gamma;\frac{s}{s-1}\right)+\frac{1}{\psi\theta}V\left(1;\theta;1+\theta;\frac{s-1}{s}\right) \tag{25}$$

where $V(\cdot)$ is the hypergeometric function and

$$\begin{aligned}
\psi &= \sqrt{\nu^2+2\rho\eta^2}\\
\gamma &= \frac{\nu-\psi}{\eta^2}\\
\theta &= \frac{\nu+\psi}{\eta^2}\\
\nu &= \nu_F-\nu_H-\phi_F^2/2+\phi_H^2/2\\
\eta^2 &= \phi_H^2+\phi_F^2
\end{aligned}$$

Without closed form solutions we would have to use two-dimensional numerical integration to compute the expected value of the popularity ratio at each point in time, which would render our empirical approach computationally much more expensive. The availability of closed form solutions also simplifies the computations of the dynamics of stock prices which determine the factor model 19. More precisely, we apply the Ito's lemma to Eq 20 and 21 to obtain

$$\begin{pmatrix}\frac{dS^H(t)}{S^H(t)}\\ \frac{dS^F(t)}{S^F(t)}\\ \frac{dq(t)}{q(t)}\end{pmatrix} = I(t)dt+\Gamma(t)\times\begin{pmatrix}f^H(t)\\ f^F(t)\\ f^s(t)\end{pmatrix}$$

$$= I(t)dt+\begin{pmatrix}1 & 0 & \left[\frac{k\times F'(s)}{F(s)+\frac{1}{\rho}\left(\frac{1}{2}-\frac{1}{2}k\right)}-\frac{k}{\alpha(t)}\right]\\ 1 & 0 & \left[\frac{-k\times F'(s)}{-F(s)+\frac{1}{\rho}\left(\frac{1}{2}+\frac{1}{2}k\right)}-\frac{k}{\alpha(t)}\right]\\ -1 & 1 & \left(\frac{k}{\alpha(t)}+\frac{k}{1-\alpha(t)}\right)\end{pmatrix}\times\begin{pmatrix}\phi_H dB_1\\ \phi_F dB_2\\ s_t(1-s_t)(\phi_H dB_1-\phi_F dB_2)\end{pmatrix} \tag{26}$$

where $\alpha(t)=0.5+k(s-0.5)$, $s=\frac{Y^H}{Y^H+Y^F}$ and $F'$ is the derivative of the hypergeometric function with respect to $s$ which is also available in closed form. For brevity, the drift

[13] See Cochrane et al. (2008) for more details on this point.

component $I(t)$ is given in the Appendix 5. In this way we obtain a tractable version of the factor model in 19. According to Eq 23, the first two factors $f^H = \phi_H dB_1$ and $f^F = \phi_F dB_2$ represent supply shocks to the home and foreign consumption goods and the third factor $f^s = s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2)$ represent shocks to the popularity of internationally traded goods.

To extract the factors from Eq 23 we need a time series of the popularity ratio $s = \frac{Y^H}{Y^H+Y^F}$. Ito's lemma reveals that the popularity ratio follows

$$\begin{aligned} ds_t &= s_t(1-s_t)\left[(\nu_H - \nu_F) - s_t\phi_H^2 + (1-s_t)\phi_F^2\right] dt \\ &+ s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2) \end{aligned} \tag{27}$$

We obtain the time series of the popularity ratio from the data using the following procedure. First we use realized growth rates of countries' consumption in conjunction with Eq 1 to back out the time series of shocks $B_1$ and $B_2$[14]. We then plug the realized shocks $B_1$ and $B_2$ into Eq 24 to back out the values of the popularity ratio[15]. We repeat the same procedure for three different initial values of the popularity ratio, that is $s_0 = 0.1$, $s_0 = 0.5$ and $s_0 = 0.9$.

In order to estimate the system 23 we follow closely Pavlova and Rigobon (2007). In the initial step, we run a VAR with five lags to clean the data from the serial correlation in the returns. In a second step, we construct the weighting matrix $\Gamma$ at any $t$, invert it and use residuals from the VAR model to obtain the latent factors $f^H$, $f^F$ and $f^s$. By doing this we impose no restrictions on correlations and variances of the latent factors. This differs from the traditional macro finance literature that typically impose identification restrictions on the factors. It is also important to note that the matrix $\Gamma$ is essentially determined by the agents' preferences only. Thus, in our model, the sensitivity of stock markets and exchange rates to supply and preferences shocks is time-varying and depends

[14]We repeat the same procedure using GDP instead of consumption and results are qualitatively the same.

[15]The same procedure is used by Heyerdahl-Larsen (2014) to estimate habit processes of internationally traded goods. The parameters describing the dynamics of countries' consumption are estimated from real data and given by $\nu = 0.018$ and $\phi = 0.008$ for the US, $\nu = 0.011$ and $\phi = 0.015$ for Germany and $\nu = 0.02$ and $\phi = 0.018$ for the UK. The sample period is from 1991 until the end 2014.

on current and expected preferences for traded goods.

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 3.51 | 5.0 | 0.73 |
| Correlations | | |
| $f^H$ | $f^F$ | $f^s$ |
| 1 | 0.53 | 0.38 |
| | 1 | -0.25 |
| | | 1 |

Table 1: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$ and $s_0 = 0.5$. All estimates are significant at the 5% level.

Table 1 reports the estimated variance-covariance matrix of the three latent factors for the case of US (assumed to be the home country) and Germany (the foreign country) and assuming that $s_0 = 0.5$ and that the common sensitivity to the popularity ratio is given by $k = 0.85$. We observe that all factors are significant and the variance of the preference factor ($f^s$) is smaller than that of supply factors ($f^H$ and $f^F$) suggesting that agents' preferences are more stable than countries' output. Moreover, the correlation structure of the factors is in line with the theoretical predictions of the model, that is, shocks to the supply of home country goods (foreign good) increases (decreases) the popularity of the home country good and are therefore positively (negatively) related to the popularity ratio. The estimates for the other countries and for different parameter values are similar and reported in the Appendix 6.

## 3.2 Using estimated factors to explain macroeconomic variable

If the factors estimated in the previous section have economic content they should be able to forecast macroeconomic variables. We examine the predictive power of our factors for industrial production, business confidence, the business climate index, consumer confidence measures and bond prices[16]. More precisely, for each macroeconomic variable

[16] Variables are described in detail in Appendix 6

$M$ we run the following regression

$$dM(t) = \alpha_M + \sum_{q=1}^{L} \beta^1_{M,q} f^H(t-q) + \sum_{q=1}^{L} \beta^2_{M,q} f^F(t-q) + \sum_{q=1}^{L} \beta^3_{M,q} f_s(t-q) + \epsilon_M(t), \quad (28)$$

where $\epsilon_M(t)$ is the error term. We choose six lags of the latent factors to capture their ability to forecast the responses of the macro variables. Notice that in this specification we use financial time series to estimate the latent factors and therefore predictive regressions of changes in macroeconomic variables on changes in the factors are done out-of-sample.

Consistently with Section 3.1 we report below the regression results for the case of US vs Germany when the initial popularity ratio is $s_0 = 0.5$, and robustness checks in Appendix 6. By inspection of Table 2, it we see that our factors can explain a significant fraction of the variation in macroeconomic variables. The first column reports the adjusted $R^2$, the second column reports the variance explained by the factors and the third column shows the significance of the regressions. For instance, looking at the adjusted $R^2$ we see that the factors explain about 20% of changes in the industrial production in the US and 13% of the fluctuations of the German industrial production. Our factors can also account for 14% and 17% of the changes in the business and consumer confidence in the US and 24% of changes in the German consumer and business confidence. Comparable numbers are obtained for other countries and for different initial values of the popularity ratio. Admittedly our approach does not seem to work properly for US bond prices because the factors together explain only 1% of their variation.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production USA | 20.7% | 26% | 0.000 |
| Industrial production GER | 13.1% | 18.7% | 0.000 |
| Business confidence USA | 13.8% | 19.4% | 0.000 |
| Business confidence GER | 23.6% | 28.6% | 0.000 |
| IFO business climate index GER | 16.7% | 22.1% | 0.000 |
| Consumer confidence USA | 16.6% | 22.0% | 0.000 |
| Consumer confidence GER | 24.4% | 29.3% | 0.000 |
| ISM employment (PMI) USA | 9.8% | 15.7% | 0.000 |
| Bond prices USA | 1% | 7.5% | 0.3 |
| Bond prices GER | 12.2% | 17.9% | 0.000 |
| Consumer confidence total (CB) USA | 17.3% | 23.0% | 0.000 |
| Consumer confidence expect (CB) USA | 16.3% | 22.0% | 0.000 |
| Consumer sentiment USA | 11.1% | 16.9% | 0.000 |
| Observations # | 277 | | |

Table 2: Regressions of the macro-variables on the estimated factors. The sample size is from 1991 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the regression, the second column gives the $R^2$, the third column gives p-values.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production USA | 19.2% | 20.4% |
| Industrial production GER | 9% | 10% |
| Observations # | 278 | |

Table 3: Regression of the Industrial Production (IP) Index on its lags $dM(t) = const + \sum_{q=1}^{n} dM(t-q)$. There are 4 lags for the IP index of USA and 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

Finally, in Tables 3 and 4 we re-estimate the same regressions to test the economic significance of the latent factors in the presence of the lagged dependent variables. We allow for several lags of the dependent variables which are chosen optimally, that is, in each regression the maximum number of lags, say $N$, is such that lags $N+1, N+2...$ are not significant. In Table 3 we see that our macro variables are serially correlated in the sense that lagged values help to predict future values. However, when we add lagged values of our factors into the regressions (Table 4) the $R^2$ increases significantly indicating that

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production USA | 27.8% | 33.5% |
| Industrial production GER | 23.3% | 29.2% |
| Observations # | 277 | |

Table 4: Regression of the Industrial Production Index (IP) on its lags and on 6 lags of the factors $dM(t) = const + \sum_{q=1}^{n} dM(t-q) + \sum_{p=1}^{6} f^H(t-p) + \sum_{p=1}^{6} f^F(t-p) + \sum_{p=1}^{6} f^s(t-p)$. There are 4 lags for the IP index of USA and 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

the explanatory power of our factors remains important even when lagged values of the dependent variable are added into the regression[17]. These findings support the mechanism of preference evolution as a plausible driver of macroeconomic fluctuations.

## 3.3 An alternative measure of popularity

The previous Sections suggest that time-variation in preferences, induced by the time-varying popularity of consumption goods, helps explain the fluctuations of key macroeconomic quantities. To come to this conclusion we have measured the popularity of consumption goods using the countries' consumption share, consistent with our theory. In this Section we try to construct a broader and possibly pure measure of popularity that is not related to any endogenous quantities of our model. The idea is to build an alternative popularity index using the Google search volume of internationally traded goods and then repeat the same test of Section 3.1 using this alternative measure of popularity. The usefulness of the Google search data has been recognized in many applications. **?** show that short-term returns are predictable with stock-ticker search volume data and **?** provide evidence that search volume of a firm's most popular product can predict revenue surprises and earnings surprises.

We proceed as follows: 1) We start with a large sample of firms from the three countries

[17] The survey variables show strong serial correlation, therefore our factors only slightly increase the $R^2$ of our regressions. This is a general result for many survey variables.

under analysis, namely we take $SP900$ firms for the US, $FTSE350$ firms for the UK and DAX, MDAX and SDAX firms for Germany. 2) From all firms we delete financials and utilities and select only those that operate internationally. This procedure leave us with 216 companies for the US, 80 for the UK and 45 for Germany. In this way we include in our test about 1/4 of the stock market of each country. We consider both durable and non-durable goods producers. 3) For all firms that operate internationally we take the most popular product[18]. 4) Using Google Trends we obtain the country specific search volume of each of these products for the time period 2004-2014 (weekly)[19]. For instance, to measure the popularity of Adidas products in the US, we take the search volume of those products in the US only. This number tells us how many times, during the time window considered, US consumers use Google to search information about Adidas products. Our implicit assumption here is that the higher is the search volume of Adidas products in the US the higher is the popularity of Adidas products in the US at a given point in time. Similarly, we measure the popularity of Adidas products in Germany using the search volume of Adidas products in Germany only. Differently from the popularity measure used in Section 3.1, Google search volumes captures not only popularity in terms of sales but, more generally, the visibility of commercial products in a given country.

Then, to obtain a measure of the popularity of goods traded between two countries we aggregate search data of single firms into one single time series. The aggregation is not straightforward because Google provides search volume data scaled by the maximum search volume realized during the period covered by the query. This makes it problematic to directly sum up the time series of the different products. To circumvent this issue we aggregate search volumes using different weighting schemes: i) the weighted average based on firms' total sales; ii) the weighted average based on market capitalization and iii) the arithmetic average[20]. It is important to stress that we do not use time-varying

[18]We use Google Trends to identify the most popular product by putting multiple products (brands) together in the search query. When data are available (mostly for pharmaceuticals companies) we identify the most popular product based on sales. We employ a topic search in Google Trends when the name of the brand or product can be mistakenly interpreted (e.g. a brand name "Gap" can be confused with a word "gap"). The topic search is a function that aggregates all search queries for a particular topic (for instance, in case of "Gap" it will aggregate every search that refers to the brand) only.

[19]We track all the firms ever included in the respective stock indices.

[20]The use of market capitalization and market share as weights in the construction of the popularity

weights but we simply take the average market capitalization (or market share) of a given firm in our sample. This is to make sure that our popularity measure changes over time only in response to changes in the search volumes of internationally traded products and is not affected by changes in the market capitalization (market share) of international companies. Moreover, working with search volumes divided by the maximum search volume realized in a given period of time might introduce forward looking information in our time series of popularity. To address this concern we scale each search volume by the median search volume realized in the past. Formally, our key variable is defined as

$$CX_j(t) = \frac{X_j(t)}{Median\left(X_j(t-1), ..., X_j(t-12)\right)}.$$

where $X_j(t)$ is a search volume for a particular product during the week $t$ which is divided by the median value of the $X_j(t)$ during the prior 12 weeks. Since both numerator and denominator are scaled by the maximum search volume, the ratio is not affected by the maximum search volume.

Consider then the couple of countries $\{US, GER\}$ and let $CX_j^{US_i}(t)$ be the the search volume of products of US-firm $i$ in country $j$ at time $t$. Similarly $CX_j^{GER_i}(t)$ is the search volume of products of GER-firm $i$ in country $j$ at time $t$. The popularity index of the economy is defined as

$$s(t) = \frac{W^{US}\overbrace{\left(\sum_i w_i^{US} \times CX_{US}^{US_i}(t) + \sum_i w_i^{US} \times CX_{GER}^{US_i}(t)\right)}^{\text{Tot. pop. of US goods in US and GER}}}{W^{US}\underbrace{\left(\sum_i w_i^{US} \times CX_{US}^{US_i}(t) + \sum_i w_i^{US} \times CX_{GER}^{US_i}(t)\right)}_{\text{Tot. pop. of US goods in US and GER}} + W^{GER}\underbrace{\left(\sum_i w_i^{GER} \times CX_{US}^{GER_i}(t) + \sum_i w_i^{GER} \times CX_{GER}^{GER_i}(t)\right)}_{\text{Tot. pop. of GER goods in US and GER}}} \quad (29)$$

where $w_i^{US}$ is the weight used for aggregation (i.e., the capitalization weight, the market share or $1/N$) of firm $i$ in the $US$, $w_i^{GER}$ is the same quantity for German firms, $W^{US}$ and $W^{GER}$ are the market capitalization (or market share) of US and Germany, respectively. The numerator of **??** measures the total popularity of US firms in both Germany and the US while the denominator measure the total popularity of German and US firms in both

index is also justified by the empirical evidence of **?** and **?**. They show that an increase in the firm's search frequency is associated with higher stock price (in the short run) and higher revenue, respectively. Consistently, our measure of popularity places heavier weights to the popularity of companies with high market value or high sales.

US and Germany. In other words the variable $s$ captures the popularity of US products relative to the total popularity of US and German products in our 2-country economy and thus represents the empirical counterpart of the popularity ratio derived in our general equilibrium model[21]. The same popularity ratio is computed for the other couples of countries.

[21] Note also that $1 - s$ represents the popularity of German goods in our 2-Country economy. Thus an increase in the popularity of US goods is automatically associated to a decrease in the popularity of German goods, consistent with our theoretical model.

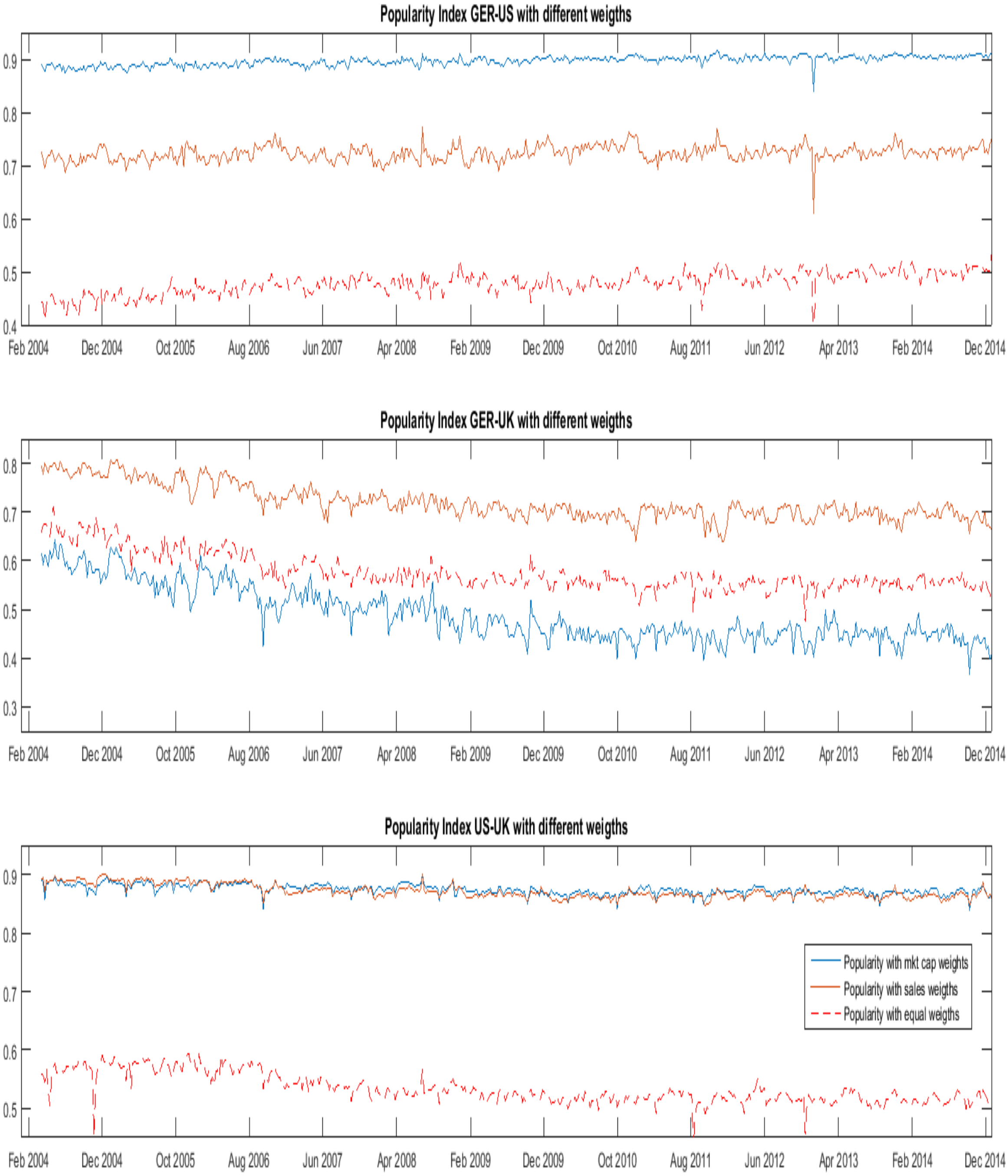


Figure 3: Popularity index for different pairs of countries with market capitalization, sales and equal weights. For the GER-US case the US is the home country. For the GER-UK case Germany is the home country. For the US-UK case US is the home country. In all cases, the popularity measure that we plot refers to the popularity of the home country relative to the other country.

| | mkt cap | sales | equal |
|---|---|---|---|
| mkt cap | 1 | 0.71 | 0.85 |
| sales | | 1 | 0.59 |
| equal | | | 1 |

Table 5: US-GER: correlation of the popularity ratios with different weighting schemes

| | mkt cap | sales | equal |
|---|---|---|---|
| mkt cap | 1 | 0.96 | 0.90 |
| sales | | 1 | 0.90 |
| equal | | | 1 |

Table 6: UK-GER: correlation of the popularity ratios with different weighting schemes

| | mkt cap | sales | equal |
|---|---|---|---|
| mkt cap | 1 | 0.82 | 0.72 |
| sales | | 1 | 0.86 |
| equal | | | 1 |

Table 7: US-UK: correlation of the popularity ratios with different weighting schemes

Figure **??** shows the popularity ratios obtained with the three different weighting procedures for the three couples of countries we consider. The series with market cap and sales weighting differ only slightly in their level. The reason is that the market capitalization of the countries differs from their markets share. For instance, for Germany and the US the popularity of US firms relative to the total popularity of German and US firms is higher under the market capitalization weighting scheme than under the weighting scheme based on sales. This is so because the difference in the market capitalization between US and German firms is higher than the difference in the market share and therefore the popularity of US goods is amplified by the market capitalization weighting scheme. Similarly, for the case of US and UK the market capitalization weighting scheme amplifies the popularity of US firms but to a lesser extent than in the case of Germany and the US. In fact the difference between the market capitalization of US and UK firms are not that pronounced as the differences between US and Germany. For the same reason the market capitalization weighting scheme amplifies the popularity of UK products as compared to Germany. The equal weighting disregards the size of the economy of the countries and therefore increases the popularity of German products relative to that of US products and UK products as compared to the popularity obtained using the market capitalization weighting scheme. However, we stress that our test is designed to explain fluctuations in macro variables and, thus, the change in our popularity measure is more important than its level. By inspection of Figure **??** we see that in all cases the measures of popularity based on the two different weighting schemes track each other closely with a correlation that ranges from 59% to 96%. Therefore we focus on the measure of popularity based on market share only[22].

Armed with our time series of popularity we repeat the same test of Section 3.1: first we back out latent factors using Eq 23 and then we use the factors to forecast macroeconomic variables. We run the same regression as in **??** but use 3 lags of the latent factors because we expect Google search volume to provide the strongest relevance on a short-term level. From Table **??** we observe that the estimates of latent factors are significant and their correlation structure is in line with the model predictions: supply shocks of the home country good (the US in this case) are positively correlated with shocks to the global popularity of US goods while supply shocks of the foreign good (Germany in this case) are negatively correlated with shocks with the global popularity of US goods. Even for our internet-based measure of popularity we infer that agents' preference are more stable than countries' output. Similar results hold for other countries (see Appendix 6). Concerning predictive regressions we observe that also in this case the three factors have significant predictive power. For instance, by inspection of Table **??**, we see that the three factors together explain up to 24% of fluctuations in the US industrial production, and more than 30% of fluctuations in German confidence indices (Business Confidence and Consumer Confidence indices). Similarly for other countries (see Appendix 6). All together

[22]The results based on different weighting schemes are very similar and available upon request.

these results reinforce the plausibility of preference evolution as a possible explanation for fluctuations in international financial markets and macroeconomic quantities.

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 7.57 | 8.14 | 1.19 |
| Correlations | | |
| $f^H$ | $f^F$ | $f^s$ |
| 1 | 0.48 | 0.28 |
| | 1 | -0.21 |
| | | 1 |

Table 8: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$. All estimates are significant at the 5% level.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production US | 24% | 29% | 0.000 |
| Industrial production GER | 16% | 22% | 0.000 |
| Business confidence US | 14% | 20% | 0.000 |
| Business confidence GER | 33% | 38% | 0.000 |
| Consumer confidence US | 18% | 23% | 0.00 |
| Consumer confidence GER | 32% | 37% | 0.000 |
| Ifo Index GER | 32% | 37% | 0.000 |
| Bond prices US | 4% | 11% | 0.13 |
| Bond prices GER | 20% | 25% | 0.000 |
| Consumer confidence total (CB) USA | 15% | 21% | 0.000 |
| Consumer confidence expect (CB) USA | 14% | 20% | 0.000 |
| Consumer sentiment USA | 10% | 16% | 0.000 |
| Observations # | 127 | | |

Table 9: Regressions of the macro-variables on the estimated factors. The sample size is from 2004 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the regression, the second column gives the $R^2$, the third column gives p-values.

## 3.4 Preference evolution and the dynamics of capital markets

Our model generates the home bias because agents' preferences are more sensitive to change in popularity of the local goods than to changes in the popularity of the foreign goods. Unfortunately preferences cannot be measured and the previous assumption cannot be directly tested. Nonetheless we can test the empirical predictions generated by the assumption that agents are more sensitive to the popularity of local goods. By inspection of Eq 15 we see that the previous assumption has a clear implication for the dynamics of price-dividend ratio in each country: When agents are more sensitive to the popularity of local goods, the stock market of each country reacts more to changes in the preferences of local agents than to changes in preferences of foreign agents. To test this prediction we run a simple regression of the log price-dividend ratios on the popularity of home goods in the home Country, the popularity of home goods in the Foreign Country and control variables (log turnover and market returns):

$$pd_t = const + \beta_H \times popHome_t + \beta_F \times popForeign_t + Controls + e_t,$$

where

$$\begin{aligned} popHome_t &= \sum_i w_i^{Home} \times CX_{Home}^{Home_i}(t) \\ popForeign_t &= \sum_i w_i^{Home} \times CX_{Foreign}^{Home_i}(t) \end{aligned}$$

We expect that the log price-dividend ratio reacts stronger to the shock of popularity of home goods in the home country, that is $|\beta_H| > |\beta_F|$. We implement this regression for different weighting schemes (market cap, sales and equal weighting) and we report the results in Table **??** for the the US and Germany[23]. First we observe that $\beta_H$ and $\beta_F$ are often negative suggesting that the impact of popularity on the current marginal utility is stronger that its impact on the future marginal utility of our representative agents (see Eq 15 and the discussion therein for more details). Moreover, the impact of the local popularity of the home goods is always bigger than the impact of the foreign popularity of the home goods as expected. The latter result is not affected by the weighting scheme used to compute the popularity of home and foreign goods. For other Countries the

[23]Results for other Countries are reported in the Appendix 6

results are largely the same. The effect of the local popularity of the home goods is always bigger than the effect of the foreign popularity of the home goods for the $1/N$ weighting scheme. We observe some differences only for the other two weighting schemes. For instance the regressions for Germany and UK confirm our main hypothesis when the popularity measures are constructed using equal weights but not when weights are based on market capitalization and sales (for the case of Germany) or when based on market capitalization (for the case of UK). The regressions for the US and UK always confirm our main hypothesis except for the US but only when the popularity measures are constructed using sales. The fact that we find stronger evidence for our main hypothesis when popularity measures are constructed using equal weights is not surprising. In fact **?** find that the effect of search volumes is stronger on small companies than on big companies. Therefore weighting schemes based on sales or market capitalization, that are typically higher for big companies, tend to obfuscate the effect of popularity on price-dividend ratios that instead emerges when using the $1/N$ weighting scheme. These results suggest that the economic mechanism through which preference evolution induces the home bias in equity portfolios is empirically plausible.

| | USA | | | Germany | | |
|---|---|---|---|---|---|---|
| | mkt cap weights | sales weights | equal weights | mkt cap weights | sales weights | equal weights |
| Local Popularity of Home Goods | **-0.978** | **-0.457** | **-1.240** | **-0.380** | **-0.370** | **-1.049** |
| | (-3.95) | (-2.10) | (-3.99) | (-2.10) | (-2.10) | (-5.67) |
| Foreign Popularity of Home Goods | **-0.179** | **0.011** | **-0.539** | **-0.135** | **-0.227** | **-0.310** |
| | (-0.97) | (0.06) | (-3.32) | (-1.25) | (-1.71) | (-2.10) |
| Turnover | -0.001 | -0.005 | -0.002 | -0.239 | -0.244 | -0.198 |
| | (-0.58) | (-2.69) | (-0.48) | (-4.38) | (-4.38) | (-4.21) |
| Market return | 0.809 | 0.830 | 0.868 | 0.434 | 0.362 | 0.516 |
| | (3.21) | (2.93) | (3.47) | (1.31) | (1.10) | (1.71) |
| Constant | 4.874 | 4.370 | 5.119 | 7.207 | 7.36 | 7.472 |
| | (21.67) | (24.03) | (18.24) | (9.75) | (9.90) | (11.79) |
| Observations # | 561 | | | | | |

Table 10: Regressions of the log price-dividend ratio on the popularity of home goods in Home Country and the popularity of home goods in Foreign Country and the set of control variables. All variables are in levels. The standard errors are computed using Newey-West (1987) formula with 12 lags. The sample size is from 2004 to the end of 2014. The data are weekly.

# 4 Conclusion

In this paper we propose a new economic mechanism, namely endogenous evolution of preferences for internationally traded goods that helps us to better understand the transmission of shocks across international stock markets and to explain the low diversification of international portfolios. In our model, changes in asset prices are determined by supply shocks and changes in the popularity of internationally traded goods that, in turn, alter the agents' preferences for consumption goods and, consequently, their portfolios. When agents are more sensitive to changes in the popularity of domestic goods rather than to changes in the popularity of foreign goods, the home bias arises because the domestic equity market is a better investment opportunity to hedge against future changes in preferences. The identification of the differences between local and foreign investors that are able to explain the observed preference for domestic equity markets is a traditionally important research theme of the international finance literature. This literature mostly focuses on the fact that local and foreign investors have different information about international equity markets, or they interpret the same information in a different way. In this paper we demonstrate the important role played by differences in the sensitivity to the popularity of internationally traded goods.

To asses the quantitative importance of preference evolution, we estimate the latent factors that drive economic fluctuations in our model and show that those factors can predict several important macroeconomic variables, excluded from our estimation. Finally, we verify empirically the economic mechanism that is responsible for the home bias on our model: international financial markets are more sensitive to the local popularity of the home goods than to the foreign popularity of the home goods. This shows that the mechanism of endogenous preference evolution is a plausible driver of fluctuations in macroeconomic quantities and asset prices and, thus, could represent an interesting avenue of future research. For instance, we regard the extension of our framework to different research areas, such as the relationship between commodity trading and spot price dynamics as fruitful topics of future research.

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# 5 Appendix A: Model solution

In this appendix we report the detail of the two-coutry model with preference evolution.

## 5.1 Optimal Consumption, popularity ratio and asset prices

We start by computing optimal consumption of internationally traded goods. The FOC of the social planner problem imply that

$$c_H^H(t) = e^{-\rho t}\frac{\lambda^H \alpha^H(t)}{m(t)}, \quad c_F^H(t) = e^{-\rho t}\frac{\lambda^H \beta^H(t)}{m(t)p(t)}$$
$$c_H^F(t) = e^{-\rho t}\frac{\lambda^F \alpha^F(t)}{m(t)}, \quad c_F^F(t) = e^{-\rho t}\frac{\lambda^F \beta^F(t)}{m(t)p(t)}$$

The price of the numeraire consumption $m(t)$ good and the relative price $p(t)$ then follow from the clearing conditions of the consumption market

$$e^{-\rho t}\frac{\lambda^H \alpha^H(t)}{m(t)} + e^{-\rho t}\frac{\lambda^F \alpha^F(t)}{m(t)} = Y^H(t),$$
$$e^{-\rho t}\frac{\lambda^H \beta^H(t)}{m(t)p(t)} + e^{-\rho t}\frac{\lambda^F \beta^F(t)}{m(t)p(t)} = Y^F(t)$$

with solution

$$m(t) = e^{-\rho t}\frac{\lambda^H \alpha^H(t) + \lambda^F \alpha^F(t)}{Y^H(t)}$$
$$p(t) = \frac{\lambda^H \beta^H(t) + \lambda^F \beta^F(t)}{\lambda^H \alpha^H(t) + \lambda^F \alpha^F(t)} \times \frac{Y^H(t)}{Y^F(t)}$$

By standard arguments, stock prices are given by the present value of the stream of dividends discounted using $m(t)$ and $p(t)$, that is

$$\begin{aligned} S_H(t) &= \mathbb{E}_t\left[\int_t^\infty \frac{m(s)}{m(t)} Y^H(s) ds\right] \\ &= \frac{Y^H(t)}{\lambda_H \alpha_H(t) + \lambda_F \alpha_F(t)}\left[\lambda_H \mathbb{E}\int_t^\infty e^{-\rho(s-t)}\alpha_H(s)ds + \lambda_F \mathbb{E}\int_t^\infty e^{-\rho(s-t)}\alpha_F(s)ds\right] \end{aligned}$$

$$\begin{aligned} S_F(t) &= \mathbb{E}_t\left[\int_t^\infty \frac{m(s)p(s)}{m(t)} Y^F(s) ds\right] \\ &= \frac{Y^F(t)p(t)}{\lambda_H \beta_H(t) + \lambda_F \beta_F(t)}\left[\lambda_H \mathbb{E}\int_t^\infty e^{-\rho(s-t)}\beta_H(s)ds + \lambda_F \mathbb{E}\int_t^\infty e^{-\rho(s-t)}\beta_F(s)ds\right] \end{aligned}$$

The popularity ratio of national goods are then computed as the solution to the system

$$\begin{cases} F_1(s^H, s^F, Y) = s^H(t) - \frac{p(t)\alpha^H(t)}{p(t)\alpha^H(t)+\beta^H(t)} = 0, \\ F_2(s^H, s^F, Y) = s^F(t) - \frac{p(t)\alpha^F(t)}{p(t)\alpha^F(t)+\beta^F(t)} = 0 \end{cases} \tag{30}$$

where $Y(t) = \frac{Y^H(t)}{Y^F(t)}$. To prove existence and uniqueness of the popularity rations we adapt the procedure developed by Curatola (2016) to the multivariate case. First note that $s^F(t), s^H(t) \in [0,1]$ which, in conjunction with the fact that $\alpha^i(t), \beta^i(t) \geq 0 \quad \forall t$, implies that

$$F_1(0,0,Y) \leq 0 \quad F_2(0,0,Y) \leq 0$$

while

$$F_1(1,1,Y) \geq 0 \quad F_2(1,1,Y) \geq 0$$

and therefore at least one solution to the system of equations 26 exists. To prove uniqueness we first note $\frac{c_H^H(t)}{c_H^H(t)+c_F^H(t)}$ and $\frac{c_H^F(t)}{c_H^H(t)+c_F^F(t)}$ are increasing functions of $Y$ and so are $s^H$ and $s^F$. As a result we have that $\frac{\partial F_1}{\partial Y} > 0$ and $\frac{\partial F_2}{\partial Y} > 0$. This means that when the relative endowment increases, the fixed points equations in 26 shift downward. Assume by contradiction that the system 26 admits more than one solution for some $Y = Y_1$. Consider the non-trivial case when these solutions differ from each other and let the solutions be given by $s^i_{1,1} < s^i_{2,1} < ... < s^i_{N,1}$ for $i = \{H, F\}$. Assume now that the relative endowment increases to $Y_2 + \varepsilon > Y_1$ for some small amount $\varepsilon > 0$. Let the new solutions be $s^i_{1,2} < s^i_{2,2} < ... < s^i_{N,2}$. Given the continuity of $F_1$ and $F_2$ we will have some $s^i_{j,2} < s^i_{j,1}$ for $j = \{1, 2, ...N\}$ contradicting the fact that the popularity ratio must be increasing in $Y$.

### 5.1.1 The symmetric economy

Under the assumption of symmetry ($\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k^H_H = k^H_F = k^F_H = k^F_F$ and $\lambda^H_H = \lambda_H = 0.5$) we have that

$$
\begin{aligned}
m(t) &= e^{-\rho t}\frac{\left(1 + k\left(s^H + s^F - 1\right)\right)}{2Y^H(t)}, \\
p(t) &= \frac{\left(1 - k\left(s^H + s^F - 1\right)\right)}{\left(1 + k\left(s^H + s^F - 1\right)\right)}Y(t).
\end{aligned}
$$

and the system of equations for the popularity ratios reduces to

$$
\begin{aligned}
s^H &= \frac{\left(0.5 + k\left(s^H - 0.5\right)\right)\left(1 - k\left(s^H + s^F - 1\right)\right)Y}{\left(0.5 + k\left(s^H - 0.5\right)\right)\left(1 - k\left(s^H + s^F - 1\right)\right)Y + \left(0.5 - k\left(s^H - 0.5\right)\right)\left(1 + k\left(s^H + s^F - 1\right)\right)} \\
s^F &= \frac{\left(0.5 + k\left(s^F - 0.5\right)\right)\left(1 - k\left(s^H + s^F - 1\right)\right)Y}{\left(0.5 + k\left(s^F - 0.5\right)\right)\left(1 - k\left(s^H + s^F - 1\right)\right)Y + \left(0.5 - k\left(s^F - 0.5\right)\right)\left(1 + k\left(s^H + s^F - 1\right)\right)}
\end{aligned}
$$

which admits the solution $s = s^H = s^F = \frac{Y^H}{Y^H + Y^F}$ as can be verified by direct substitution. As a result, the equilibrium outcomes simplify to

$$
\begin{aligned}
m(t) &= e^{-\rho t}\frac{\left(0.5 + k\left(s - 0.5\right)\right)}{Y^H(t)}, \\
p(t) &= \frac{\left(0.5 - k\left(s - 0.5\right)\right)}{\left(0.5 + k\left(s - 0.5\right)\right)}Y(t)
\end{aligned}
$$

and the corresponding asset prices are

$$S_H(t) = \mathbb{E}_t\left[\int_t^\infty \frac{m(s)}{m(t)} Y^H(s) ds\right] = Y^H(t) \frac{\frac{0.5(1-k)}{\rho} + k\int_t^\infty e^{-\rho(u-t)}\mathbb{E}_t\left[s(u)\right] du}{0.5 + k\left(s(t) - 0.5\right)}$$
$$S_F(t) = \mathbb{E}_t\left[\int_t^\infty \frac{m(s)p(s)}{m(t)} Y^F(s) ds\right] = p_{2,t} Y^F(t) \frac{\frac{0.5(1+k)}{\rho} - k\int_t^\infty e^{-\rho(s-t)}\mathbb{E}_t\left[s_s\right] ds}{0.5 - k\left(s(t) - 0.5\right)}.$$

Applying the Ito's lemma we obtain the dynamics of stock prices and the terms of trade $p(t)$

$$\begin{aligned}
\frac{dS^H(t)}{S^H(t)} &= \frac{dY^H(t)}{Y^H(t)} - \frac{k}{\alpha(t)} ds_t + \left(\frac{k \times F(s)'}{F(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)}\right) ds_t \\
&= \left(\nu_H + \left(\frac{k \times F(s)'}{F(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right) s_t(1-s_t)\left[(\nu_H - \nu_F) - s_t\phi_H^2 + (1-s_t)\phi_F^2\right]\right) dt \\
&+ \phi_H dB_1 + \left(\frac{k \times F(s)'}{F(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right) s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2)
\end{aligned}$$

$$\begin{aligned}
\frac{dS^F(t)}{S^F(t)} &= \frac{dY^H(t)}{Y^H(t)} + \frac{k}{\alpha(t)} ds_t + \left(\frac{-k \times F(s)'}{-F(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)}\right) ds_t \\
&= \left(\nu_H + \left(\frac{-k \times F(s)'}{-F(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right) s_t(1-s_t)\left[(\nu_H - \nu_F) - s_t\phi_H^2 + (1-s_t)\phi_F^2\right]\right) dt \\
&+ \phi_H dB_1 + \left(\frac{-k \times F(s)'}{-F(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right) s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2) \\
\frac{dp(t)}{p(t)} &= \frac{dY^H(t)}{Y^H(t)} - \frac{dY^F(t)}{Y^F(t)} - \left(\frac{k}{\alpha(t)} + \frac{k}{1-\alpha(t)}\right) ds_t \\
&= \left(\nu_H - \nu_F - \left(\frac{k}{\alpha(t)} + \frac{k}{1-\alpha(t)}\right) s_t(1-s_t)\left[(\nu_H - \nu_F) - s_t\phi_H^2 + (1-s_t)\phi_F^2\right]\right) dt \\
&+ \phi_H dB_1 - \phi_F dB_2 + \left(\frac{-k \times F(s)'}{-F(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right) s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2),
\end{aligned}$$

where

$$F \equiv \mathbb{E}_t\left[\int_t^\infty e^{-\rho(\tau-t)} s(\tau) d\tau\right] = \frac{s}{\psi(1-\gamma)(1-s)} V\left(1; 1-\gamma; 2-\gamma; \frac{s}{s-1}\right) + \frac{1}{\psi\theta} V\left(1; \theta; 1+\theta; \frac{s-1}{s}\right) \tag{31}$$

$V(\cdot)$ is the hypergeometric function and

$$
\begin{aligned}
\psi &= \sqrt{\nu^2 + 2\rho\eta^2} \\
\gamma &= \frac{\nu - \psi}{\eta^2} \\
\theta &= \frac{\nu + \psi}{\eta^2} \\
\nu &= \nu_F - \nu_H - \phi_F^2/2 + \phi_H^2/2 \\
\eta^2 &= \phi_H^2 + \phi_F^2
\end{aligned}
$$

## 5.2 Agents' wealth and optimal portfolios

Agents' wealth is given by the present value of the agents' total consumption discounted using $m(t)$ and $p(t)$:

$$
\begin{aligned}
w_H(t) &= \mathbb{E}_t \left[ \int_t^\infty \left( \frac{m(s)}{m(t)} c_H^H(s) + \frac{m(s)p(s)}{m(t)} c_F^H(s) \right) ds \right] \\
&= \frac{\lambda^H}{\lambda_H \alpha_H(t) + \lambda_F \alpha_F(t)} \left[ \mathbb{E}_t \int_t^\infty e^{-\rho(s-t)} \alpha_H(s) ds + \mathbb{E}_t \int_t^\infty e^{-\rho(s-t)} \beta_H(s) ds \right]
\end{aligned}
$$

$$
\begin{aligned}
w_F(t) &= \mathbb{E}_t \left[ \int_t^\infty \left( \frac{m(s)}{m(t)} c_H^F(s) + \frac{m(s)p(s)}{m(t)} c_F^F(s) \right) ds \right] \\
&= \frac{\lambda^F}{\lambda_H \alpha_H(t) + \lambda_F \alpha_F(t)} \left[ \mathbb{E}_t \int_t^\infty e^{-\rho(s-t)} \alpha_F(s) ds + \mathbb{E}_t \int_t^\infty e^{-\rho(s-t)} \beta_F(s) ds \right]
\end{aligned}
$$

To compute optimal portfolios we first introduce some more notation. Let

$$
\begin{aligned}
f_H^\alpha(t) &= \mathbb{E}_t \left( \int_t^\infty e^{-\rho(s-t)} \alpha_H(s) ds \right), \quad f_H^\beta(t) = \mathbb{E}_t \left( \int_t^\infty e^{-\rho(s-t)} \beta_H(s) ds \right) \\
f_F^\alpha(t) &= \mathbb{E}_t \left( \int_t^\infty e^{-\rho(s-t)} \alpha_F(s) ds \right), \quad f_F^\beta(t) = \mathbb{E}_t \left( \int_t^\infty e^{-\rho(s-t)} \beta_F(s) ds \right)
\end{aligned}
$$

and $\lambda = \lambda_F/\lambda_H$. To compute the social weight $\lambda$ we solve numerically the equation $w_H(t) = S^H(0)$. Using the functions $f_H^\alpha, f_H^\beta, f_F^\alpha$ and $f_F^\beta$ we can rewrite the investor's wealth in a more compact way as follows

$$w_H(t) = \frac{f_H^\alpha(t) + f_H^\beta(t)}{\alpha_H(t) + \lambda\alpha_F(t)}$$
$$w_F(t) = \frac{\lambda(f_F^\alpha(t) + f_F^\beta(t))}{\alpha_H(t) + \lambda\alpha_F(t)}$$

As a result,

$$\frac{dw_H(t)}{w_H(t)} = [...]dt + \theta_1^H(t)dB_1 + \theta_2^H(t)dB_2 \tag{32}$$
$$\frac{dw_F(t)}{w_F(t)} = [...]dt + \theta_1^F(t)dB_1 + \theta_2^F(t)dB_2 \tag{33}$$

where

$$\theta_1^H(t) = \phi_H \left( 1 - \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial s^F}{\partial Y}}{\alpha_H(t) + \lambda\alpha_F(t)} Y(t) + \frac{\frac{\partial(f_H^\alpha(t) + f_H^\beta(t))}{\partial Y}}{f_H^\alpha(t) + f_H^\beta(t))} Y(t) \right)$$
$$\theta_2^H(t) = \phi_F \left( \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial s^F}{\partial Y}}{\alpha_H(t) + \lambda\alpha_F(t)} Y(t) - \frac{\frac{\partial(f_H^\alpha(t) + f_H^\beta(t))}{\partial Y}}{f_H^\alpha(t) + f_H^\beta(t))} Y(t) \right)$$
$$\theta_1^F(t) = \phi_H \left( 1 - \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial\partial s^F}{\partial Y}}{\alpha_H(t) + \lambda\alpha_F(t)} Y(t) + \frac{\frac{\partial(f_F^\alpha(t) + f_F^\beta(t))}{\partial Y}}{f_F^\alpha(t) + f_F^\beta(t))} Y(t) \right)$$
$$\theta_2^F(t) = \phi_F \left( \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial s^F}{\partial Y}}{\alpha_H(t) + \lambda\alpha_F(t)} Y(t) - \frac{\frac{\partial(f_F^\alpha(t) + f_F^\beta(t))}{\partial Y}}{f_F^\alpha(t) + f_F^\beta(t))} Y(t) \right)$$

Similarly for stock prices

$$S_H(t) = \frac{f_H^\alpha(t) + f_F^\alpha(t)}{\alpha_H(t) + \lambda\alpha_F(t)} Y^H(t)$$
$$S_F(t) = \frac{f_H^\beta(t) + f_F^\beta(t)}{\alpha_H(t) + \lambda\alpha_F(t)} Y^H(t)$$

As a result,

$$\frac{dS_H(t)}{S_H(t)} = [...]dt + \sigma_{1,1}(t)dB_1 + \sigma_{1,2}dB_2$$
$$\frac{dS_F(t)}{S_F(t)} = [...]dt + \sigma_{2,1}(t)dB_1 + \sigma_{2,2}(t)dB_2$$

where

$$\sigma_{1,1}(t) = \phi_H \left( 1 - \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial s^F}{\partial Y}}{\alpha_H(t) + \lambda \alpha_F(t)} Y(t) + \frac{\frac{\partial (f_H^\alpha(t) + f_F^\alpha(t))}{\partial Y}}{f_H^\alpha(t) + f_F^\alpha(t))} Y(t) \right)$$

$$\sigma_{1,2}(t) = \phi_F \left( \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial s^F}{\partial Y}}{\alpha_H(t) + \lambda \alpha_F(t)} Y(t) - \frac{\frac{\partial (f_H^\alpha(t) + f_F^\alpha(t))}{\partial Y}}{f_H^\alpha(t) + f_F^\alpha(t))} Y(t) \right)$$

$$\sigma_{2,1}(t) = \phi_H \left( 1 - \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial \partial s^F}{\partial Y}}{\alpha_H(t) + \lambda \alpha_F(t)} Y(t) + \frac{\frac{\partial (f_H^\beta(t) + f_F^\beta(t))}{\partial Y}}{f_H^\beta(t) + f_F^\beta(t))} Y(t) \right)$$

$$\sigma_{2,2}(t) = \phi_F \left( \frac{k_H^H \frac{\partial s^H}{\partial Y} + k_H^F \lambda \frac{\partial s^F}{\partial Y}}{\alpha_H(t) + \lambda \alpha_F(t)} Y(t) - \frac{\frac{\partial (f_H^\beta(t) + f_F^\beta(t))}{\partial Y}}{f_F^\alpha(t) + f_F^\beta(t))} Y(t) \right)$$

Finally, the agents' optimal portfolio follows by comparing Eq 28 and 29 with the dynamic budget constraint 9:

$$\begin{pmatrix} \pi_1^i \\ \pi_2^i \end{pmatrix} = \Sigma^{-1} \begin{pmatrix} \theta_1^i \\ \theta_2^i \end{pmatrix}.$$

where $i = \{H, F\}$ and $\Sigma = \begin{pmatrix} \sigma_{11} & \sigma_{21} \\ \sigma_{12} & \sigma_{22} \end{pmatrix}$ is the diffusion matrix of stock prices. It is important to note that the popularity ratio is a function of the relative endowment $Y$ only. Thus, all the equilibrium quantities are functions of $Y$ only. Let $d = \frac{Y^H(t)}{Y^H(t)+Y^F(t)}$ be the supply share of the home good. Given the identity $d(t) = \frac{Y^H(t)}{Y^H(t)+Y^F(t)} = \frac{Y(t)}{1+Y(t)}$, we can equivalently express all the equilibrium quantities as a function of the supply share $d$ only.

## 5.3 Numerical method

To solve for the equilibrium explicitly we have to compute the following quantities:

$$s^H, s^F, \quad \frac{\partial s^H}{\partial Y}, \frac{\partial s^F}{\partial Y} \quad \frac{\partial^2 s^H}{\partial Y^2}, \frac{\partial^2 s^F}{\partial Y^2}, \quad \mathbb{E}_t[s^H(s)], \mathbb{E}_t[s^F(s)], \quad \text{for} \quad s \geq t.$$

We construct the functions $s^H$ and $s^F$ by solving numerically the fixed-point problem 26 on a fine grid of the relative endowment $Y$. First and second order derivatives of $s^H$ and $s^F$ are approximated using the finite-difference method. To compute expected values we recall that

$$dY = Y\mu_Y dt + Y(\phi_H dB_1 - \phi_F dB_2)$$

where $\mu_Y = \nu_H - \nu_F + \phi_F^2$. This implies that $\log(Y(s))$ is a normal random variable with conditional mean $(\mu_Y - .5\,(\phi_H^2 + \phi_F^2))\,(s-t)$ and variance $(\phi_H^2 + \phi_F^2)(s-t)$, for any time $s \geq t$. Accordingly, we compute the expected values $\mathbb{E}_t[s^H(s)]$ and $\mathbb{E}_t[s^F(s)]$ using standard quadrature technique. In the symmetric economy the procedure is much simpler because we only need to compute the hyper-geometric function and its derivatives.

# 6 Appendix B: Data and additional empirical results

## 6.1 Data description

We use financial and macro data on a monthly level for the United States, United Kingdom and Germany. All data are from DataStream, if not specified otherwise. We take broad indices to represent the financial markets of each country: (1) SP500 for US, (2) FTSE All Share which comprises the whole universe of companies for UK and (3) CDAX which is a composite index of all stocks listed in the Frankfurt Stock Exchange. We also use the dollar-pound, dollar-euro and euro-pound exchange rates. The quarterly consumption series on non-durables and services are taken from NIPA tables for the USA, from the Bureau of Economics Analysis for UK and from the OECD database for Germany. We then interpolate quarterly values to have data available at the monthly frequency. As a proxy for the bond prices, the data on 3-month yields for each country are used.

The empirical analysis is always conducted for pairs of countries. The time span for the pairs US-GER and GER-UK is from 1991 until the end of 2014. The data for the pair US-UK are from 1985 until the end of 2014. In the main text we focus on the pair US-GER. The results for US-GER when initial value of the popularity ratio $s_t = 0.1$ (US-GER(1)), for US-GER when initial value of the popularity ratio $s_t = 0.9$ (US-GER(2)) and the other two specifications of countries (GER-UK and US-UK) are given in this

Appendix.

The following macroeconomic and survey variables are employed in the analysis. The industrial production for all countries is obtained from DataStream. The business and consumer confidence variables are taken from OECD database (Main Economic Indicators). IFO business climate index is published by Ifo Institute in Munich, Germany. Alternatively, other survey variables are also obtained for USA: consumer confidence indices (total and expectations) published by the Conference Board and Consumer Sentiment Index computed by University of Michigan (available from FRED database). For USA we also employ the Purchasing Managers' Index (ISM Employment) which is derived from monthly surveys of private sector companies. Generally, business confidence surveys ask the participants about the prospects in production, exports and employment. The consumer confidence survey are typically based on a sample of households that are asked about the future purchasing decisions, their economic situation and their expectations for the near future.

## 6.2 Estimation of the popularity of traded goods using Google search volumes: additional details

To estimate the dynamics of the share $s_t$

$$\begin{aligned} ds_t &= s_t(1-s_t)\left[(\nu_H - \nu_F) - s_t\phi_H^2 + (1-s_t)\phi_F^2\right] dt \\ &+ s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2) \end{aligned}$$

we have to rewrite the process as

$$ds_t = s_t(1-s_t)\left[h - s_t\sigma^2\right] dt + s_t(1-s_t)\sigma dB_t^{joint},$$

where

$$
\begin{aligned}
h &= (\nu_H - \nu_F + \phi_F^2) \\
\sigma &= \sqrt{\phi_H^2 + \phi_F^2};
\end{aligned}
$$

In order to get the parameters necessary for calculating the hypergeometric function consider the following transformation

$$
\begin{aligned}
-h &= \nu_F - \nu_H - \phi_F^2 \\
\Rightarrow -(h - \sigma^2) &= \nu_F - \nu_H + \phi_H^2 \\
\Rightarrow -\frac{h}{2} - \frac{1}{2}(h - \sigma^2) &= \frac{1}{2}(\nu_F - \nu_H - \phi_F^2) + \frac{1}{2}(\nu_F - \nu_H + \phi_H^2) \\
&= \nu_F - \nu_H - \phi_F^2/2 + \phi_H^2/2
\end{aligned}
$$

Therefore parameters for hypergeometric function are given by

$$
\begin{aligned}
\nu &= -\frac{h}{2} - \frac{1}{2}(h - \sigma^2) \\
\eta^2 &= \sigma \\
\psi &= \sqrt{\nu^2 + 2\rho\eta^2} \\
\gamma &= \frac{\nu - \psi}{\eta^2} \\
\theta &= \frac{\nu + \psi}{\eta^2}
\end{aligned}
$$

Next consider the substitution $x = \frac{s}{1-s}$. By applying Ito formula we obtain

$$
dx = (\nu_H - \nu_F + \phi_F^2)xdt + \phi_H x dB_1 + \phi_F x dB_2,
$$

Equivalently rewrite $x_t$ process as

$$
dx = x\left(hdt + \sigma dB_t^{joint}\right),
$$

which is straight forward to estimate.

## 6.3 Additional empirical results

### 6.3.1 GER-US: Initial popularity ratio $s_0 = .1$

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 3.44 | 5.0 | 0.39 |
| Correlations | | |
| $f^F$ | $f^H$ | $f^s$ |
| 1 | 0.56 | 0.34 |
| | 1 | -0.24 |
| | | 1 |

Table 11: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$ and $s_0 = 0.1$. All estimates are significant at the 5% level.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production USA | 21.0% | 26.2% | 0.000 |
| Industrial production GER | 13.1% | 18.8% | 0.000 |
| Business confidence USA | 13.7% | 19.3% | 0.000 |
| Business confidence GER | 23.4% | 28.4% | 0.000 |
| IFO business climate index GER | 16.4% | 21.9% | 0.000 |
| Consumer confidence USA | 16.6% | 22.0% | 0.000 |
| Consumer confidence GER | 24.0% | 29.0% | 0.000 |
| ISM employment (PMI) USA | 10.0% | 15.9% | 0.000 |
| Bond prices USA | 0.9% | 7.4% | 0.32 |
| Bond prices GER | 12.1% | 17.9% | 0.000 |
| Consumer confidence total (CB) USA | 17.6% | 23.2% | 0.000 |
| Consumer confidence expect (CB) USA | 16.6% | 22.3% | 0.000 |
| Consumer sentiment USA | 11.3% | 17.1% | 0.000 |
| Observations # | 277 | | |

Table 12: Regressions of the macro-variables on the estimated factors. The sample size is from 1991 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the regression, the second column gives the $R^2$, the third column gives p-values.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production USA | 19.2% | 20.4% |
| Industrial production GER | 9% | 10% |
| Observations # | 278 | |

Table 13: Regression of the Industrial Production (IP) Index on its lags $dM(t) = const + \sum_{q=1}^{n} dM(t-q)$. There are 4 lags for the IP index of USA and 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production USA | 28.0% | 33.7% |
| Industrial production GER | 23.5% | 29.3% |
| Observations # | 277 | |

Table 14: Regression of the Industrial Production Index (IP) on its lags and on 6 lags of the factors $dM(t) = const + \sum_{q=1}^{n} dM(t-q) + \sum_{p=1}^{6} f^H(t-p) + \sum_{p=1}^{6} f^F(t-p) + \sum_{p=1}^{6} f^s(t-p)$. There are 4 lags for the IP index of USA and 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

### 6.3.2 GER-US: Initial popularity ratio $s_0 = .9$

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 3.50 | 5.1 | 0.40 |
| Correlations | | |
| $f^H$ | $f^F$ | $f^s$ |
| 1 | 0.51 | 0.37 |
| | 1 | -0.30 |
| | | 1 |

Table 15: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$ and $s_0 = 0.9$. All estimates are significant at the 5% level.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production USA | 20.7% | 25.8% | 0.000 |
| Industrial production GER | 12.6% | 18.3% | 0.000 |
| Business confidence USA | 13.8% | 19.4% | 0.000 |
| Business confidence GER | 23.7% | 28.6% | 0.000 |
| IFO business climate index GER | 16.7% | 22.1% | 0.000 |
| Consumer confidence USA | 16.6% | 22.0% | 0.000 |
| Consumer confidence GER | 24.5% | 29.4% | 0.000 |
| ISM employment (PMI) USA | 9.7% | 15.6% | 0.000 |
| Bond prices USA | 1% | 7.5% | 0.3 |
| Bond prices GER | 12.2% | 17.9% | 0.000 |
| Consumer confidence total (CB) USA | 17.0% | 22.7% | 0.000 |
| Consumer confidence expect (CB) USA | 16.1% | 21.8% | 0.000 |
| Consumer sentiment USA | 10.7% | 16.5% | 0.000 |
| Observations # | 277 | | |

Table 16: Regressions of the macro-variables on the estimated factors. The sample size is from 1991 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the regression, the second column gives the $R^2$, the third column gives p-values.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production USA | 19.2% | 20.4% |
| Industrial production GER | 9% | 10% |
| Observations # | 278 | |

Table 17: Regression of the Industrial Production (IP) Index on its lags $dM(t) = const + \sum_{q=1}^{n} dM(t-q)$. There are 4 lags for the IP index of USA and 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production USA | 27.8% | 33.6% |
| Industrial production GER | 23.0% | 28.8% |
| Observations # | 277 | |

Table 18: Regression of the Industrial Production Index (IP) on its lags and on 6 lags of the factors $dM(t) = const + \sum_{q=1}^{n} dM(t-q) + \sum_{p=1}^{6} f^H(t-p) + \sum_{p=1}^{6} f^F(t-p) + \sum_{p=1}^{6} f^s(t-p)$. There are 4 lags for the IP index of USA and 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

### 6.3.3 GER-UK: Initial popularity ratio $s_0 = .5$

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 3.42 | 4.89 | 0.67 |
| Correlations | | |
| $f^H$ | $f^F$ | $f^s$ |
| 1 | 0.57 | 0.37 |
| | 1 | -0.24 |
| | | 1 |

Table 19: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$ and $s_0 = 0.5$. All estimates are significant at the 5% level.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production UK | 4.3% | 10.6% | 0.041 |
| Industrial production GER | 9.9% | 15.7% | 0.000 |
| Business confidence UK | 16.0% | 21.4% | 0.000 |
| Business confidence GER | 23.2% | 28.2% | 0.000 |
| Consumer confidence UK | 6.8% | 12.9% | 0.09 |
| Consumer confidence GER | 20.4% | 25.6% | 0.000 |
| Ifo Index GER | 13.5% | 19.2% | 0.000 |
| Bond prices UK | 11.2% | 17.0% | 0.000 |
| Bond prices GER | 15.0% | 20.5% | 0.000 |
| Observations # | 277 | | |

Table 20: Regressions of the macro-variables on the estimated factors. The sample size is from 1991 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the simple regression, the second column gives the $R^2$, the third column gives p-values.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production UK | 4.5% | 5.0% |
| Industrial production GER | 9.0% | 10.0% |
| Observations # | 279 | |

Table 21: Regression of the Industrial Production (IP) Index on its lags $dM(t) = const + \sum_{q=1}^{n} dM(t-q)$. There is 1 lag for the IP index of UK and there are 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production UK | 9.5% | 15.7% |
| Industrial production GER | 18.8% | 24.9% |
| Observations # | 277 | |

Table 22: Regression of the Industrial Production Index (IP) on its lags and on 6 lags of the factors $dM(t) = const + \sum_{q=1}^{n} dM(t-q) + \sum_{p=1}^{6} f^H(t-p) + \sum_{p=1}^{6} f^F(t-p) + \sum_{p=1}^{6} f^s(t-p)$. There is 1 lag for the IP index of UK and there are 3 lags for the IP index of Germany. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

### 6.3.4 US-UK: Initial popularity ratio $s_0 = .5$

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 3.45 | 5.10 | 0.62 |
| Correlations | | |
| $f^H$ | $f^F$ | $f^s$ |
| 1 | 0.35 | -0.34 |
| | 1 | 0.41 |
| | | 1 |

Table 23: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$ and $s_0 = 0.5$. All estimates are significant at the 5% level.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production US | 16.1% | 20.5% | 0.000 |
| Industrial production UK | 3.2% | 8.2% | 0.048 |
| Business confidence US | 9.7% | 14.4% | 0.000 |
| Business confidence UK | 11.7% | 16.3% | 0.000 |
| Consumer confidence US | 15.7% | 20.0% | 0.000 |
| Consumer confidence UK | 5.2% | 10.1% | 0.008 |
| ISM Employment (PMI) US | 5.8% | 10.7% | 0.004 |
| Bond prices US | 7.1% | 11.9% | 0.000 |
| Bond prices UK | 8.9% | 13.6% | 0.000 |
| Consumer confidence total (CB) USA | 12.3% | 17.0% | 0.000 |
| Consumer confidence expect (CB) USA | 12.6% | 17.3% | 0.000 |
| Consumer sentiment USA | 7.1% | 11.9% | 0.000 |
| Observations # | 349 | | |

Table 24: Regressions of the macro-variables on the estimated factors. The sample size is from 1985 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the regression, the second column gives the $R^2$, the third column gives p-values.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production UK | 7.1% | 7.4% |
| Industrial production USA | 17.7% | 18.6% |
| Observations # | 350 | |

Table 25: Regression of the Industrial Production (IP) Index on its lags $dM(t) = const + \sum_{q=1}^{n} dM(t-q)$. There is 1 lag for the IP index of UK and there are 4 lags for the IP index of USA. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

| | Adjusted $R^2$ | Unadjusted $R^2$ |
|---|---|---|
| Industrial production UK | 11.5% | 16.4% |
| Industrial production USA | 25.3% | 30.0% |
| Observations # | 349 | |

Table 26: Regression of the Industrial Production Index (IP) on its lags and on 6 lags of the factors $dM(t) = const + \sum_{q=1}^{n} dM(t-q) + \sum_{p=1}^{6} f^H(t-p) + \sum_{p=1}^{6} f^F(t-p) + \sum_{p=1}^{6} f^s(t-p)$. There is 1 lag for the IP index of UK and there are 4 lags for the IP index of USA. The optimal number of lags of the dependent variables is chosen by sequentially testing for the significance of the each lagged dependent variable in the respective regression.

## 6.4 Additional empirical results with Google search volume

### 6.4.1 UK-GER

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 6.96 | 11.68 | 0.95 |
| Correlations | | |
| $f^H$ | $f^F$ | $f^s$ |
| 1 | 0.58 | 0.22 |
| | 1 | -0.34 |
| | | 1 |

Table 27: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$. All estimates are significant at the 5% level.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production UK | 12% | 18% | 0.000 |
| Industrial production GER | 25% | 30% | 0.000 |
| Business confidence UK | 37% | 41% | 0.000 |
| Business confidence GER | 41% | 45% | 0.000 |
| Consumer confidence UK | 5% | 12% | 0.09 |
| Consumer confidence GER | 41% | 45% | 0.000 |
| Ifo Index GER | 33% | 37% | 0.000 |
| Bond prices UK | 28% | 33% | 0.000 |
| Bond prices GER | 17% | 23% | 0.000 |
| Observations # | 127 | | |

Table 28: Regressions of the macro-variables on the estimated factors. The sample size is from 2004 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the simple regression, the second column gives the $R^2$, the third column gives p-values.

### 6.4.2 US-UK

| Standard deviations | | |
|---|---|---|
| $f^H$ | $f^F$ | $f^s$ |
| 7.72 | 9.05 | 0.78 |
| Correlations | | |
| $f^H$ | $f^F$ | $f^s$ |
| 1 | 0.37 | 0.36 |
| | 1 | -0.37 |
| | | 1 |

Table 29: Estimated standard deviations and correlations: $k = 0.85$, $\rho = 0.03$. All estimates are significant at the 5% level.

| | Adjusted $R^2$ | Unadjusted $R^2$ | F-test (p-values) |
|---|---|---|---|
| Industrial production US | 26% | 31% | 0.000 |
| Industrial production UK | 7% | 13% | 0.046 |
| Business confidence US | 21% | 26% | 0.000 |
| Business confidence UK | 30% | 35% | 0.000 |
| Consumer confidence US | 17% | 23% | 0.00 |
| Consumer confidence UK | 5% | 12% | 0.095 |
| Bond prices US | 6% | 13% | 0.048 |
| Bond prices UK | 36% | 40% | 0.000 |
| Consumer confidence total (CB) USA | 26% | 30% | 0.000 |
| Consumer confidence expect (CB) USA | 26% | 31% | 0.000 |
| Consumer sentiment USA | 19% | 25% | 0.000 |
| Observations # | 129 | | |

Table 30: Regressions of the macro-variables on the estimated factors. The sample size is from 2004 to the end of 2014. The data are monthly. The first column corresponds to the adujsted $R^2$ from the regression, the second column gives the $R^2$, the third column gives p-values.

## 6.5 Home Bias Tests

### 6.5.1 UK-GER

| | Germany | | | UK | | |
|---|---|---|---|---|---|---|
| | mkt cap weights | sales weights | equal weights | mkt cap weights | sales weights | equal weights |
| Local Popularity of Home Goods | -0.175 | -0.305 | **-0.902** | -0.296 | **-0.486** | **-0.570** |
| | (-0.97) | (-1.66) | (-3.73) | (-2.66) | (-3.71) | (-4.90) |
| Foreign Popularity of Home Goods | -0.302 | -0.667 | **-0.667** | -0.658 | **-0.391** | **-0.663** |
| | (-2.37) | (-3.73) | (-4.48) | (-3.58) | (-2.07) | (-1.80) |
| Turnover | -0.187 | -0.182 | -0.170 | -0.083 | -0.103 | -0.114 |
| | (-3.27) | (-3.27) | (-3.21) | (-2.27) | (-2.76) | (-3.36) |
| Market return | 0.464 | 0.422 | 0.443 | 0.932 | 0.913 | 0.833 |
| | (1.26) | (1.19) | (1.29) | (3.34) | (3.32) | (3.07) |
| Constant | 6.574 | 6.330 | 6.761 | 4.144 | 4.648 | 4.905 |
| | (8.69) | (8.43) | (10.42) | (6.57) | (7.00) | (8.19) |
| Observations # | 561 | | | | | |

Table 31: Regressions of the log price-dividend ratio on the popularity of home goods in Home Country and the popularity of home goods in Foreign Country and the set of control variables. All variables are in levels. The standard errors are computed using Newey-West (1987) formula with 12 lags. The sample size is from 2004 to the end of 2014. The data are weekly.

### 6.5.2 US-UK

| | US | | | UK | | |
|---|---|---|---|---|---|---|
| | mkt cap weights | sales weights | equal weights | mkt cap weights | sales weights | equal weights |
| Local Popularity of Home Goods | **-0.955** | -0.520 | **-1.150** | **-0.277** | **-0.479** | **-0.541** |
| | (-3.91) | (-2.43) | (-4.07) | (-2.41) | (-4.08) | (-4.50) |
| Foreign Popularity of Home Goods | **-0.171** | -0.569 | **-0.534** | **-0.081** | **-0.361** | **0.260** |
| | (-0.82) | (-3.11) | (-3.67) | (-0.36) | (1.29) | (1.19) |
| Turnover | -0.001 | -0.001 | -0.001 | -0.068 | -0.103 | -0.108 |
| | (-0.49) | (-0.39) | (-0.21) | (-1.98) | (-2.88) | (-3.02) |
| Market return | 0.809 | 0.857 | 0.847 | 0.998 | 0.905 | 0.871 |
| | (3.26) | (3.15) | (3.34) | (3.28) | (3.12) | (3.13) |
| Constant | 4.851 | 4.425 | 5.043 | 3.894 | 4.641 | 4.787 |
| | (21.93) | (22.02) | (19.57) | (6.55) | (7.42) | (7.61) |
| Observations # | 561 | | | | | |

Table 32: Regressions of the log price-dividend ratio on the popularity of home goods in Home Country and the popularity of home goods in Foreign Country and the set of control variables. All variables are in levels. The standard errors are computed using Newey-West (1987) formula with 12 lags. The sample size is from 2004 to the end of 2014. The data are weekly.