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Working Paper

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SAFE Working Paper, No. 176

Provided in Cooperation with:
Leibniz Institute for Financial Research SAFE

Suggested Citation: Curatola, Giuliano; Dergunov, Ilya (2017) : International capital markets with time-varying preferences, SAFE Working Paper, No. 176, Goethe University Frankfurt, SAFE - Sustainable Architecture for Finance in Europe, Frankfurt a. M., https://doi.org/10.2139/ssrn.3013062

This Version is available at:
https://hdl.handle.net/10419/167573

HOUSE OF FINANCE
WORKING PAPER SERIES

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SAFE Working Paper No. 176

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Non-Technical Summary

The traditional international finance literature assumes that preferences for traded goods are constant over time. In this paper we assume that investors' preferences are time-varying because they depend on the local popularity (in terms of sales) of internationally traded goods. There are 2 Countries in the model, for brevity named Home and Foreign country. In each country, agents make consumption choices based on the local popularity of traded goods and are more sensitive to the popularity of the home good than to the popularity of the foreign good. For instance, 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. This mechanism helps explain several puzzles in the international finance literature such as a lack of risk sharing, a lack of portfolio diversification and, more generally, fluctuations in asset prices and exchange rates.

We test our model empirically using data from the United States, the United Kingdom and Germany. Our analysis shows that time-varying preferences are a plausible driver of asset prices and exchange rates and also forecast important macroeconomic variables, such as industrial production business confidence and consumer confidence, of the countries listed above. These results suggest that time-variation in preferences is both theoretically and empirically important and, therefore, could represent an interesting avenue for future research.

International capital markets with time-varying preferences

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August 2, 2017

Abstract

We propose a 2-country asset-pricing model where agents' preferences change endogenously as a function of the popularity of internationally traded goods. We determine the effect of the time-variation of preferences on equity markets, consumption and portfolio choices. When agents are more sensitive to the popularity of domestic consumption goods, the local stock market reacts more strongly to the preferences of local agents than to the preferences of foreign agents. Therefore, home bias arises because home-country stock represents a better investment opportunity for hedging against future fluctuations in preferences. 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.

*We would like to thank Pooyan Amir-Ahmadi, Nicole Branger, Andrea Buraschi, Enrico De Giorgi, Jerôme Detemple, Pierre Collin-Dufresne, Diego Garcia, Alessandro Gioffré, Michael Haliassos, Martin Herdegen, Julien Hugonnier, Daniela Iorio, Yigitcan Karabulut, Matti Keloharju, Holger Kraft, Alexander Kupfer, Marco Pagano, Roberto Marfé, Claudia Ravanelli, Jacob Sagi, Christian Schlag, David Solomon, Denitsa Stefanova, Andreea Mitrache and Michael Ungeheuer for stimulating discussions and suggestions. We also thank seminar participants to the 2017 World finance Conference (Cagliari), the First Catalan Economic Society Conference, the 34th French Finance Association Conference, the 2017 Annual Conference of the Swiss Society for Financial Market Research, the 2016 Auckland Finance Meeting, the 9th FIW Research Conference in International Economics, the 23rd Conference of the German Finance Association, the 2nd Research in Behavioral Finance Conference, the 13th Workshop on Social Economy for Young Economists and Seminar participants at the University of Zurich for helpful comments. All errors are our responsibility. We gratefully acknowledge financial support from the Research Center SAFE, funded by the State of Hessen initiative for research LOEWE. e-mail: Giuliano Curatola: curatola@safe.uni-frankfurt.de, Ilya Dergunov: dergunov@safe.uni-frankfurt.de

1 Introduction

The international finance literature has traditionally been concerned with the differences between local and foreign agents that help explain features observed in international capital markets, such as a lack of risk sharing, a lack of portfolio diversification and, more generally, fluctuations in asset prices and exchange rates. In this paper, we propose a two-country model where, in each country, preferences evolve in favor of goods with the highest local demand and agents are more sensitive to changes in the local popularity of domestic goods than changes in the local popularity of foreign goods. In equilibrium, the demand for international consumption goods, and, in turn, exchange rates, depends not only on the supply of consumption goods but also on time-varying preferences for consumption goods. Holding everything else constant, popular goods (i.e., goods preferred by agents in both countries) have a larger demand and a higher relative price. Since agents finance their desired level of consumption by trading in financial assets, preference evolution also determines portfolio decisions and the value of international capital markets. The assumption that agents are relatively more sensitive to changes in the local popularity of the domestic good implies that the domestic equity market reacts more to changes in the preferences of local agents than to changes in the preferences of foreign agents. As a result, a sizable home bias arises because domestic equity represents a better investment opportunity in each country for hedging against future changes in preferences.

We then ask ourselves whether the mechanism of preference evolution is empirically plausible. To answer this question, we frame 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 fluctuations in international capital markets. We also find that supply and preference shocks have significant explanatory power for important variables, such as industrial production and different measures of business and consumer confidence in the United States, the United Kingdom and Germany. This

suggests that preference shocks are both theoretically and empirically important.

In our empirical tests, we rely on two empirical measures of the popularity of internationally traded goods. The first measure is derived by our model, which suggests that, in a two-country economy, the popularity of goods produced by a given country is a function of the country's share of consumption. In line with this, we construct our first measure of popularity by 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 include firms that operate internationally and measure the internet search volume of their products. The predictive power of our model is not sensitive to the measure of the popularity of internationally traded goods and previous results continue to hold even when we measure popularity using internet data. Finally, we verify empirically that local equity markets are more affected by changes in the local popularity of home consumption goods than by changes in the foreign popularity of home consumption goods, which is consistent with our theory. Using Google Trends, we measure the popularity of consumption goods among local investors and foreign investors, and show that in all examined countries (the US, the UK and Germany), the aggregate price-dividend ratio is indeed more sensitive to changes in the local popularity of home consumption goods than to changes in the foreign popularity of home consumption goods.

Together, these results support the argument that preference evolution is 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 that there is an economic link between preference evolution and the dynamics of international 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), but its implications for financial markets and, most importantly, empirical plausibility, have not yet been verified. Curatola (2017) proposes a two-sector, one-country model in which agents' preferences evolve globally rather than locally; before deciding their optimal consumption, agents in the economy look at the consumption choices of all other agents in the economy. The global

evolution of preferences produces a strong desire for herd behavior, which implies that agents' aggregate consumption and portfolio choices are identical. Conversely, modeling the local evolution of preferences allows for heterogeneity between the sensitivity to the popularity of the local good and the sensitivity to the popularity of the foreign good; this is key to generating the home bias in both countries. Moreover, empirical tests of two-sector models are challenging because they require the identification of two sectors for which the mechanism of preference evolution is particularly relevant. In the two-country model we propose in this paper, however, the mechanism of preference evolution operates through the popularity of internationally traded goods. This allows for a clean empirical strategy based on aggregate consumption and aggregate popularity data, which we use to validate the idea of preference evolution.

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

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

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. α^H (β^H) and α^F (β^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 Sub-

rahmanyan (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.

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, should be 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 good 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 the popularity of the home good and k_F^H as the sensitivity of the home agent to 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 the popularity of the home good than to 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 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 good in the foreign country.

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

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 goods. 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. This mechanism is consistent with the extensive empirical and experimental evidence of interdependent consumption and portfolio choices, namely, the fact that individual consumption and portfolio choice depends on other people- consumption and portfolio choices[3].

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. In this sense our model can be interpreted a micro-founded model of demand shocks. 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 2.1.2 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 $\alpha^H(t), \alpha^F(t), \beta^H(t), \beta^F(t) \in [0,1] \quad \forall t$.

[3]The empirical evidence in favor of interdependent consumption dates back to Pollak and Wales (1978) and since then has been growing continuously until the recent works of Alvarez-Cuadrado et al. (2016) and De Giorgi et al. (2017). Scholars have shown that evidence of interdependent choices can be found in aggregate consumption expenditures, many consumption categories, investment strategies and is robust across different countries. See Curatola (2017) for a detailed review of this literature.

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

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

where $\pi_b^i, \pi_H^i, \pi_F^i$ denote the fraction of wealth of agent $i \in \{H, F\}$ allocated to the bond, to the risky asset of country H and to 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 [4]. The social planner chooses consumption of home and foreign agents to maximize the weighted sum of utilities using weights λ^H and λ^F:

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

[4] Cass and Pavlova (2004) show that for a special case of our economy where α^i and β^i are constant, any equilibrium of this economy is Pareto optimal and thus can be obtained by solving the social planner problem. However, under the assumption of constant log-linear preferences financial markets are typically incomplete (see Cass and Pavlova (2004), Berrada et al. (2007), Ehling and Heyerdahl-Larsen (2015), Serrat (2001) and Kollmann (2006).) Curatola (2017) shows that when preferences depend on the popularity of traded good i) financial markets are complete even when agents are equipped with log utility and ii) the equilibrium obtained by solving the decentralized economy and the equilibrium obtained by solving the social planner problem are equivalent.

subject to the resource constraint

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

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

2.1.1 Preference evolution and optimal consumption

Taking the FOC of the previous problem we obtain the sharing rules[5]

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

where $m(t)$ is the Lagrange multiplier attached to 12 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 13 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 terms 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 15 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 terms 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

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

demand for this good and its price increase. Time variation in preferences has important effects for the equilibrium consumption sharing rules. In fact using 15 in conjunction with optimal consumption 14 we obtain

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

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 $\alpha^H(t)$, $\alpha^F(t)$, $\beta^H(t)$ and $\beta^F(t)$ are stochastic and therefore the evolution of consumption shares depends on the country-specific evolution of preferences and the cross-country consumption correlation is therefore smaller than 1.

The equilibrium values of the popularity ratios s^H and s^F are then obtained as the unique solution to the system of equations[6]

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

where $\alpha^H(t)$, $\alpha^F(t)$, $\beta^H(t)$ and $\beta^F(t)$ also depend on $s^H(t)$ and $s^F(t)$ through Eq 7 and Eq 9. 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 $\frac{\partial s^H}{\partial(Y^H/Y^F)} > 0$ and $\frac{\partial s^F}{\partial(Y^H/Y^F)} > 0$ 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 market clearing. The increase in consumption

[6]See Appendix 5 for more details.

implies that home good 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.

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's total output:

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

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

Other things held constant, the value of each country stock market positively depends on the national output. Moreover, that current and future preferences for the national output have different impact on aggregate price-dividend ratios. Consider for instance the home stock market. If the current preference of home and foreign agents for the home good increases (i.e. current $\alpha^H(t)$ and $\alpha^F(t)$ increase) their current marginal utility from consuming the home good tends 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 (i.e. the expected value of future α^H and α^F increases), 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, α^H and β^F change over time while α^F and β^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 for the local good. 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 2.1.2 below).

Finally note that in the standard case without preference evolution, the price-dividend ratios are deterministic functions of time (Pavlova and Rigobon, 2007), contrary to the data. Differently in our model, time variation in preferences makes price-dividend ratios stochastic even if we use log utility.

2.1.2 Preference evolution and portfolio diversification

In this section we illustrate the implications of preference evolution for international portfolio diversification. To determine portfolio holdings we first have to compute the

wealth of the representative agents along their optimal strategy:

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

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

From Eq 20 and 21 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 (relative to the value of country's output) 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 local good (i.e., and increase of $\lambda^H \alpha^H(t) + \lambda^F \alpha^F(t)$ for the home country or an increase of $\lambda_H \beta^H(t) + \lambda_F \beta^F(t)$ for the foreign country) 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.

To determine agents' portfolios we apply the Ito's lemma on Eq 20 and 21 and compare coefficients with Eq 10. Details of this computations are given in the Appendix 5 and optimal portfolios are plotted in Figures 1, 2 and 3 below. We assume that the expected value and the standard deviation of output growth is the same across countries so that differences in portfolios are only due to differences in preferences. First we analyze the case of symmetric preference evolution, that is, we assume that $\bar{\alpha} = \bar{\beta} = \bar{s}$ and $k_H^H = k_F^H = k_H^F = k_F^F > 0$. 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 other words, our

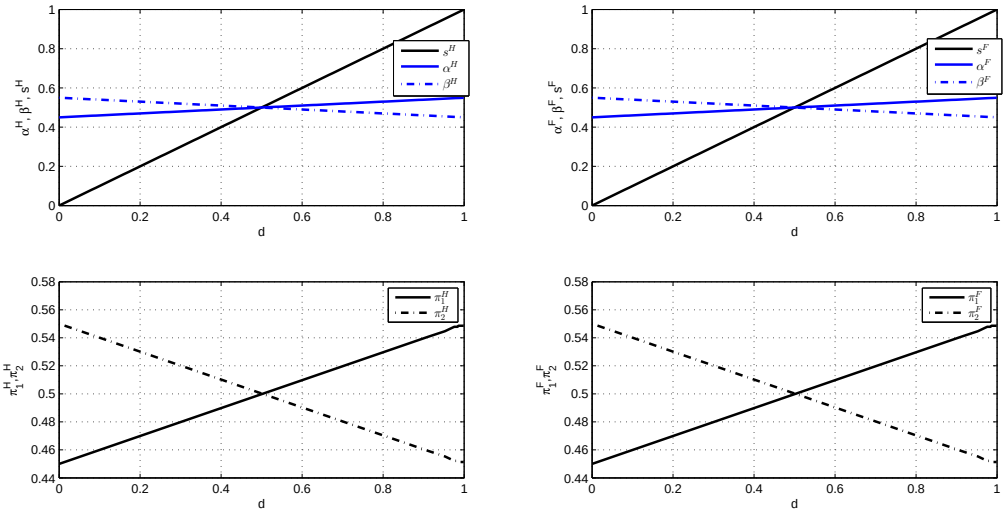

Figure 1: Agents' preference (upper panels) and portfolios as a function of the supply share of the home consumption good in the case of symmetric preference evolution. $\rho = 0.03$, $\mu_H = \mu_F = 0.02$, $\phi_H = \phi_F = .03$, $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^H = k_H^F = k_F^F = 0.1$

model suggests that consumption and portfolio diversification are related to each other 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 is re-balanced in favour of the country producing the preferred good. This is consistent with the idea that international trade in consumption goods and international investments in financial assets are intimately linked to each other (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 is theoretically consistent with several stylized facts about international markets, it cannot fully 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[7], that is, we assume that $k_H^H > k_F^H$ and $k_F^F > k_H^F$. Figure 2 represents the case of moderate heterogeneity in the sensitivity to the popularity of consumption goods ($k_H^H = k_F^F = 0.8$, $k_F^H = k_H^F = 0.4$). In this case agents trade-off the desire to invest in the currently popular country with the fact that their future preferences are now more closely tied to local financial markets. For low values of popularity of the home good the former effect dominates and the investors show a foreign bias when their country popularity is low (i.e. s^H or s^F smaller than about 0.3) and a complete home bias otherwise. Finally, we increase the degree of preference heterogeneity and assume that $k_H^H = k_F^F = 0.8$ and $k_F^H = k_H^F = 0.2$. Preferences for the domestic good are now much more sensitive to supply shocks than preferences for the foreign good in each country (that is, α^H is steeper than β^H and β^F is steeper than α^F) and the desire to allocate wealth according to future preference evolution dominates for any value of the current popularity of the home good (Figure 3). 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 toward the local consumption good. The consequent desire to consume the home good can be satisfied given that an important fraction of wealth comes 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 large amounts of the local 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

[7]This assumption seems natural in this framework and may be the result of the fact that home investors are more frequently exposed to the home consumption goods than to the foreign consumption good, for instance, through more frequent advertising campaigns.

the foreign good by investing a relatively low fraction of wealth into the foreign asset. In other words, the domestic equity is a better investment opportunity to protect against future preference fluctuations and is thus preferred relative to foreign equity for any value of the current popularity of the local good.

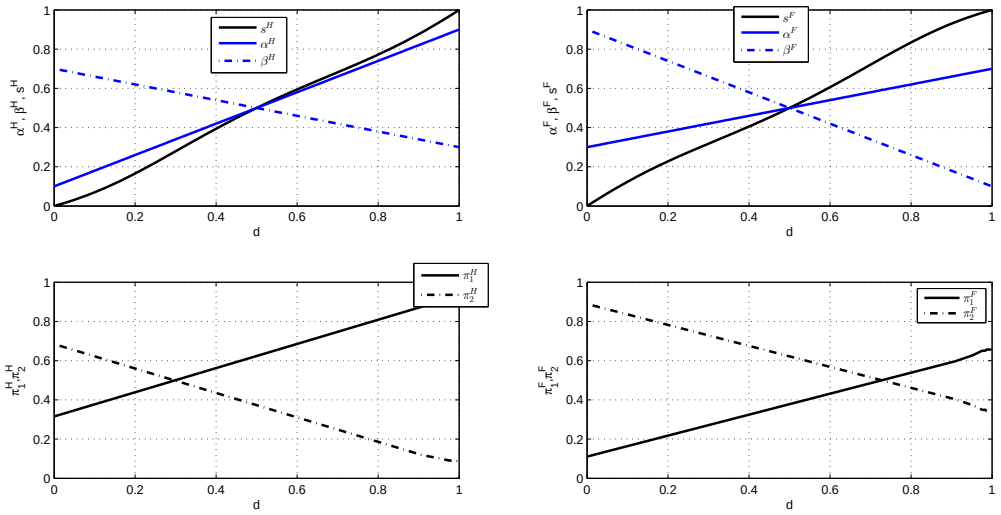

Figure 2: Agents' preference (upper panels) and portfolios as a function of the supply share of the home consumption good in the case of asymmetric preference evolution. $\rho = 0.03$, $\mu_H = \mu_F = 0.02$, $\phi_H = \phi_F = .03$, $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^F = 0.8$, $k_F^H = k_H^F = 0.4$

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 on 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.

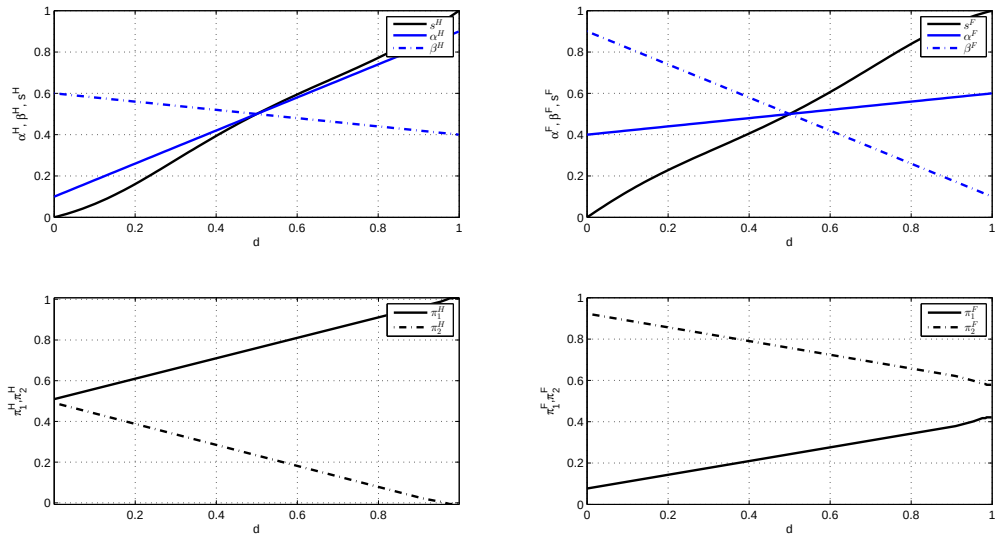

Figure 3: Agents' preference (upper panels) and portfolios as a function of the supply share of the home consumption good in the case of asymmetric preference evolution. $\rho = 0.03$, $\mu_H = \mu_F = 0.02$, $\phi_H = \phi_F = .03$, $\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^F = 0.8$, $k_F^H = k_H^F = 0.2$

2.2 Discussion and alternative explanations

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 Coeurdacier and Gourinchas (2016), Lin and Viswanathan (2015), Levy and Levy (2014), Coeurdacier and Rey (2013), Mishra and Ratti (2013), Hamberg et al. (2013), Daly and Vo (2013) and Sercu and Vanpée (2012)). Many explanations for the home bias puzzle have been proposed so far. Dumas et al. (2016) 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. 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 Grinblatt and Keloharju (2001) and Huberman (2001) argue in favor of emotional factors driven by common language or familiarity[8].

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 good. 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. The existing 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.

Finally 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.

[8]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 3×1 vector of intercepts, Γ is 3×3 factor loading matrix and f^H, f^F and f^s are latent factors. The system 22 is derived by applying Ito's formula to 15, 18 and 19 (see 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[9]. 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 22 is the availability of closed form solutions for the matrix Γ 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 $\lambda^H = \lambda^F = 0.5$ there 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 the equilibrium popularity ratio equals 50% when the supply

[9]The left-hand side of Eq 22 is obtained from empirical data, I and Γ are given by our equilibrium model, thus the only thing we need to to is to invert Eq 22 and solve for f^H, f^F and f^s at any point in time

of the two consumption goods is the same (this can be verified by looking at Figures 1 and 2). Thus, if one assumes that $Y^H(0) = Y^F(0)$, agents have the same initial preferences for the two goods. 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. Given that preferences are symmetric it is natural to assume that the two representative agents are treated equally by the social planner (i.e., $\lambda^H = \lambda^F = 0.5$) which, in turn, implies that the two representative agents have the same initial wealth, i.e. $w^H(0) = w^F(0)$. 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[10].

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

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

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

where $d = \frac{Y^H}{Y^H+Y^F}$. The advantage of 23 and 24 with respect to 18 and 19 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 using the hypergeometric function as follows[11]

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

[10] In summary we test a restricted version of our model that should work against us finding significant results.

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

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 more expensive. The availability of closed form solutions also simplifies the computations of the dynamics of stock prices which determine the factor model 22. More precisely, we apply the Ito's lemma to Eq 23 and 24 to obtain

$$\begin{aligned}
\begin{pmatrix} \frac{dS^H(t)}{S^H(t)} \\ \frac{dS^F(t)}{S^F(t)} \\ \frac{dq(t)}{q(t)} \end{pmatrix} &= I(t)dt + \Gamma(t) \times \begin{pmatrix} f^H(t) \\ f^F(t) \\ f^s(t) \end{pmatrix} \\
&= I(t)dt + \begin{pmatrix} 1 & 0 & \left[\frac{kF'(s)}{kF(s)+\frac{1}{\rho}\left(\frac{1}{2}-\frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right] \\ 1 & 0 & \left[\frac{-kF'(s)}{-kF(s)+\frac{1}{\rho}\left(\frac{1}{2}+\frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right] \\ -1 & 1 & \left(\frac{k}{\alpha(t)} + \frac{k}{1-\alpha(t)}\right) \end{pmatrix} \times \begin{pmatrix} \phi_H dB_1 \\ \phi_F dB_2 \\ s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2) \end{pmatrix}
\end{aligned} \tag{26}$$

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. In this way we obtain a tractable version of the factor model in 22. According to Eq 26, 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 26 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[12]. Then we plug the realized shocks B_1 and B_2 into Eq 27 to back out the values of the popularity ratio[13]. 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 26 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 Γ at any t, invert it and use residuals from the VAR model to obtain the latent factors f^H, f^F and f^s.

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)

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

[13]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.

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. These results are in line with (Pavlova and Rigobon, 2007): they find that demand shocks in one country are positively correlated with supply shocks in the same country and negatively correlated with supply shocks of foreign countries. Their story is about consumer confidence: agents become happier when their economy is doing well. We have a similar interpretation but our model also provides a micro-founded reason for the origin of consumer confidence. When the home economy is growing agents consumption of the home good increases. If preferences are interdependent the individual marginal utility of consuming the home good depends on other people's consumption and, therefore, it also increases in reaction to an increase in the home total consumption. This mechanism explains why agents become happier when their economy is doing well.

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[14]. More precisely, for each macroeconomic variable M we run the following regression

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

[14]Variables are described in Appendix 6

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.

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. 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. By inspection of Table 2, we see that our factors can explain a significant fraction of the variation in macroeconomic variables. 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.

	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.

Finally, in Tables 3 and 4 we re-estimate the same regressions for the industrial production in Germany and US to test the economic significance of the latent factors in the presence of the lagged dependent variables[15]. 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 the explanatory power of our factors remains important even when lagged values of the dependent variable are added into the

[15]The survey variables feature strong serial correlation, therefore our factors only slightly increase the R^2 of our regressions when we control for lagged dependent variables. This is a general result for many survey variables and therefore we only report the augmented regressions in Tables 3 and 4 for industrial production.

regression. 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 construct a broader and possibly pure measure of popularity. 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. Da et al. (2011a) show that short-term returns are predictable with stock-ticker search volume data and Da et al. (2011b) 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 under analysis, namely $SP900$ firms for the US, $FTSE350$ firms for the UK and DAX, MDAX and SDAX firms for Germany. 2) We exclude financials and utilities and select only firms that operate internationally. We consider both durable and non-durable goods. This procedure leave us with 216 companies for the US, 80 for the UK and 45 for Germany. 3) For all firms that operate internationally we take the most popular product[16]. 4) Using Google Trends we obtain the country specific search volume of each of these products for the time period 2004-2014 (weekly)[17].

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,

[16]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.

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

during the time window considered, US consumers use Google to search information about Adidas products. Our implicit assumption 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 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[18]. It is important to stress that we do not use time-varying weights but we simply take the average market capitalization (total sales) 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 (total sales) of international companies. Note also that Google provides search volume data scaled by the maximum search volume realized during the period covered by the query. The scaling factor might introduce forward looking information in our time series of popularity that may affect the results of predictive regressions[19]. 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

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

[18]The use of market capitalization and total sales as weights in the construction of the popularity index is also justified by the empirical evidence of Da et al. (2011a) and Da et al. (2011b). 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 weighted measure of popularity places heavier weights to the popularity of companies with high market value or high sales.

[19]Assume for instance that we compute the popularity measure of a given product at time t. If the maximum volume of search is located at some point in time $t' > t$ then the popularity measure computed at time t includes future information about the product popularity. This might be problematic because the popularity measure is used to extract the latent factors which are then used to forecast future macroeconomic variables.

where $X_j(t)$ is the total search volume of firm j's products during the week t. Then we divide the previous quantity by the median value of X_j 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[20]. Accordingly, $CX_j(t)$ can be interpreted as the growth rate of popularity of firm j with respect to its past median popularity.

Consider then the couple of countries $US - GER$ and let $CX_j^{US_i}(t)$ be 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

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

where w_i^{US} is the weight used for aggregation (i.e., the capitalization weight, total sales 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 (total sales or $1/2$) of US and Germany, respectively. The numerator of 29 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 US and Germany[21]. The same popularity ratio is computed for the other couples of countries[22].

[20] We also run predictive regressions without scaling the search frequency by its past median. Results are very similar and available upon request.

[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 associated to a decrease in the popularity of German goods, consistent with our theoretical model.

[22] The complete list of firms used to compute the Goggle-based popularity measure is available upon request.

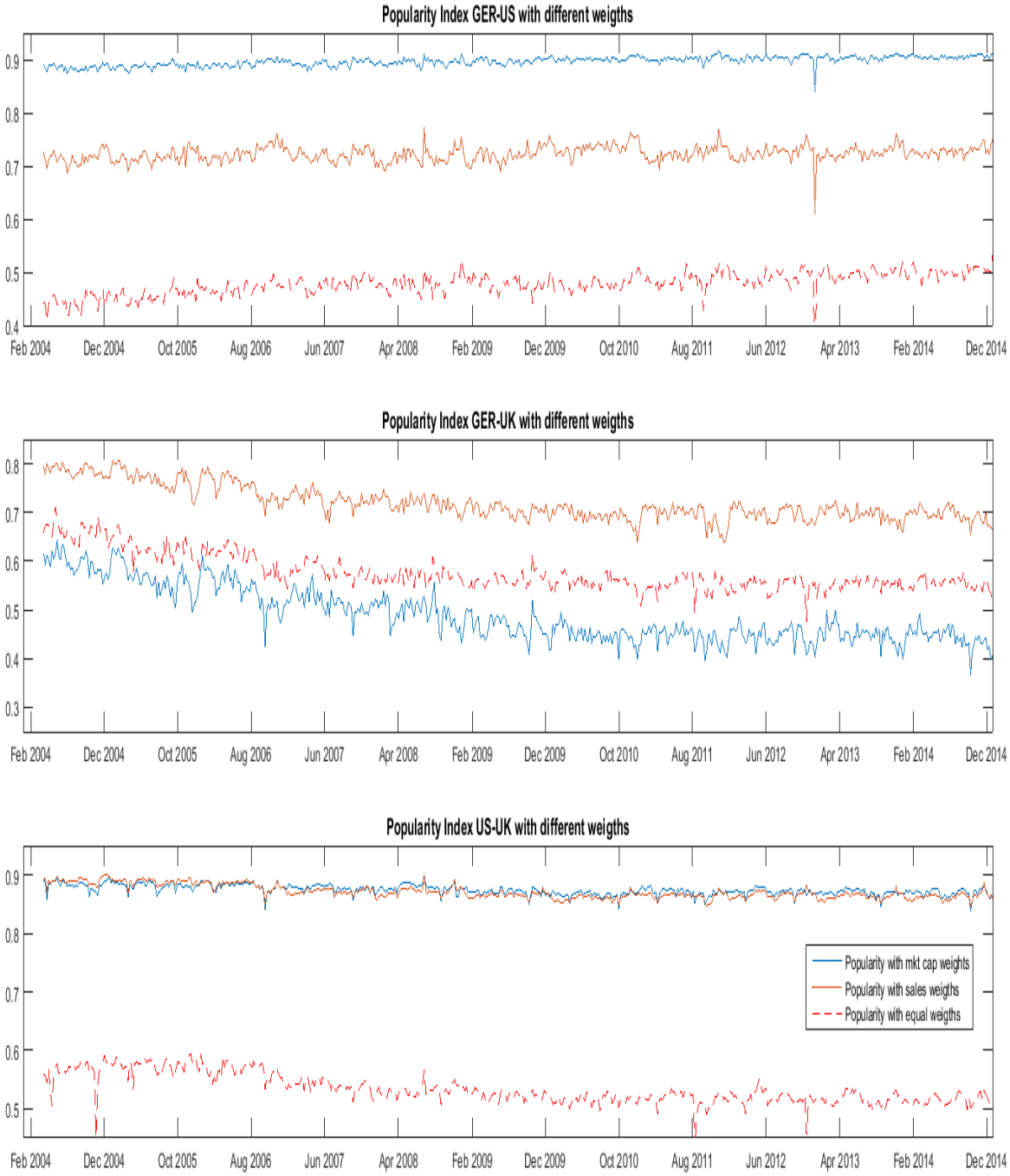

Figure 4: Popularity index for different pairs of countries with market capitalization, sales and equal weights. For the GER-US case the US is the home country. For the GER-UK case Germany is the home country. For the US-UK case US is the home country. In all cases, the popularity measure that we plot refers to the popularity of the home country relative to the other country.

US-GER	mkt cap	sales	equal
mkt cap	1	0.71	0.85
sales		1	0.59
equal			1
UK-GER	mkt cap	sales	equal
mkt cap	1	0.96	0.90
sales		1	0.90
equal			1
US-UK	mkt cap	sales	equal
mkt cap	1	0.82	0.72
sales		1	0.86
equal			1

Table 5: Correlation of the popularity ratios with different weighting schemes

Figure 4 shows the popularity ratios obtained with the three different weighting procedures for the three couples of countries we consider. The series with market capitalization and total sales weighting differ only slightly in their level. The reason is that the market capitalization of the countries differs from their total sales. For instance, for the Germany-US case 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. The difference in the market capitalization between US and German firms tends to be higher than the difference in the total sales and therefore the popularity of US goods is amplified by the market capitalization weighting scheme. Similarly, for the US-UK case the market capitalization weighting scheme amplifies the popularity of US firms but to a lesser extent than in the Germany-US case. 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, time variation in our popularity measure is more important than its level. By

inspection of Table 5 we see that in all cases the measures of popularity based on the three 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 total sales only[23].

Armed with our time series of popularity we repeat the same test of Section 3.1: first we back out latent factors using Eq 26 and then we use the factors to forecast macroeconomic variables. We run the same regression as in 28 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 6 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' preferences 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 7, 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 these results reinforce the plausibility of preference evolution as a possible explanation for fluctuations in international financial markets and macroeconomic quantities.

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

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 6: 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 7: 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 changes 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 consequence of this assumption, that is, the fact that financial markets should react more to changes in the preferences of local agents for the home good than to changes in preferences of foreign agents for the home

good. If this is true, the aggregate price-dividend ratio of each country should be more sensitive to the local popularity of the home goods that to the foreign popularity of the home good. 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

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

where $CX_{Home}^{Home_i}$ measures the popularity of the home firm i's products in the home country (i.e. the local popularity of home goods) while $CX_{Foreign}^{Home_i}$ measures the popularity of the home firm i's products in the foreign country (i.e. the foreign popularity of home goods). These two variables are computed as in Section 3.3 above. We expect that the price-dividend ratio reacts stronger to the local popularity of home goods than to the foreign popularity of the home goods, that is $|\beta_H| > |\beta_F|$. The absolute value accounts for the fact that local and foreign popularity of the home goods affect both current and future marginal utility of consumption and therefore can either increase or decrease the current price dividend ratio (see Eq 18 and the discussion therein for more details).

We implement this regression for different weighting schemes (market capitalization, total sales and equal weighting) and we report the results in Table 8 for the the US and Germany[24]. First, we observe that β_H and β_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. Moreover, the impact of the local popularity of the home goods is always bigger than the impact of the foreign popularity

[24]Results for other countries are reported in the Appendix 6

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 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 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 confirm our main hypothesis except for the US when the popularity measures are constructed using sales. The fact that we find stronger evidence when popularity measures are constructed using equal weights is not surprising. Da et al. (2011a) show 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 8: 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 and 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, the endogenous evolution of preferences for internationally traded goods. This mechanism helps us better understand the dynamics of international financial markets. 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 agents' preferences for consumption goods and, consequently, their portfolios. When agents are more sensitive to changes in the popularity of domestic goods rather than changes in the popularity of foreign goods, a home bias arises because the domestic equity market is a better investment opportunity for hedging against future changes in preferences. These results are consistent with the spirit of the recent work of Bansal et al., who argue that asset-pricing models should also shed light on the micro-founded origin of investors' hedging demand; the hedging demand is particular important in finance because it is ultimately responsible for wealth fluctuations that are unexplained by usual risk/return arguments. In this paper, we suggest that endogenous preference evolution induces investors to hedge against future changes in preferences and that this mechanism helps us understand the polarization of international portfolios.

Finally, we conduct a battery of tests to check the empirical plausibility of our model. These results show that the mechanism of endogenous preference evolution is a plausible driver for fluctuations in macroeconomic quantities and asset prices and, thus, could represent an interesting avenue for future research. Our framework could be extended to a variety of different research areas, with the relationship between commodity trading and spot price dynamics being one possible area where its use would be fruitful for 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

5.1.1 Optimal consumption and popularity ratios

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

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

As a result popularity ratios are given by

$$s^H(t) = \frac{c_H^H(t)}{c_H^H(t)+c_F^H(t)} = \frac{p(t)\alpha^H(t)}{p(t)\alpha^H(t)+\beta^H(t)}, \quad s^F(t) = \frac{c_H^F(t)}{c_H^H(t)+c_F^F(t)} = \frac{p(t)\alpha^F(t)}{p(t)\alpha^F(t)+\beta^F(t)}$$

Given that $\alpha^H(t)$, $\beta^H(t)$, $\alpha^F(t)$ and $\beta^F(t)$ are function of $s^H(t)$ and $s^F(t)$ the equations above define a fixed point problem in the popularity ratios. As a result, popularity ratios of national goods are then computed as the solution to the system

$$\begin{cases} \xi_1(s^H, s^F, Y) = s^H(t) - \frac{p(t)\alpha^H(t)}{p(t)\alpha^H(t)+\beta^H(t)} = 0, \\ \xi_2(s^H, s^F, Y) = s^F(t) - \frac{p(t)\alpha^F(t)}{p(t)\alpha^F(t)+\beta^F(t)} = 0 \end{cases} \tag{30}$$

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 (2017) to the multivariate case. First note that, by definition, $s^F(t), s^H(t) \in [0,1]$. To proceed further we need the following parametric

restriction

$$\bar{\alpha} - k_H^j \bar{s} \geq 0 \quad \text{for} \quad j = H, F$$
$$\bar{\beta} - k_F^j (1 - \bar{s}) \geq 0 \quad \text{for} \quad j = H, F$$

which implies $\alpha^j(t), \beta^j(t) \geq 0 \ \forall t$. This, in conjunction with the fact that $s^F(t), s^H(t) \in [0, 1]$, implies

$$\xi_1(0, 0, Y) \leq 0 \quad \xi_2(0, 0, Y) \leq 0$$

while

$$\xi_1(1, 1, Y) \geq 0 \quad \xi_2(1, 1, Y) \geq 0$$

and therefore we conclude that at least one solution to the system of equations 30 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 $\frac{\partial \xi_1}{\partial Y} > 0$ and $\frac{\partial \xi_2}{\partial Y} > 0$. This means that when the relative endowment increases, the fixed points equations in 30 shift downward. Assume by contradiction that the system 30 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 $s_{1,1}^i < s_{2,1}^i < ... < s_{N,1}^i$ 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 $s_{1,2}^i < s_{2,2}^i < ... < s_{N,2}^i$. Given the continuity of ξ_1 and ξ_2 we will have some $s_{j,2}^i < s_{j,1}^i$ for $j = \{1, 2, ...N\}$ contradicting the fact that the popularity ratio must be increasing in Y.

5.1.2 Equilibrium prices

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

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

with solution

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

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

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

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

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 $p(t)$:

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

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

where the last equality uses the expression for the relative price $p(t)$. 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 $\lambda = \lambda_F/\lambda_H$ solves the equation $w_H(0) = S^H(0)$. Using the functions $f_H^\alpha, f_H^\beta, f_F^\alpha$ and f_F^β we can rewrite the investor's wealth in a more compact way as follows

$$\begin{aligned} w_H(t) &= \frac{f_H^\alpha(t) + f_H^\beta(t)}{\alpha_H(t) + \lambda\alpha_F(t)}Y^H(t) \\ w_F(t) &= \frac{\lambda(f_F^\alpha(t) + f_F^\beta(t))}{\alpha_H(t) + \lambda\alpha_F(t)}Y^H(t) \end{aligned}$$

As a result,

$$\frac{dw_H(t)}{w_H(t)} = [...]dt + \theta_1^H(t)dB_1 + \theta_2^H(t)dB_2 \tag{31}$$
$$\frac{dw_F(t)}{w_F(t)} = [...]dt + \theta_1^F(t)dB_1 + \theta_2^F(t)dB_2 \tag{32}$$

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

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

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

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

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

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

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

Finally, the agents' optimal portfolio follows by comparing Eq 31 and 32 with the dynamic budget constraint 10:

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

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 The symmetric economy

First note that under the assumption of symmetry ($\bar{\alpha} = \bar{\beta} = \bar{s} = 0.5$, $k_H^H = k_F^H = k_H^F = k_F^F$ and $\lambda_H^H = \lambda_H = 0.5$) we must have $s^H = s^F$ and therefore the system 30 reduces to

$$s(t) - \frac{p(t)\alpha(t)}{p(t)\alpha(t) + \beta(t)} = 0 \tag{33}$$

where s is the popularity ratio common to both countries, $\alpha(t)$ and $\beta(t)$ the time varying preferences for the home good and the foreign good, respectively. The index H (or F) is

not needed anymore because preferences are now the same across countries. In addition, the parametric assumption above implies that

$$\beta(t) = 1 - \alpha(t)$$
$$p(t) = \frac{1-\alpha(t)}{\alpha(t)} \frac{d(t)}{1-d(t)}$$

where $d(t) = \frac{Y^H(t)}{Y^H(t)+Y^F(t)}$. Plugging the previous expression into the fixed point problem 33 one obtains

$$\begin{aligned}
&s(t) - \frac{p(t)\alpha(t)}{p(t)\alpha(t) + \beta(t)} = 0 \Leftrightarrow \\
&s(t)p(t)\alpha(t) + s(t)(1-\alpha(t)) - p(t)\alpha(t) = 0 \Leftrightarrow \\
&\frac{1-\alpha(t)}{\alpha(t)} \frac{d(t)}{1-d(t)} s(t)\alpha(t) + s(t)(1-\alpha(t)) - \frac{1-\alpha(t)}{\alpha(t)} \frac{d(t)}{1-d(t)} \alpha(t) = 0 \Leftrightarrow \\
&s(t)\left(1 + \frac{d(t)}{1-d(t)}\right) = \frac{d(t)}{1-d(t)} = 0 \Leftrightarrow \\
&s(t) = d(t).
\end{aligned}$$

As a result, the equilibrium prices simplify to

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

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

$$\begin{aligned}
\frac{dS^H(t)}{S^H(t)} =& [...]dt \\
&+ \phi_H dB_1 + \left(\frac{k \times F'(s)}{kF(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)} - \frac{k}{\alpha(t)}\right) s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2) \quad (34)
\end{aligned}$$

$$\frac{dS^F(t)}{S^F(t)} = [...]dt + \phi_H dB_1 + \left(\frac{-k \times F'(s)}{-kF(s) + \frac{1}{\rho}\left(\frac{1}{2} - \frac{1}{2}k\right)} - \frac{k}{\alpha(t)} \right) s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2) \tag{35}$$

$$\frac{dp(t)}{p(t)} = [...]dt + \phi_H dB_1 - \phi_F dB_2 - \left(\frac{k}{\alpha(t)} + \frac{k}{1-\alpha(t)} \right) s_t(1-s_t)(\phi_H dB_1 - \phi_F dB_2), \tag{36}$$

and the diffusion part of $q = 1/p$ is given by minus times the diffusion part of p. Note that we have ignored drift terms $[...]dt$ because they are irrelevant for our empirical estimation. In Eq's 34 and 35 above

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

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

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

The hypergeometric function is defined by the power series

$$V(a,b,c,z) = 1 + \frac{a \cdot b}{c \cdot 1} z + \frac{a(a+1) \cdot b(b+1)}{c(c+1) \cdot 1 \cdot 2} z^2 + \frac{a(a+1)(a+2) \cdot b(b+1)(b+2)}{c(c+1)(c+2) \cdot 1 \cdot 2 \cdot 3} z^3 + ...$$

which admits an integral representation for the case beyond $||z|| < 1$

$$V(a,b,c,z) = \frac{\Gamma(c)}{\Gamma(b)\Gamma(c-b)} \int_0^1 w^{b-1}(1-w)^{c-b-1}(1-wz)^{-a} dw,$$

where Γ is a gamma function. The derivative of the hypergeometric function is given by

$$\frac{d}{dz}V(a,b,c,z) = \frac{ab}{c}V(a+1,b+1,c+1,z).$$

5.4 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 30 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 $\log(Y(t)) + (\mu_Y - .5\,(\phi_H^2 + \phi_F^2))\,(s-t)$ 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) SP900 for US which constituents are large and medium capitalization companies, (2) FTSE350 for UK which also comprises large and medium capitalization companies and (3) DAX, MDAX and SDAX for Germany which include large, medium and small companies. We also use the dollar-pound, dollar-euro and euro-pound exchange rates. The quarterly consumption series of 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 the 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 pairs 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 of 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 first 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

$$\begin{aligned} h &= (\nu_H-\nu_F+\phi_F^2) \\ \sigma &= \sqrt{\phi_H^2+\phi_F^2} \\ dB_t^{joint} &= \frac{\phi_H dB_1-\phi_F dB_2}{\sqrt{\phi_H^2+\phi_F^2}} \end{aligned}$$

Consider now 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

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

Finally let $x = \frac{s}{1-s}$. Therefore

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

or, equivalently

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

which is straightforward 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 9: 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 10: 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 11: 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 12: 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 13: 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 14: 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 15: 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 16: 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 17: 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 18: 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 19: 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 20: 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 21: 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 22: 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 23: 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 24: 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 25: 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 26: 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 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 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 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 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 29: 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 and 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 30: 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 and West (1987) formula with 12 lags. The sample size is from 2004 to the end of 2014. The data are weekly.

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