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International Portfolios, Capital Accumulation and Foreign Asset Dynamics

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Abstract

Despite the liberalization of capital flows among OECD countries, equity home bias remains sizable. We depart from the two familiar explanations of equity home bias: transaction costs that impede international diversification, and terms of trade responses to supply shocks that provide risk sharing, so that there is little incentive to hold diversified portfolios. We show that the following ingredients are key for generating realistic equity home bias: shocks to total factor productivity and to the efficiency of physical investment, as well as the possibility for agents to trade in stocks and bonds. In our model, domestic stocks are used to hedge fluctuations in local wage income triggered by shocks to investment spending. Terms of trade risk is hedged using bonds denominated in local goods and in foreign goods. In contrast to related models, the low level of international diversification does not depend on the response of terms-of-trade to technology shocks. The model captures the fact that net exports are countercyclical. It also reproduces the cyclical dynamics of foreign asset positions and of international capital flows.

JEL classification: F2, F3, G1.

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1 Introduction

Cross-country capital flows have increased greatly, since the liberalization of international capital markets two decades ago (Lane and Milesi-Feretti (2003)). Equity home bias, while less severe than in earlier decades, remains sizable and is observed in all industrialized countries (see French and Poterba (1991) for early evidence and Sercu and Vanpée (2007) for a recent survey). There are broadly two classes of explanations that have been given to rationalize the persisting equity home bias. The first one, quite naturally, centers on transaction costs and informational barriers in cross-border financial transactions and suggests that international risk sharing is insufficient.[1] The second one focuses on the possibility that terms of trade changes in response to technology shocks may provide international insurance against these shocks, so that even a portfolio with home bias delivers international risk sharing (Cole and Obstfeld (1991)).

Both types of explanations are helpful but are not without problems. Several authors have argued that frictions would have to be large to fully explain the equity home bias (French and Poterba (1991), Tesar and Werner (1995), Warnock (2002)). In order to interpret terms of trade changes as providing insurance (rather than a source of risk), one would need to believe that terms of trade improve strongly after a negative technology shock. The empirical literature is at best sceptical on such a possibility: as documented below, terms of trade are only weakly correlated with output.

The recent literature on general equilibrium models of international equity holdings (see Devereux and Sutherland (2006) for references) has mostly studied models of endowment economies–i.e. models without production or capital accumulation. Heathcote and Perri (2007) is a notable exception discussed below. In such economies, households trade in international financial markets solely for consumption smoothing and risk sharing purposes so that the equity portfolio is structured to sustain net imports in states of nature where local production is low. This leads to Home equity bias or Foreign equity bias depending on the endogenous covariance between equity returns and the real exchange rate. Given the weak covariance between the two in the data (Van Wincoop and Warnock (2007)), this literature is far from being conclusive[2]. In reality, one of the key functions of international capital markets is to

[1] See, e.g., Martin and Rey (2004), Heathcote and Perri (2004), Tille and van Wincoop (2007) Coeurdacier and Guibaud (2006) and Van Nieuwerburgh and Veldkamp (2007) for recent contributions on the role of frictions in international financial markets.

[2] See Uppal (1993), Coeurdacier (2005), Kollmann (2006).

finance physical investment (Obstfeld and Rogoff (1996)). In a world with capital accumulation, efficient international portfolios have to be structured to finance an increase in net imports in states of the world were investment demand is high. It seems especially important to study the role of physical investment for international portfolio choices, as empirically productive investment has been found to be a key driver of fluctuations in net imports (Backus, Kehoe and Kydland (1992, 1994), henceforth BKK).

We show that the interaction of the following ingredients is key for generating realistic equity home bias in a standard two-country/two-good real business cycle model: shocks to TFP and to the efficiency of physical investment, and the possibility for agents to trade both equity shares **and** bonds denominated in local and foreign goods (see Rigobon and Pavlova (2004, 2007) and Coeurdacier, Kollmann and Martin (2007) for previous models with trade in local and foreign good bonds). Investment specific technical change (as in Greenwood, Hercowitz and Krusell (1997, 2000), Fisher (2002, 2006)) is assumed here, because recent empirical research suggests that investment efficiency shocks are a very important source of output fluctuations (Fisher (2002, 2006), Justiniano and Primiceri (2006), Justiniano et al. (2007)).

With two stocks and two bonds, and two types of (Home and Foreign) technology shocks, markets are effectively complete, up to a first order (linear) approximation of the model. The equilibrium portfolios is structured to optimally hedge fluctuations in labor incomes,[3] and in terms of trade.[4] Specifically, bonds are used for terms-of-trade hedging (as in Coeurdacier, Kollmann and Martin (2007), and Coeurdacier and Gourinchas (2008)), since the differential between the two bonds is correlated with the terms of trade. Fluctuations in labor incomes are hedged through the equity portfolios. The key mechanism here is that, holding terms-of-trade constant, investment risk driven by TFP and investment efficiency shocks generates a negative comovement between Home dividends and Home labor incomes (relative to their Foreign counterpart). A Home investment boom lowers Home dividend payments (to finance investment) and raises Home wage earnings (relative to Foreign wages) provided that there is Home bias in investment spending. In other words, during an investment boom at Home, the share of output distributed to Home workers increases, and investment fluctuations act as a redistributive shock (like in Coeurdacier, Kollmann, Martin (2007)). Thus, local equity offers a good hedge against fluctuations in

[3] As in Baxter and Jermann (1995), Heathcote and Perri (2007), Engel and Matsumoto (2006), Bottazzi, Pesenti and van Wincoop (1996), Julliard (2002 and 2004), among others.

[4] See Adler and Dumas (1983) for early work that stresses exchange rate hedging as a determinant of portfolio choice, as well as Uppal (1993), Van Wincoop and Warnock (2006), Coeurdacier (2005), Kollmann (2006) among others.

local labor incomes driven by investment risk–which explains why equity portfolios exhibit home bias. Due to the possibility to trade in bonds, the predicted equity home bias is not sensitive to preference parameters (see Coeurdacier and Gourinchas (2008) for a detailed analysis of this point); it only depends on the degree of home bias in investment expenditures, and on the labor share.

The closest paper to ours is Heathcote and Perri (2007) [HP] who were the first to investigate the importance of physical investment for equity portfolios. Trade in bonds, and the shocks to investment efficiency assumed here differentiate our model from HP (who do not allow for trade in bonds and assume that aggregate shocks only take the form of TFP shocks). Compared to the HP model, we can disentangle the hedging of labor income due to investment risk, and the hedging of real exchange rate risk. While the HP model only generates realistic equity portfolios if terms-of-trade effects are sufficiently strong (or, equivalently, if preferences are "close enough" to log-separability between the two goods as in a Cole and Obstfeld (1991) economy), our model does not require strong terms-of-trade effects following productivity shocks. This is important since the empirical evidence concerning the response of terms-of-trade to technology shocks is mixed.[5] In our model (like in the data), terms-of-trade are essentially a-cyclical ; nevertheless, there is sizable equity home bias. In a sense, our paper shows that local equity bias driven by capital accumulation, as analyzed by HP, is a very general and robust mechanism.

In addition, we explore the quantitative implications of the model regarding the cyclical and stochastic properties of net exports, international capital flows and external asset position. We compare these predictions to annual data of G7 countries over the period 1984-2004. While we focus our attention on international portfolios, we believe that our model with investment specific technology shocks has also appealing feature for international business cycles and the international transmission of technology shocks. Empirically, net exports are countercyclical. Models of endowment economies are inconsistent with this fact (when a country receives a higher endowment, it runs a trade balance surplus, in order to smooth its consumption and/or share risk with the rest of the world). By contrast, the presence of capital accumulation can generate counter-cyclical movements in net exports, due to the pro-cyclical response of physical investment to shocks to investment efficiency. Investment efficiency shocks generates terms-of-trade volatility and net exports volatility that are larger, and thus more in line with the data,

[5] Corsetti, Dedola and Leduc (2006) argue that, empirically, a positive technology shocks triggers a terms of trade appreciation; Acemoglu and Ventura (2002) and Kollmann (2006) provide evidence that higher productivity depreciates the terms-of-trade in the long term.

than the terms of trade and next exports fluctuations induced by standard TFP shocks. Moreover, in our model, terms-of-trade are very weakly correlated with changes in output (see Raffo (2006) for recent empirical evidence)–equity portfolio results do not hinge on the cyclical nature of the terms of trade. Indeed, TFP shocks increase output and decrease the Home terms-of-trade and shocks to the efficiency of investment appreciates on impact the terms-of-trade (due to a larger demand for Home goods as investment inputs[6]) and increase output, making the terms-of-trade very weakly correlated with output changes. Corsetti, Dedola and Leduc (2007) provide evidence that US terms of trade improve following a positive productivity shock. Their explanation of this phenomena relies on strong wealth effects due to financial market incompleteness. Our model can also account for this feature, and thus with efficient risk-sharing, if technology shocks are mostly affecting the production of investment goods (rather than standard TFP shocks).

Fluctuations in the value of domestic and foreign asset induce external capital gains/losses that have a substantial effect on countries' financial wealth (Gourinchas and Rey (2005), Tille (2005), Lane and Milesi-Ferretti (2006)). We investigate the predictions of our model for the behavior of net foreign asset positions and international capital flows. To do so, we solve for time-varying (first-order accurate) equilibrium portfolio holdings using the method developed by Devereux and Sutherland (2006). In the model, fluctuations in a country's net foreign asset position (NFA) are largely driven by movements in equity and bond prices. NFA thus is predicted to have the time series properties of asset prices; the change (first difference) of a country's NFA is predicted to be highly volatile and to have low serial correlation. These predictions are consistent with new NFA measures evaluated at market prices that have recently been compiled by Lane and Milesi Ferretti (2006) and the IMF (International Investment Positions database). Moreover, in response to a positive TFP or investment efficiency shock, a country is predicted to experience a reduction in its net exports, on impact; however, the present value of its current and future net imports rises; as the country's NFA equals the present value of its current and future net imports, the NFA drops, on impact. Thus, the change in NFA is predicted to be countercyclical, as is consistent with the data. The model generates sizable asset trades. In response to a positive domestic TFP and investment-efficiency shock, a country purchases local and foreign equity shares and it raises its

[6] An alternative explanation, see Corsetti, Martin and Pesenti (2007), is that increased efficiency in investment leads to the entry of new goods which generates a terms of trade appreciation.

holding of local good bonds, while it lowers its holding of foreign good bonds. A 1% innovation to domestic TFP (relative to foreign TFP) induces a country to purchase local and foreign shares worth 0.65% and 1.26% of GDP, respectively. However, up to a first order approximation, these asset transactions do not affect NFA: the value of stock purchases equals the value of bond sales. In other terms (up to first order), NFA changes are *solely* due to asset price changes.

Several recent empirical studies have shown that capital gains/losses greatly affect net foreign asset positions (NFA). However, none of those previous papers has documented and analyzed quantitatively the cyclical behavior (volatility, serial correlation, correlation with output) of changes in external financial positions and of capital flows. For descriptions and analyses of external valuation effects, see, Kraay et al. (2005), Lane and Milesi-Ferretti (2001, 2005), Gourinchas and Rey (2005), Kim (2002), Tille (2003, 2004), Hau and Rey (2004), Devereux and Saito (2005), Ghironi, Lee and Rebucci (2005), Backus et al. (2005) and Pavlova and Rigobon (2007). Cantor and Mark (1988) provided an early theoretical discussion of the role of equity price changes for current accounts, based on a one-good model with equities trade (their model predicts full portfolio diversification). Most other previous models of net exports typically assume that international financial markets are restricted to bonds (e.g., Bergin (2004), Obstfeld and Rogoff (1996)).

The paper is structured as follows. In section 2, we present the model set-up. In section 3, we derive equilibrium equity and bond portfolios, and we provide empirical support for the key condition that drives equity home bias in the model. In section 4, we provide stylized facts on the dynamics of portfolios and external positions in G7 countries; we present simulation results that suggest that the model captures key dynamic stylized facts.

2 The model

There are two symmetric countries, Home (H) and Foreign (F), each with a representative household. Each country i produces one good using labor and capital. There is trade in goods and in financial assets (stocks and bonds). All markets are perfectly competitive.

2.1 Preferences

Country i is inhabited by a representative household who lives in periods $t = 0, 1, 2, ...$ The household has the following life-time utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{i,t}^{1-\sigma}}{1-\sigma} - \frac{l_{i,t}^{1+\omega}}{1+\omega} \right) \tag{1}$$

where $C_{i,t}$ is i's aggregate consumption in period t and $-\frac{l_{i,t}^{1+\omega}}{1+\omega}$ denotes the disutility from labor (with $\omega > 0$). Like much of the macroeconomics and finance literature, we take the coefficient of relative risk aversion to be greater than unity. $\sigma > 1$.

$C_{i,t}$, for $i = H, F$ is a composite good given by:

$$C_{H,t} = \left[a^{1/\phi} \left(c_{H,t}^{H} \right)^{(\phi-1)/\phi} + (1-a)^{1/\phi} \left(c_{F,t}^{H} \right)^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \tag{2}$$

$$C_{F,t} = \left[a^{1/\phi} \left(c_{F,t}^{F} \right)^{(\phi-1)/\phi} + (1-a)^{1/\phi} \left(c_{H,t}^{F} \right)^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)} \tag{3}$$

where $c_{j,t}^{i}$ is country $i\prime s$ consumption of the good produced by country j at date t. $\phi > 0$ is the elasticity of substitution between the two goods. In a symmetric steady state, a is the share of consumption spending devoted to the local good. We assume a preference bias for local goods, $\frac{1}{2} < a < 1$.

The welfare based consumer price indices that correspond to these preferences are:

$$P_{H,t} = \left[a \left(p_{H,t} \right)^{1-\phi} + (1-a) \left(p_{F,t} \right)^{1-\phi} \right]^{1/(1-\phi)} \tag{4}$$

$$P_{F,t} = \left[(1-a) \left(p_{H,t} \right)^{1-\phi} + a \left(p_{F,t} \right)^{1-\phi} \right]^{1/(1-\phi)}, \tag{5}$$

where $p_{H,t}$ and $p_{F,t}$ are the prices of goods H and F, respectively.

2.2 Technologies

In period t, country i produces $y_{i,t}$ units of good i according to the production function

$$y_{i,t} = \theta_{i,t}(k_{i,t})^{\kappa}(l_{i,t})^{1-\kappa}, \tag{6}$$

with $0 < \kappa < 1$. $l_{i,t}$ is the labor supply in country i at date t. $k_{i,t}$ is the country's stock of capital. Total factor productivity $\theta_{i,t} > 0$ is an exogenous random variable.

Capital is derived from physical investment in previous periods:

$$k_{i,t+1} = (1-\delta)k_{i,t} + \chi_{i,t} I_{i,t} \tag{7}$$

where $0 < \delta < 1$ is the depreciation rate of capital. $I_{i,t}$ is gross investment in country i at fate t. $\chi_{i,t} > 0$ is an exogenous shock to the productivity of investment (Fisher (2002, 2006), Greenwood, Hercowitz and Krusell (1997), Justiniano et al. (2007)); $\chi_{i,t}$ affects output at t only through the endogenous response of labor supply and affects future production through capital accumulation; hence, $\chi_{i,t}$ can be viewed as a 'news shock' about future output (see Beaudry and Portier (2006) and Jaimovich and Rebelo (2007) for analysis of 'new shocks'). We assume that $\chi_{i,t}$ is not perfectly correlated with the productivity shocks $\theta_{i,t}$. The stochastic properties of both shocks are symmetric across countries.

In both countries, investment goods are generated using Home and Foreign inputs:

$$I_{H,t} = \left[a_I^{1/\phi_I}\left(i_{H,t}^H\right)^{(\phi_I-1)/\phi_I} + (1-a_I)^{1/\phi_I}\left(i_{F,t}^H\right)^{(\phi_I-1)/\phi_I}\right]^{\phi_I/(\phi_I-1)} \quad (8)$$

$$I_{F,t} = \left[a_I^{1/\phi_I}\left(i_{F,t}^F\right)^{(\phi_I-1)/\phi_I} + (1-a_I)^{1/\phi_I}\left(i_{H,t}^F\right)^{(\phi_I-1)/\phi_I}\right]^{\phi_I/(\phi_I-1)} \quad (9)$$

where $i_{j,t}^i$ is the quantity of the good produced by country j used for investment in country i. The associated (ideal) price indices of investment goods are given by

$$P_{H,t}^I = \left[a_I\left(p_{H,t}\right)^{1-\phi_I} + (1-a_I)\left(p_{F,t}\right)^{1-\phi_I}\right]^{1/(1-\phi_I)}, \quad (10)$$

$$P_{F,t}^I = \left[(1-a_I)\left(p_{H,t}\right)^{1-\phi_I} + a_I\left(p_{F,t}\right)^{1-\phi_I}\right]^{1/(1-\phi_I)}. \quad (11)$$

We assume a local bias for investment spending, $\frac{1}{2} < a_I < 1$. Home bias and the substitution elasticity between domestic and imported inputs may be different for investment and consumption: $a_I \neq a, \phi_I \neq \phi$.

2.3 Firms' decisions

Firms maximize profits, taking goods and factor prices as given. Due to the Cobb-Douglas technology, a share $(1-\kappa)$ of output is paid to workers. Thus, labor income in country i is given by:

$$w_{i,t}l_{i,t} = (1-\kappa)p_{i,t}y_{i,t}, \quad (12)$$

where $p_{i,t}$ is the price of the country i good and $w_{i,t}$ is the wage in country i. A share κ of country i output, net of physical investment spending, is paid as a dividend $d_{i,t}$ to shareholders:

$$d_{i,t} = \kappa p_{i,t}y_{i,t} - P_{i,t}^I I_{i,t} \quad (13)$$

Investment decisions have two dimensions: firms choose aggregate investment spending $P_{i,t}^I I_{i,t}$, and they decide how to allocate that spending over Home and Foreign inputs. For country H firms, the allocation over the two inputs must satisfy the following first-order conditions:

$$\frac{i^H_{H,t}}{I_{H,t}} = a_I \left(\frac{p_{H,t}}{P^I_{H,t}}\right)^{-\phi_I} \tag{14}$$

$$\frac{i^H_{F,t}}{I_{H,t}} = (1-a_I) \left(\frac{p_{F,t}}{P^I_{H,t}}\right)^{-\phi_I} \tag{15}$$

Investment spending at date t must equalize the expected future marginal gain of investment to the marginal cost at date t. So at time time t, the first-order condition for investment in country i is:

$$1 = E_t \varrho^i_{t,t+1} \frac{P_{i,t}}{P_{i,t+1}} \frac{\chi_{i,t}}{P^I_{i,t}} [p_{i,t+1}\theta_{i,t+1}\kappa k^{\kappa-1}_{i,t+1} l^{1-\kappa}_{i,t+1} + (1-\delta)\frac{P^I_{i,t+1}}{\chi_{i,t+1}}], \tag{16}$$

where $\varrho^i_{t,t+1}$ is a pricing kernel used by the firm at date t to value date $t+1$ payoffs (that are expressed in units of the country i final consumption good).

Perfect competition implies that equilibrium price of stock i (discussed below) is the value of the capital stock owned by firm i: $p^S_{i,t} = P^I_{i,t} K_{i,t+1}/\chi_{i,t}$.When the Home and Foreign households' Euler equations for stocks shown below (see (21)) holds, then the Euler equation for physical capital (16) holds for a pricing kernel $\varrho^i_{t,t+1}$ that equals the Home household's *or* the Foreign household's intertemporal marginal rate of substitution.

2.4 Financial markets, household decisions, market clearing

Stocks and bonds are traded internationally. The country i firm issues a stock that represents a share in the stream of dividends $\{d_{i,t}\}$.The supply of each stock is normalized at unity. There is a bond denominated in the Home good, and a bond denominated in the Foreign good. Buying one unit of the Home (Foreign) bond in period t gives one unit of the Home (Foreign) good in all future periods. Both bonds are in zero net supply. Each household fully owns the local stock, at birth, and has zero initial foreign assets.[7] Let $S^i_{j,t+1}$ denote the number of shares of stock j held by country i at the end of period t, while $b^i_{j,t+1}$ represents claims held by i (at the end of t) to future unconditional payments of good j. At date t, the country i household faces the following budget constraint:

$$\begin{aligned} & P_{i,t}C_{i,t} + S^i_{i,t+1}p^S_{i,t} + S^i_{j,t+1}p^S_{j,t} + p^b_{j,t}b^i_{j,t+1} + p^b_{i,t}b^i_{i,t+1} \\ = \; & w_{i,t}l_{i,t} + S^i_{i,t}(d_{i,t}+p^S_{i,t}) + S^i_{j,t}(d_{j,t}+p^S_{i,t}) + (p_{i,t}+p^b_{i,t})b^i_{i,t} + (p_{j,t}+p^b_{j,t})b^i_{j,t} \end{aligned} \tag{17}$$

[7] This insures that both countries have equal wealth at birth and preserves the (ex ante) symmetry of the model.

where $p^S_{i,t}$ is the price of stock i and $p^b_{i,t}$ is the price of bond i.

The country i household selects portfolios and consumptions and supplies a quantity of labor that maximize her life-time utility subject to the budget constraint (**??**) for $t \geq 0$. The following equations are first-order conditions of the decision problem of the country H household:

Intra-temporal allocation across goods:

$$c^H_{H,t} = a\left(\frac{p_{H,t}}{P_{H,t}}\right)^{-\phi} C_{H,t}, \quad c^H_{F,t} = (1-a)\left(\frac{p_{F,t}}{P_{H,t}}\right)^{-\phi} C_{H,t} \tag{18}$$

Labor supply decision:

$$l^{\omega}_{H,t} = \left(\frac{w_{H,t}}{P_{H,t}}\right) C_{H,t}{}^{-\sigma} \tag{19}$$

Euler equations for bonds and stocks:

$$1 = E_t\beta\left(\frac{C_{H,t+1}}{C_{H,t}}\right)^{-\sigma} \frac{P_{H,t}}{P_{H,t+1}} \frac{p^b_{H,t+1} + p_{H,t+1}}{p^b_{H,t}}, \; 1 = E_t\beta\left(\frac{C_{H,t+1}}{C_{H,t}}\right)^{-\sigma} \frac{P_{H,t}}{P_{H,t+1}} \frac{p^b_{F,t+1} + p_{F,t+1}}{p^b_{F,t}} \tag{20}$$

$$1 = E_t\beta\left(\frac{C_{H,t+1}}{C_{H,t}}\right)^{-\sigma} \frac{P_{H,t}}{P_{H,t+1}} \frac{p^S_{i,t+1} + d_{i,t+1}}{p^S_{i,t}}, \; 1 = E_t\beta\left(\frac{C_{H,t+1}}{C_{H,t}}\right)^{-\sigma} \frac{P_{H,t}}{P_{H,t+1}} \frac{p^b_{j,t+1} + p_{F,t+1}}{p^b_{j,t}} \tag{21}$$

Symmetric expressions hold for the country F household.

Market-clearing in goods and asset markets requires:

$$c^H_{H,t} + c^F_{H,t} + i^H_{H,t} + i^F_{H,t} = y_{H,t}\ , \quad c^F_{F,t} + c^H_{F,t} + i^F_{F,t} + i^H_{F,t} = y_{F,t}\ , \tag{22}$$

$$S^H_{H,t} + S^F_{H,t} = S^F_{F,t} + S^H_{F,t} = 1, \tag{23}$$

$$b^H_{H,t} + b^F_{H,t} = b^F_{F,t} + b^H_{F,t} = 0. \tag{24}$$

2.5 Relative demand for consumption and investment

Subsequent discussions will use the following properties of relative consumption and investment demand: the first-order condition for consumption (18) and the resource constraint (22) imply:

$$c^H_{H,t} + c^F_{H,t} = p^{-\phi}_{H,t}\left[aC_{H,t}P^{\phi}_{H,t} + (1-a)\,C_{F,t}P^{\phi}_{F,t}\right] = y_{H,t} - (i^H_{H,t} + i^F_{H,t}) \tag{25}$$

$$c^F_{F,t} + c^H_{F,t} = p^{-\phi}_{F,t}\left[aC_{F,t}P^{\phi}_{F,t} + (1-a)\,C_{H,t}P^{\phi}_{H,t}\right] = y_{F,t} - (i^F_{F,t} + i^H_{F,t}) \tag{26}$$

Taking the ratio of these expressions gives:

$$y_{C,t} \equiv \frac{y_{H,t} - (i^H_{H,t} + i^F_{H,t})}{y_{F,t} - (i^F_{F,t} + i^H_{F,t})} = q_t^{-\phi}\Omega\left[\left(\frac{P_{F,t}}{P_{H,t}}\right)^{\phi} \frac{C_{F,t}}{C_{H,t}}\right], \tag{27}$$

where $y_{C,t}$ the ratio of world consumption of Home goods over world consumption of Foreign goods, while $q_t \equiv p_{H,t}/p_{F,t}$ denote the country H terms of trade. $\Omega(x) \equiv \frac{1+x(\frac{1-a}{a})}{x+(\frac{1-a}{a})}$.

The ratio of world demands for Home vs. Foreign goods used for physical investment $y_{I,t} \equiv \frac{i^H_{H,t}+i^F_{H,t}}{i^F_{F,t}+i^H_{F,t}}$ satisfies the following condition (from (14) and (15)):

$$q^{-\phi_I}\Omega\left(\frac{P^I_{H,t}{}^{\phi_I} I_{H,t}}{P^I_{F,tI}{}^{\phi_I} I_{F,t}}\right) = y_{I,t} \tag{28}$$

3 Characterization of (steady state) equilibrium portfolios

The equilibrium portfolio holdings chosen in period t $(S^i_{i,t+1}, S^i_{j,t+1}, b^i_{i,t+1}, b^i_{j,t+1})$ are functions of predetermined state variables, and of exogenous shocks at t. Devereux and Sutherland (2006) show that an $n-th$ order accurate approximations of those equilibrium portfolio decision rules (in the neighborhood of the deterministic steady state) can be computed from a $(n+1)-st$ order approximation of household Euler equations, and an $n-th$ order approximation of the remaining equilibrium conditions. In this Section, we provide closed form solutions for zero-order accurate portfolios $S^i_i, S^i_j, b^i_i, b^i_j$,i.e. portfolios evaluated at steady state values of state variables. Those "steady state portfolios" can be computed from a quadratic approximation of Euler equations and a linear approximation of all remaining equations. Solving for those portfolios is greatly facilitated by the fact that, up to a linear approximation, the asset structure (with four assets and four exogenous shocks) here supports a Pareto efficient outcome: consumptions and labor supplies in the competitive equilibrium satisfy (Pareto) efficiency conditions, up to first order.

3.1 Linearization of the model

We thus linearize the model around its (deterministic) steady state and find the portfolios that are consistent with Pareto efficiency (up to first order). In what follows, $x_t \equiv \frac{x_{H,t}}{x_{F,t}}$ denote the ratio of Home over Foreign values. In particular, $y_t \equiv \frac{y_{H,t}}{y_{F,t}}$ and $I_t \equiv \frac{I_{H,t}}{I_{F,t}}$ are relative output and relative (real) investment. Variables without a time subscript refer to the steady state; $\widehat{x}_t \equiv (x_t - \bar{x})/\bar{x}$ denotes the relative deviation of a variable x_t from its steady state value x.

The Home country's CPI-based real exchange is $RER_t \equiv \frac{P_{H,t}}{P_{F,t}}$. Thus:

$$\widehat{RER_t} = \widehat{\frac{P_{H,t}}{P_{F,t}}} = (2a-1)\,\widehat{q_t}. \tag{29}$$

Note that, due to consumption home bias ($a > \frac{1}{2}$), an improvement of the Home terms-of-trade generates an appreciation of the Home real exchange rate.

In a Pareto efficient equilibrium, the ratio of Home and Foreign marginal utilities of aggregate consumption is equated to the real exchange rate. Linearization of this risk sharing condition gives:

$$-\sigma(\widehat{C_{H,t}} - \widehat{C_{F,t}}) = (2a-1)\,\widehat{q_t} \tag{30}$$

Linearizing (27) and using (30) yields (see Coeurdacier (2005) and Coeurdacier, Kollmann, Martin (2007) for a similar derivation):

$$\widehat{y_{C,t}} = -\left[\phi\left(1-(2a-1)^2\right) + (2a-1)^2\,\frac{1}{\sigma}\right]\widehat{q_t} \equiv -\lambda\widehat{q_t} \tag{31}$$

where $\lambda \equiv \phi(1-(2a-1)^2) + \frac{(2a-1)^2}{\sigma}$. Note that $\lambda > 0$ as $1/2 < a < 1$. An increase in the Home terms-of-trade lowers worldwide relative consumption of the Home good; the higher is ϕ, the stronger is the response of relative Home good consumption to a relative price change.

The linearization of the relative price of investment goods gives:

$$\widehat{\frac{P^I_{H,t}}{P^I_{F,t}}} = (2a_I-1)\,\widehat{q_t} \tag{32}$$

Up to first order, relative investment spending $\widehat{\frac{P^I_{H,t}I_{H,t}}{P^I_F I_{F,t}}}$ is then equal to $(2a_I-1)\,\widehat{q_t}+\widehat{I_t}$, where $I_t = \frac{I_{H,t}}{I_{F,t}}$ denotes relative (real) investment in the two countries.

The linearization of equation (28) then gives:

$$\widehat{y_{I,t}} = -\phi_I\left(1-(2a_I-1)^2\right)\widehat{q_t} + (2a_I-1)\widehat{I_t} \tag{33}$$

Relative world demand for the Home good, for investment purposes, decreases with the Home terms-of-trade; like for consumption, the relative demand response is stronger when Home and Foreign investment inputs are closer substitutes (higher ϕ_I). Holding constant the terms of trade, the relative demand for Home investment goods increases with relative real investment in the Home country, since Home aggregate investment is biased towards Home goods ($a_I > \frac{1}{2}$).

The market clearing conditions for goods (see (22)) imply:

$$(1-\Lambda)\widehat{y_{C,t}}+\Lambda\widehat{y_{I,t}}=\widehat{y_t}, \tag{34}$$

where $\Lambda \equiv \frac{P_H^I I_H}{p_H y_H}=\frac{P_F^I I_F}{p_F y_F}$ is the steady-state ratio of investment spending over nominal GDP.[8] Equations (31),(33) and (34) imply:

$$\widehat{y_t}=-\lambda^*\widehat{q_t}+\Lambda(2a_I-1)\widehat{I_t} \tag{35}$$

where $\lambda^*=(1-\Lambda)\lambda+\Lambda\phi_I\left(1-(2a_I-1)^2\right)>0$ [9].

Not surprisingly, Home terms-of-trade worsen when the relative supply of Home goods increases, for a given amount of relative (real) Home country investment; by contrast, Home terms-of-trade improve when Home investment rises (due to home bias in investment spending).

3.2 Steady state portfolios

Ex-ante symmetry implies that the steady state portfolios have to satisfy the following conditions:, $S\equiv S_1^1=S_2^2=1-S_1^2=1-S_2^1$; $b\equiv b_1^1=b_2^2=-b_1^2=-b_2^1$. The pair $(S;b)$ thus describes the (zero-order accurate) equilibrium portfolio. Note that S denotes a country's holdings of local stock, while b denotes its holdings of bonds denominated in its local good. There is equity home bias when $S>\frac{1}{2}$. $b>0$ means that a country issues bonds denominated in its local good.

As shown in the Appendix, the (zero-order accurate) equilibrium portfolio $(S;b)$ has to satisfy the following *static* budget constraint, for efficient consumptions and goods prices:

$$P_{i,t}C_{i,t}=w_{i,t}l_{i,t}+Sd_{i,t}+(1-S)d_{j,t}+b(p_{i,t}-p_{j,t}). \tag{36}$$

In other terms, the efficient consumption spending of the country i household has to equal the sum of her efficient wage income, $w_{i,t}$, dividend income, $Sd_{i,t}+(1-S)d_{j,t}$, and bond income, $b(p_{i,t}-p_{j,t})$. Subtracting the budget constraint of country F from that of country H gives $P_{H,t}C_{H,t}-P_{F,t}C_{F,t}=(w_{H,t}l_{H,t}-w_{F,t}l_{F,t})+(2S-1)(d_{H,t}-d_{F,t})+2b(p_{i,t}-p_{j,t})$. Linearizing this yields:

$$(1-\Lambda)(\widehat{P_{H,t}C_{H,t}}-\widehat{P_{F,t}C_{F,t}})=(1-\Lambda)(1-\frac{1}{\sigma})\underbrace{(2a-1)\,\widehat{q_t}}_{\widehat{RER_t}}=(1-\kappa)\widehat{w_t l_t}+(2S-1)\,(\kappa-\Lambda)\widehat{d_t}+2b\widehat{q_t} \tag{37}$$

[8] The steady state is symmetric: $q=1, I_H=I_F$, $i_F^H=i_H^F$, $i_H^H=i_F^F$.
[9] When $\phi_I=\phi$ and $a_I=a$ then $\lambda^*=\phi(1-(2a-1)^2)+\frac{1-\Lambda}{\sigma}(2a-1)^2$

where $\widehat{w_t l_t} \equiv \widehat{w_{H,t} l_{H,t}} - \widehat{w_{F,t} l_{F,t}}$ denotes relative labor income, while and $\widehat{d}_t \equiv \widehat{d_{H,t}} - \widehat{d_{F,t}}$ denotes relative dividends.

The first equality follows from the risk-sharing condition (30) and from (29); it shows the Pareto optimal reaction of relative consumption spending to a change of the welfare based real exchange rate. This reaction depends on the coefficient of relative risk aversion. In a Pareto efficient equilibrium, a shock that appreciates the real exchange rate of country H, induces an increase in country H relative consumption spending when $\sigma > 1$ (as assumed in the analysis here). (30) shows that when the real exchange rate appreciates by 1%, then relative aggregate country H consumption $\left(\frac{C_H}{C_F}\right)$ decreases by $1/\sigma$ %. Hence, efficient relative country H consumption spending $(\frac{P_H C_H}{P_F C_F})$ increases by $(1 - \frac{1}{\sigma})$%. The expression to the right shows the change in country H income (relative to the income of F) necessary to obtain the Pareto optimal allocation. Given $\sigma > 1$, the efficient portfolio has to be such that a real appreciation is associated with an increase in relative spending and income.

Since labor income is a constant share of output, relative labor income $(\widehat{w_t l_t})$ is given by: $\widehat{w_t l_t} = \widehat{q}_t + \widehat{y}_t$.

Dividends equal a share κ of output, from which investment spending is subtracted. The relative dividends $(\widehat{d}_t)$ is given by:

$$(\kappa - \Lambda)\widehat{d}_t = \kappa(\widehat{q}_t + \widehat{y}_t) - \Lambda(\widehat{P^I_{H,t} I_{H,t}} - \widehat{P^I_{F,t} I_{F,t}}) = \kappa(\widehat{q}_t + \widehat{y}_t) - \Lambda((2a_I - 1)\,\widehat{q}_t + \widehat{I}_t). \tag{38}$$

Substituting (38) into (37) gives:

$$(1 - \Lambda)(1 - \frac{1}{\sigma})\,(2a - 1)\,\widehat{q}_t = (1 - \kappa)(\widehat{q}_t + \widehat{y}_t) + (2S - 1)\,\{\kappa(\widehat{q}_t + \widehat{y}_t) - \Lambda((2a_I - 1)\,\widehat{q}_t + \widehat{I}_t)\} + 2b\widehat{q}_t \tag{39}$$

Using the goods market equilibrium condition $\widehat{y}_t = -\lambda^* \widehat{q}_t + \Lambda(2a_I - 1)\widehat{I}_t$ (see (35)), we can express (39) as:

$$(1-\Lambda)(1-\frac{1}{\sigma})\,(2a - 1)\,\widehat{q}_t = [(1-\kappa)+\kappa\,(2S - 1)]((1-\lambda^*)\widehat{q}_t+\Lambda(2a_I-1)\widehat{I}_t)-\Lambda\,(2S - 1)\,[(2a_I - 1)\,\widehat{q}_t+\widehat{I}_t]+2b\widehat{q}_t \tag{40}$$

The asset structure supports the complete markets allocation (up to the first-order approximation) if (40) holds for all realizations of the two (relative) exogenous shocks $(\widehat{\theta}_t, \widehat{\chi}_t)$. As in the analysis of Coeurdacier, Kollmann and Martin (2007), the correlation between shocks - as long as it is not perfect - does not matter for the equilibrium portfolio.[10] In fact, to solve for the steady state portfolio, we do not

[10] The persistence of the shocks is also irrelevant for the portfolio.

have to solve for output and investment, as a unique pair of terms of trade and relative real investment $(\widehat{q}_t, \widehat{I}_t)$ is associated with each realizations of $(\widehat{\theta}_t, \widehat{\chi}_t)$.

The following portfolio (S, b) ensures that (40) holds for arbitrary realizations of the shocks $(\widehat{\theta}_t, \widehat{\chi}_t)$:

$$S = \frac{1}{2}\left[1+\frac{(2a_I-1)(1-\kappa)}{1-(2a_I-1)\kappa}\right] > \frac{1}{2}, \tag{41}$$

$$b = \frac{1}{2}\left[(1-\Lambda)(1-\frac{1}{\sigma})\,(2a-1)+\frac{(1-\kappa)\left[\lambda^*-1+\Lambda(2a_I-1)^2\right]}{1-(2a_I-1)\kappa}\right] \tag{42}$$

Interestingly, the equity portfolio is independent of the degree of consumption home bias and of preference parameters. The equity portfolio is solely a function of the home bias in investment spending and of the capital share (κ) (a result already present in Castello (2007)). By contrast, the bond portfolio depends on the substitution elasticity between Home and Foreign goods (via λ^*) and on the coefficient of risk aversion (σ). Coeurdacier and Gourinchas (2008) provide a general discussion of conditions under which equity portfolios are independent of preferences. As shown by them, an important condition is that bonds exist whose relative returns perfectly track terms of trade -real exchange rate- movements.

As explained below, in the model here, equities are used to hedge fluctuations in relative wages and dividends that are orthogonal to terms of trade changes. The bond portfolio hedges fluctuations in relative wages and dividends that are correlated with the terms of trade. As substitution elasticities and risk aversion affect the efficient responses of terms of trade and relative consumptions to shocks, the bond portfolio depends on those preference parameters (in contrast to the equity portfolio).

Assume a combination of $(\widehat{\theta}_t, \widehat{\chi}_t)$ shocks that raises relative country H real investment spending, without altering the terms of trade: $\widehat{I}_t > 0$, $\widehat{q}_t = 0$. From (35), we know that this combination of shocks has to raise H relative output $\widehat{y}_t$ as there is local bias in investment spending ($a_I > 1/2$): $\widehat{y}_t = \Lambda(2a_I-1)\widehat{I}_t > 0$, when $\widehat{I}_t > 0$, $\widehat{q}_t = 0$. Given that the real exchange rate is constant with such a combination of shocks, efficient risk sharing requires that countries' relative consumption spending should also be constant. Hence, the efficient portfolio has to be such that relative incomes too are unaffected. From (39) it can be seen that this requires that:

$$0 = (1-\kappa)\widehat{y}_t + (2S-1)\{\kappa\widehat{y}_t - \Lambda\widehat{I}_t\}. \tag{43}$$

The first term on the right-hand side represents the change in relative labor income, under constant terms of trade. Note that $[\kappa-\Lambda]\widehat{d}_t = \kappa(\widehat{q}_t+\widehat{y}_t)-\Lambda[(2a_I-1)\widehat{q}_t+\widehat{I}_t]$, with $\kappa-\Lambda>0$.[11] The term $\{\kappa\widehat{y}_t-\Lambda\widehat{I}_t\}$ is thus proportional to the change in relative dividend generated by the Home firm, at constant terms of trade. Note that $\kappa\widehat{y}_t-\Lambda\widehat{I}_t=[\kappa(2a_I-1)-1]\,\Lambda\widehat{I}_t<0$ when $\widehat{y}_t=\Lambda(2a_I-1)\widehat{I}_t$. Thus, a combination of shocks that raises H relative investment without affecting the terms of trade induces a rise in $H\prime s$ relative wage income, and a fall in the relative dividend paid out by stock H. This makes holding local equity attractive to insure relative income (the sum of wage incomes and dividends) and therefore relative consumption against this type of uncertainty. Hence, equity home bias is optimal: $S>1/2$. [12]

Once investment/output shocks that do not affect the terms of trade have been hedged by holding local equity, the remaining risk (changes in output/investment that affect the terms of trade) is hedged using the bond portfolio; this is so because terms of trade movements affect the difference between the returns on Home and Foreign good bonds.

Comparison with Heathcote and Perri (2007)

Our equity portfolio (41) corresponds to that obtained by Heathcote and Perri (2007) [HP] for a special case of the HP model where $\sigma=\phi=1$. HP consider a model with just TFP shocks and just trade in stocks. In their model, the equity portfolio is sensitive to slight changes in risk aversion or the substitution elasticity across goods: when σ or ϕ are only slightly larger than unity, their model generates equity *foreign* bias: households *short* the home stock.[13] Here we show that that sensitivity of portfolio choices disappears once we allow for trade in bonds, and a shock to investment efficiency. This robustness is due to the fact that, in our model, terms-of-trade risk is hedged by the bond portfolio.[14] This result is important, as there is considerable uncertainty regarding the value of the domestic/foreign good substitution elasticity: estimates from aggregate macro data are scattered around unity, but estimates from sectoral trade data are above 4; see Coeurdacier (2005) and Imbs and Mejean (2008) for a more detailed discussion of empirical estimates of the substitution elasticity.[15]

[11] The steady state investment/GDP ratio is given by $\Lambda=k/[(1/\delta)(1-\beta)/\beta+1]$. Thus $\varkappa-\Lambda>0$. This ensure that dividends are strictly positive in steady state. Empirically, $\varkappa\approx 0.4$, and $\Lambda\approx 0.2$, in OECD countries.

[12] To derive the value of S shown in (41), one can substitute $\widehat{y}_t=\Lambda(2a_I-1)\widehat{I}_t$ into (43); the only value of S for which the resulting expression holds for arbitrary $\widehat{I}_t$ is given by (41).

[13] Castello (2007) considers a model of portfolio choice with capital close to HP; in her model too, equity portfolios are highly sensitive to preference parameters.

[14] Although it is still necessary in our model that goods are imperfect substitutes $\phi<\infty$ such that real exchange rate are affected by shocks.

[15] Imbs and Mejean (2008) reconcile the estimates based on macro and sectoral data, pointing out an aggregation bias in

3.3 The role of the correlation between relative wage incomes and relative dividends

In HP's setting with just TFP shocks and no bonds, $\sigma = \phi = 1$ entails that a country's relative wage income is negatively correlated with the relative dividend of the stock issued by the country: $Corr(\widehat{w_t l_t}, \widehat{d_t}) < 0$. As documented below, the unconditional correlation between relative wage income ($\widehat{w_t l_t}$) and the relative dividend ($\widehat{d_t}$) is positive, for G7 countries ($Corr(\widehat{w_t l_t}, \widehat{d_t}) > 0$). Hence, the key condition under which the HP model generates equity home bias is rejected empirically.

In the model here, the unconditional $Corr(\widehat{w_t l_t}, \widehat{d_t})$ per se does not matter for the equilibrium equity portfolio. What matters is the correlation between the components of $\widehat{w_t l_t}$ and $\widehat{d_t}$ that are *orthogonal* to $\widehat{q_t}$; specifically, there is equity home bias when that correlation is negative. To see this, project both sides of equation (37) on terms of trade. This gives:

$$(1-\Lambda)(1-\frac{1}{\sigma})\,(2a-1)\,\widehat{q_t} = (1-\kappa)P[\widehat{w_t l_t}|\widehat{q_t}] + (2S-1)\,(\kappa-\Lambda)P[\widehat{d_t}|\widehat{q_t}] + 2b\widehat{q_t}, \quad (44)$$

where $P[\widehat{w_t l_t}|\widehat{q_t}]$ is the projection of $\widehat{w_t l_t}$ on $\widehat{q_t}$. (NB $\widehat{q_t} = P[\widehat{q_t}|\widehat{q_t}]$.) Subtracting this from (37) gives:

$$0 = (1-\kappa)\{\widehat{w_t l_t} - P[\widehat{w_t l_t}|\widehat{q_t}]\} + (2S-1)\,(\kappa-\Lambda)\{\widehat{d_t} - P[\widehat{d_t}|\widehat{q_t}]\}. \quad (45)$$

This shows that the efficient equity portfolio has to hedge $\widehat{w_t l_t} - P[\widehat{w_t l_t}|\widehat{q_t}]$ and $\widehat{d_t} - P[\widehat{d_t}|\widehat{q_t}]$, i.e. the components of $\widehat{w_t l_t}$ and $\widehat{d_t}$ that are orthogonal to the terms of trade $\widehat{q_t}$. Multiplying (45) by $\{\widehat{d_t} - P[\widehat{d_t}|\widehat{q_t}]\}$ and taking expectations gives the following expression for S:

$$S - \frac{1}{2} = -\frac{1}{2}\frac{1-\kappa}{\kappa-\Lambda}\frac{Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d_t})}{Var_{\widehat{q}}(\widehat{d_t})},$$

where $Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d_t}) \equiv E[\{\widehat{w_t l_t} - P[\widehat{w_t l_t}|\widehat{q_t}]\}\{\widehat{d_t} - P[\widehat{d_t}|\widehat{q_t}]]$ is the covariance between components of $\widehat{w_t l_t}$ and $\widehat{d_t}$ that are orthogonal to the terms of trade $\widehat{q_t}$. ($Var_{\widehat{q}}(\widehat{d_t}) \equiv E\{\widehat{d_t} - P[\widehat{d_t}|\widehat{q_t}]\}^2$.). Note that there is equity home bias if and only if $Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d_t}) < 0$. The model here (with trade in bonds and two types of shocks) generates $Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d_t}) = (\kappa-\Lambda)(2a_I-1)/[(\kappa(2a_I-1)-1)] < 0$. Empirically, $Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d_t}) < 0$, for G7 countries, as documented below.

Note that $(1-\kappa)P[\widehat{w_t l_t}|\widehat{q_t}] + (2S-1)\,(\kappa-\Lambda)P[\widehat{d_t}|\widehat{q_t}] = \gamma\widehat{q_t}$ for some coefficient γ. Hence, (44) can be expressed as: $(1-\Lambda)(1-\frac{1}{\sigma})\,(2a-1)\,\widehat{q_t} = \gamma\widehat{q_t} + 2b\widehat{q_t}$. The bond position is set at the value for which

macro estimates.

this condition holds for any realization of $\widehat{q}_t$: $b = \frac{1}{2}[(1-\Lambda)(1-\frac{1}{\sigma})(2a-1)-\gamma]$. Thus, the optimal bond position hedges terms of trade risk: that position ensures that terms of trade fluctuations induce movements in the two countries' relative incomes (given the optimal equity portfolio) that track optimal relative consumption spending.

Equilibrium portfolios in a world with countries of different sizes

For simplicity, the analysis above assumed that, in steady state, the two countries have equal size. In order to permit empirical analysis, this Section considers countries of unequal size. Assume that the capital share (κ) and the steady state ratio of investment spending to GDP (Λ), the risk aversion coefficient (σ), and the substitution elasticities between domestic and imported inputs (ϕ, ϕ_I) are identical across countries. Then the country i household holds the following share of the local firm, in equilibrium:

$$S_i^i = \mu_i + (1-\mu_i)\frac{(1-\kappa)(a_{H,I}+a_{F,I}-1)}{1-\kappa(a_{H,I}+a_{F,I}-1)}, \tag{46}$$

where $\mu_i \equiv p_i y_i/(p_i y_i + p_j y_j)$, is the (steady state) share of country i's GDP in world GDP, while $a_{i,I}$ is the steady state share of local inputs in country i physical investment spending. If trade in investment goods is balanced, in steady state, then $(1-a_{IH})\mu_H = (1-a_{IF})\mu_F$; then S_i^i can be expressed as:

$$S_i^i = \mu_i + (1-\mu_i)\frac{(1-\kappa)(a_{i,I}-\mu_i)/(1-\mu_i)}{1-\kappa(a_{i,I}-\mu_i)/(1-\mu_i)}.$$

Note that, for a 'small' economy (for which μ_i close to zero), $S_i^i \simeq \frac{(1-\kappa)a_{i,I}}{1-\kappa a_{i,I}}$. Assume $\kappa = 0.4$; consider a small economy that devotes 80% of investment spending to local inputs; the model then predicts that 84% of the equity issued by that country is locally held.

The equilibrium local equity position S_i^i can also be expressed as:

$$S_i^i = \mu_i - (1-\mu_i)\frac{1-\kappa}{\kappa-\Lambda}\frac{Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t)}{Var_{\widehat{q}}(\widehat{d}_t)}. \tag{47}$$

The degree of equity home bias $S_i^i - \mu_i$ is thus given by: $S_i^i - \mu_i = (1-\mu_i)\frac{(1-\kappa)(a_{i,I}-\mu_i)/(1-\mu_i)}{1-\kappa(a_{i,I}-\mu_i)/(1-\mu_i)} = -(1-\mu_i)\frac{1-\kappa}{\kappa-\Lambda}\frac{Cov_{\widehat{q}}(\widehat{w_t l_t}_t, \widehat{d}_t)}{Var_{\widehat{q}}(\widehat{d}_t)}$. Again, the condition for the existence of an equity home bias ($S_i^i > \mu_i$) is $Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t) < 0$.We now turn to the empirical analysis of this condition.

Empirical evidence on the (un-)conditional correlation between relative wage income and relative dividends

For each G7 country, we obtained annual time series on nominal wage incomes and profits (in local currency) from OECD National Accounts.[16] We construct an empirical counterpart to the model's country i dividend variable d_i by subtracting gross investment from profits. We divided each G7 country's nominal wage income (dividends) series by an aggregate wage income (dividend) series for the remaining countries in the sample (nominal exchange rates were used to express all series in a common currency). We finally logged and linearly de-trended the resulting relative labor income (dividends) series to obtain estimates of the variable $\widehat{wl}$ $(\widehat{d})$ in the model. We consider two sample periods: 1972-2003 and 1990-2003. The empirical unconditional correlations $Corr(\widehat{w}_t, \widehat{d}_t)$ are given in table 1.

Table 1: **Estimates of** $Corr(\widehat{w_t l_t}, \widehat{d}_t)$

	US	JA	DE	FR	UK	IT	CA
$1972-2003$	.76 (.07)	.82 (.05)	.76 (.09)	.71 (.08)	.80 (.08)	.82 (.06)	.63 (.10)
$1990-2003$	.83 (.05)	.93 (.02)	.88 (.04)	.61 (.11)	.78 (.10)	.68 (.07)	.85 (.04)

Note: Figures in parentheses are standard deviations of correlations (based on GMM)

For each G7 country (and for both sample periods), $\widehat{w_t l_t}$ is highly positively correlated with $\widehat{d}_t$; in all cases the correlations are significantly different from zero.

Table 2 reports $Corr_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t)$ for the G7 countries. We use a country's GDP deflator as a measure of its output price p_i. Our measure of the country i terms of trade is the ratio of its GDP deflator to a geometric weighted average of the GDP deflators of the remaining G7 countries, expressed in country i currency using nominal exchange rates (the weights are given by country's relative GDPs). The resulting series is logged and linearly detrended. We regressed $\widehat{w_t l_t}$ and $\widehat{d}_t$ on $\widehat{q}_t$; the correlation between the residuals of those regressions is our estimate of $Corr_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t)$.

It appears that $Corr_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t) < 0$, for the G7 countries (the only exception if Italy, for the period 1972-2003; but for 1990-2003, $Corr_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t) < 0$ holds for Italy too.) Note that, in most cases $Corr_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t)$ is highly statistically significant.

Table 2: **Estimates of** $Corr_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d}_t)$

	US	JA	DE	FR	UK	IT	CA
$1972-2003$	$-.21$ (.12)	$-.42$ (.15)	$-.48$(.17)	$-.72$ (.07)	$-.65$ (.11)	.48 (.16)	$-.10$ (.15)
$1990-2003$	$-.07$ (.10)	$-.56$ (.21)	$-.56$ (.17)	$-.50$ (.11)	$-.84$ (.07)	$-.44$ (.16)	$-.19$ (.22)

Note: Figures in parentheses are standard deviations of correlations (based on GMM)

[16] Series: 'Compensation of employees' and 'Gross operating surplus and gross mixed income'.

Implied equity portfolios

Across G7 countries, the average capital share is $\kappa = 0.4$; the average share of gross physical investment in GDP is $\Lambda = 0.22$. The mean values (1972-2003) of the G7 countries's shares in total G7 GDP are: 0.44 (US), 0.19(Japan), 0.11 (Germany), 0.08(France), 0.06 (UK), 0.06 (Italy) and 0.04 (Canada), respectively. Using these values for κ, Λ and μ_i, as well as estimates of $Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d_t})/Var_{\widehat{q}}(\widehat{d_t})$, we construct the locally held equity share, and the implied degrees of equity home bias generated by the model (from equation (47).)[17]. The results are shown in table 3.

Table 3: **Implied locally held equity position** $S_i^i = \mu_i - (1-\mu_i)\frac{1-\kappa}{\kappa-\Lambda} Cov_{\widehat{q}}(\widehat{w_t}, \widehat{d_t})/Var_{\widehat{q}}(\widehat{d_t})$

	US	JA	DE	FR	UK	IT	CA
1972 – 2003	.62 (.14)	.68 (.18)	.37 (.08)	.70 (.10)	.77 (.14)	−.53 (.19)	.08 (.08)
1990 – 2003	.50 (.20)	.73 (.21)	.44 (.13)	.57 (.23)	.77 (.12)	1.06 (.56)	.17 (.18)

Note: Figures in parentheses are standard deviations.

The implied degree of equity home bias is mostly sizable and highly statistically significant. For the period 1990-2003, it ranges between 5% (US) and 100% (Italy). The implied locally held equity share S_i^i ranges between 17% (Canada) and 106% (Italy).

4 The dynamics of external financial positions

The liberalization of international capital flows has increased the size and volatility of international capital flows; the gross external assets and liabilities of leading industrialized countries now exceed 100% of their respective GDPs, and thus fluctuations in the value of domestic and foreign assets induce external capital gains/losses that have a substantial effect on countries' financial wealth (Gourinchas and Rey (2005), Tille (2005), Lane and Milesi-Ferretti (2006)). This Section describes the dynamics of the external financial positions of G7 countries; we then show that our model captures key aspects of the observed dynamics.

4.1 External position dynamics: empirical evidence

Table 4 documents time series properties of international financial/macroeconomic variables for the G7 countries. The sample period is 1984-2004. All data are annual. GDP and physical investment series

[17] Note that $Cov_{\widehat{q}}(\widehat{w_t l_t}, \widehat{d_t})/Var_{\widehat{q}}(\widehat{d_t})$ is the regression coefficient in an OLS regression of $\widehat{w_t l_t} - P[\widehat{w_t}|\widehat{q_t}]$ on $\widehat{d_t} - P[\widehat{d_t}|\widehat{q_t}]$. We regress $\widehat{w_t}$ and $\widehat{d_t}$ on $\widehat{q_t}$ to construct $P[\widehat{w_t l_t}|\widehat{q_t}]$ and $P[\widehat{d_t}|\widehat{q_t}]$.

are logged. Standard deviations, correlations with domestic GDP and autocorrelations are reported. All statistics are based on HP-filtered series (smoothing parameter: 400).

The Table reports properties of annual first differences (changes) of G7 countries' net foreign assets (NFA), net foreign bond assets, and net foreign equity assets, normalized by domestic nominal GDP. Note that these assets/liabilities are evaluated at *market prices* (data source: Lane and Milesi-Ferretti (2007)).

For 6 of the G7 countries, the annual NFA change is more volatile than GDP; the mean standard deviations of ΔNFA and GDP across the G7 countries are 3.23% and 2.07%, respectively. NFA changes are slightly countercyclical and essentially serially uncorrelated (mean correlation with domestic GDP: -0.22; mean autocorrelation: -0.01)

As our model assumes trade in stocks and in bonds, we decompose NFA change into the change of a country's equity position and into the change of its net bond position (at market prices). [18] Stocks and bonds both contribute noticeably to NFA changes (mean standard deviations of net equity assets and of net bond assets: 2.97% and 2.20%, respectively). Net equity assets and net bond assets are negatively correlated (mean correlation: -0.27). Like NFA changes, the changes of net equity and net bond positions tend to be weakly countercyclical and they have weak serial correlation.

The changes in net equity/bond positions at market prices reflect asset price changes, as well as net asset acquisitions. The net flow of assets acquired by a country is measured by its current account (CA). In contrast to the first difference of NFA (at market prices), the CA does *not* take into account external capital gains/losses (on assets acquired in the past). Table 4 reports time series properties of CAs; it also disaggregates the CA in its equity component ('Net equity outflow' = net equity purchases from the rest of the world) and its bond component ('Net bond outflow' = net bond purchase from the rest of the world). (Note: the statistics in Table 4 pertain to CA and Net equity/bond outflow series that have been normalized by domestic GDP). The CA is only about a third as volatile as the NFA change (mean standard deviation of CA [ΔNFA]: 1.11% [3.23%]). [19] Thus, NFA changes are largely driven by asset price (valuation) changes, and not by net asset flows. Note also that CA is clearly countercyclical

[18] We construct a country's 'equity' position by adding portfolio equity and FDI positions (at market prices); our measure of country's 'bond' position is the sum of debt and bank loans (data source: Lane and Milesi-Ferretti (2007)).

[19] See Kollmann (2006b) documents the fact that ΔNFA is more volatile than CA, for a broader sample of 18 OECD countries. Faruquee and Lee (2007) confirm that empirical result for a sample of 100 countries.

and highly persistent (mean correlation with domestic GDP: -0.40; mean autocorrelation: 0.64); this too distinguishes the behavior of CA from that of ΔNFA.

Net equity outflows (mean standard deviation: 1.38%) and net bond outflows (mean standard deviation: 1.71%) are only sightly more volatile than CA. Net equity flows are highly (statistically significantly) negatively correlated with net debt flows (mean correlation between the two flows: -0.68). Net bond outflows are countercyclical (except for the US), whereas net equity outflows have no clear cyclical pattern. Net equity/bond outflows are less strongly serially correlated than the CA. Note also that net equity/bond outflows are less volatile than changes in net foreign equity/bond positions at market prices; the difference is especially noticeable for net equities–which shows that, valuation effects are more important for stocks than for bonds. However, irrespective of whether valuation changes are taken into account, net equity positions are negatively correlated with net bond positions.

Net exports (normalized by GDP) are less volatile than GDP, while terms of trade (measured by a country's export price index divided its import price index) are more volatile than GDP (mean standard deviations of NX and t.o.t : 1.14% and 3.77%, respectively). Net exports are significantly negatively correlated with GDP (in 6 of the G7 countries), while the terms of trade have no clear cyclical patter (mean correlation with GDP: 0.08).

4.2 Dynamics of external financial positions: model predictions

We now study the predictions of the model regarding the cyclical behavior of key-macroeconomic variables, and the dynamics of foreign asset positions and capital flows.

4.2.1 Model calibration

We adopt a model calibration that closely follows the International Real Business Cycle literature (e.g. Backus, Kehoe and Kydland (1992, 1994), Kollmann (1996, 1998)). We set the degrees of consumption and investment home bias at $\alpha = \alpha_I = 0.85$, which implies that the trade share (imports/GDP ratio) is 15% in the (deterministic) steady state. The labor share (ratio of wage earnings to GDP) is about 60% in G7 countries; accordingly, we set $1 - \kappa = 0.6$.

The risk aversion coefficient, the labor supply elasticity, and the substitution elasticity between domestic and foreign goods are set at $\sigma = 2$, $1/\omega = 2$ and $\phi = \phi_I = 2$ respectively; these parameter values are well in the range of empirical parameter estimates, for G7 countries (see Coeurdacier, Kollmann and Martin (2007) for a detailed justification).

The model is calibrated to annual data. As is standard in annual macro models, we set the subjective discount factor and the depreciation rate of capital at $\beta = 0.96$ and $\delta = 0.1$, respectively. This implies that, in steady state, the return on equity is about 4.16% p.a, the capital-output ratio is 2.82, and 28% of GDP is used for investment.

We assume that the exogenous variables follow AR(1) processes:

$$\log(\theta_{i,t}) = \rho^{\theta} \log(\theta_{i,t-1}) + \varepsilon^{\theta}_{i,t}, \tag{48}$$

$$\log(\chi_{i,t}) = \rho^{\chi} \log(\chi_{i,t-1}) + \varepsilon^{\chi}_{i,t} \tag{49}$$

We fitted (48) to detrended annual (log) TFP series, for the G7 countries (1972-2004) [20]. The estimates of ρ^{θ} range between 0.64 (US) and 0.80 (Canada); the mean autocorrelation (across G7 countries) is 0.75. The standard deviation of $\varepsilon^{\theta}_{i,t}$ ranges between 1.01% (France) and 1.48% (Japan), with a mean of 1.20%. TFP is positively correlated across countries; for each G7 country, we constructed a measure of 'foreign' TFP, by taking a weighted average (using GDP weights) of (log) TFP in the remaining G7 countries; we then fitted (48) to (linearly detrended) 'foreign' TFP The correlation of domestic-foreign productivity innovation ranges between 0.29 (UK) and 0.70 (Germany), with an average correlation of 0.45. We thus set $\rho^{\theta} = 0.75$, $Std(\varepsilon^{\theta}_{H,t}) = Std(\varepsilon^{\theta}_{F,t}) = 1.20\%$, $corr(\varepsilon^{\theta}_{H,t}, \varepsilon^{\theta}_{F,t}) = 0.45$. [21]

When $\alpha = \alpha_I$ holds, one unit of the country i aggregate investment good in *efficiency* units is worth $1/\chi_{i,t}$ units of the aggregate consumption good in that country. The literature on investment specific technology shocks has used the ratio of the CPI to the price of investment goods as an estimate of investment specific technology shocks (see Fisher (2006)). We follow that literature. For each G7 country, we computed annual time series of $\chi_{i,t} \equiv$CPI/(investment deflator), for the period 1972-2004 (data source: OECD National Accounts).[22] The autocorrelations of (linearly detrended) $\log(\chi_{i,t})$ range between 0.93

[20] Our estimate of country i TFP (in logs) is: $\log(TFP_{i,t}) = \log(Y_{i,t}) - (1 - k_i)\log(L_{i,t})$, with $1 - k_i$: i's mean labor share during the sample period; $L_{i,t}$: total hours worked (from OECD Productivity Database). No capital stocks were used, due to the absence of consistent capital data in G7 countries, during sample period.

[21] We also estimated VARs in home and foreign TFP: $(\log(\theta_{H,t}), \log(\theta_{F,t})) = R(\log(\theta_{H,t-1}), \log(\theta_{F,t-1})) + \epsilon^{\theta}_t$ where R is a 2x2 matrix. We find that the off-diagonal elements of R are generally not statistically significant; the mean value (across G7 countries) of the off-diagonal elements is zero. The simulations thus assume univariate technology processes with correlated innovations.

[22] The empirical literature on investment specific technology shocks has focused on the US. It documents a secular fall in the real price of investment goods (relative to the CPI). Our data show that a similar downward trend exists in the

(US) and 0.79 (Canada); the mean autocorrelation is 0.79. The standard deviations of $\varepsilon^{\chi}_{i,t}$ ranges between 1.18% (US) and 2.48% (Japan), with a mean of 1.73%. Innovations to investment efficiency in country i and in a rest-of-G7 aggregate are only weakly correlated (mean correlation: 0.19). Empirically, log $(\chi_{i,t})$ is thus roughly as persistent as $\log(\theta_{i,t})$, but more volatile, and less correlated across countries. Based on this evidence, we set $\rho^{\chi} = 0.79$, $Std(\varepsilon^{\chi}_{H,t}) = Std(\varepsilon^{\chi}_{F,t}) = 1.73\%$, $corr(\varepsilon^{\chi}_{H,t}, \varepsilon^{\chi}_{F,t}) = 0.19$.

The correlations between TFP and investment efficiency innovations $(\varepsilon^{\theta}_{i,t}, \varepsilon^{\chi}_{i,t})$ are very close to zero (mean correlation: 0.0003). In the simulations, we thus assume that TFP and investment efficiency shocks are independent.

4.2.2 Numerical solution method

We numerically solve for time-varying first-order accurate equilibrium portfolios, building on Devereux and Sutherland (2006)[23]. The solution expresses portfolios held at the end of period t as a function of endogenous and exogenous state variables known at t: $S^i_{j,t+1} = S^i_j + \gamma^{S,i}_j (Z_t - Z)$, $b^i_{j,t+1} = b^i_j + \gamma^{b,i}_j (Z_t - Z)$ with $Z_t \equiv (K_{H,t+1}, K_{F,t+1}, NFA_{F,t+1}, \theta_{H,t}, \theta_{F,t}, \chi_{H,t}, \chi_{F,t})$, where $NFA_{H,t}$ is the Home country net foreign asset position at the end of period t (see below). The coefficients $\gamma^{S,i}_j, \gamma^{b,i}_j$ of these linear portfolio decision rules can be computed using a third-order accurate approximation of the household Euler equations, and a second-order accurate approximation of the remaining equilibrium conditions. We use Sims (2000) algorithm (see Kim, Kim and Kollmann (2007a,b)) for that purpose.

4.2.3 Simulation results

Table 5 shows moments of Home country variables, based on a simulation run with 10000 periods. First-order accurate model solutions for portfolios and other endogenous variables are used. All Home country variables are expressed in terms of Home country output, i.e. the Home good is used as numeraire ($p_{H,t} \equiv 1$). Statistics for GDP and physical investment pertain to logged series. Net exports, the changes in net foreign assets, the current account, as well as net bond and net equity flows are normalized using Home GDP. All series have been HP filtered (smoothing parameter: 400). (The normalization/filter applied to the simulated series parallels the normalization/filter used for the empirical series in Table 4).

remaining G7 countries. In 1972-2004, the average annual rates of *decline* of the relative price of investment were: 0.99% (US), 0.84% (Japan), 0.52% (Germany) 0.35% (France), 0.66% (UK), 0.32% (Italy), 1.33% (Canada).

[23]Devereux and Sutherland (2006) compute dynamic portfolios in an economy with *two* assets; we extend their method to the case with more than two assets.

The theoretical counterparts to the financial variables considered in Table 4 are defined as follows: The Home country's *net foreign equity assets* at the end of period t are $p^S_{F,t}S^H_{F,t+1} - p^S_{H,t}S^F_{H,t+1}$, while Home *net foreign bond assets* are: $p^b_{H,t}b^H_{H,t+1} + p^b_{F,t}b^H_{F,t+1}$. *Net Foreign Assets* are the sum of net Bond and net Equity Assets. The Home *net bond outflow* (net purchase of bonds) is $p^b_{H,t}\Delta b^H_{H,t+1} + p^b_{F,t}\Delta b^H_{F,t+1}$ (with $\Delta x_t \equiv x_t - x_{t-1}$); the *net equity outflow* is $p^S_{F,t}\Delta S^H_{F,t+1} - p^S_{H,t}\Delta S^F_{H,t+1}$ The period t *current account* is the sum of equals net purchases of stocks *and* bonds: $CA_{H,t} = p^S_{F,t}\Delta S^H_{F,t+1} - p^S_{H,t}\Delta S^F_{H,t+1} + p^b_{H,t}\Delta b^H_{H,t+1} + p^b_{F,t}\Delta b^H_{F,t+1}$. Up to a linear approximation, the change in the NFA position equals the current account plus the change in the value of the steady state stock and bond holdings: $\Delta NFA_{H,t+1} = CA_{H,t} + (\Delta p^S_{F,t} - \Delta p^S_{H,t})(1-S) + (\Delta p^b_{H,t} - \Delta p^b_{F,t})b$. [24] By the same logic, the change in the net foreign equity [bond] position (at market prices) equals the net equity [bond] outflow, plus the change in the value of the steady state stock [bond] holdings.[25] Finally, Home *net exports* (in terms of good H) are $NX_{H,t} = (c^F_{H,t} + i^F_{H,t}) - p_{F,t}(c^H_{F,t} + i^H_{F,t}) = Y_{H,t} - P_{H,t}C_{H,t} - P^I_{H,t}I_{Ht}$, while the Home terms of trade are: $1/p_{F,t}$.

Steady state portfolio and responses of portfolio to shocks

The steady state portfolio is: $S = 0.79, b = 0.26$. Thus on average, 79% of a country's capital stock is predicted to be held by local investors, which is broadly in line with the current degree of equity home bias in OECD countries. An innovation to country H TFP (θ_H) induces H to purchase H and F stocks and good H bonds, and to simultaneously reduce her holding of good F bonds [Intuition to be added.] A 1% innovation to country H TFP (θ_H) triggers a purchase by household H of stocks H and F and of good H bonds that represent 1.65%, 1.45% and 2.75%, respectively Home GDP (responses not shown in Table); the reduction in the household's holding of good F bonds represents 5.68% of GDP. A 1% shock to country H investment efficiency (χ_H) triggers purchases by household H of stocks H and F and of good H bonds that represent 0.43%, 0.44% and 0.17%, respectively, of GDP.

Predicted cyclical behavior

Col. 1 of Table 5 reports predicted statistics for the benchmark model with the two types of shocks.

[24] To see this, note that, up to a linear approximation, the change in the country H net foreign asset position and its current account are given by: $\Delta NFA_{H,t+1} = p^S(\Delta S^H_{F,t+1} - \Delta S^F_{H,t+1}) + p^b(\Delta b^H_{F,t+1} + \Delta b^F_{H,t+1}) + (\Delta p^S_{F,t} - \Delta p^S_{H,t})(1-S) + (\Delta p^b_{H,t} - \Delta p^b_{F,t})b$, $CA_{H,t} = p^S(\Delta S^H_{F,t+1} - \Delta S^F_{H,t+1}) + p^b(\Delta b^H_{H,t+1} + \Delta b^H_{F,t+1})$.

[25] E.g., up to first order, the net equity outflow is: $p^S(\Delta S^H_{F,t+1} - \Delta S^F_{H,t+1})$, while the change in the net foreign equity position is $p^S(\Delta S^H_{F,t+1} - \Delta S^F_{H,t+1}) + (\Delta p^S_{F,t} - \Delta p^S_{H,t})(1-S)$.

In order to assess the relative importance of each type of shock, we also report predicted statistics for a world with only TFP shocks (see Col. 2) and for a setting with only investment efficiency shocks (Col. 3).[26] Col. 4 reports historical statistics for the G7 (averages of statistics across the G7 countries).

The model (with simultaneous θ and χ shocks) matches closely the observed volatility of GDP, and it captures the fact that investment spending is markedly more volatile than GDP (predicted standard deviations of GDP and investment: 1.86%, 8.33%). The predicted standard deviation of net exports (1.04%) is close to the empirical volatility (1.14%). The model predicts that net exports are countercyclical, which is consistent with the data. Cols. 2 and 3 show that TFP (θ) shocks are the main source of output fluctuations, but that investment and net exports are mainly driven by investment efficiency shocks (χ). χ also generates the countercyclicality of net exports (with just θ shocks, net exports are procyclical). When domestic investment rises, because of a positive investment efficiency shock, net exports fall, on impact, as domestic investment requires foreign the input [27] The model also captures the fact that fluctuations of GDP, investment and net exports are persistent.

The high volatility of terms of trade is one of the key puzzles of international macro models. Standard RBC models underpredict sharply the empirical t.o.t. volatility; those models also predicts that terms of trade are highly countercyclical–see, e.g., Backus et al, (1994) whose benchmark model predicts that the standard deviation of the t.o.t. and its correlation with GDP are 0.59% and -0.49, respectively. The model here, with the two types of shocks, performs better than conventional models. The predicted standard deviation of terms of trade is 1.93%, i.e. the model explains about 50% of the empirical standard deviation (3.77%); the predicted correlation of the terms of trade (-0.22) is closer to the empirical correlation (0.08). Note that this success of the model is due to the investment efficiency shocks: those shocks generate larger t.o.t. fluctuations than TFP shocks (standard deviation of t.o.t. with just χ [just θ] shocks: 1.74% [0.86%]). χ shocks generate t.o.t. fluctuations that are essentially acyclical (while the t.o.t. are strongly countercyclical when there are just θ shocks). On impact, a positive Home investment efficiency shock appreciates the Home t.o.t. (as the shock triggers an increase in Home investment which raises demand for the H good); however, in subsequent periods, the Home t.o.t. depreciates (once Home has increased

[26] Cols. 2 and 3 assume the equilibrium policy/price functions of the model with both types of shocks–we merely feed just one type of disturbances into the model.

[27] A positive θ shock also raises investment. However that shock raises domestic output much more strongly, on impact, and as a result next exports are procyclical, when there are just θ shocks.

its capital stock, the supply of the H good is above its pre-shock level, and thus its relative prices is lower); this explains why t.o.t are acyclical when there are just χ shocks.

The strong responses of stock and bond holdings to technology innovations (see above) explain why the *simulated* net bond outflows and net equity outflows undergo sizable fluctuations; the predicted standard deviation of both flows is 3.22% (mean empirical standard deviations of net bond flows and of net equity flows: 1.71% and 1.38%.). The θ and χ shocks both account for roughly the same share of the variance of net equity/bond flows. However, up to a first order approximation, these asset transactions do not affect the current account: the value of stock purchases equals the value of bond sales, and the current account is zero. The model thus predicts that net outflow and the net bond outflow are perfectly *negatively* correlated with net bond outflows. Empirically, net bond and net equity flows are highly negatively correlated (mean correlation: -0.68). The model predicts that net bond outflows are countercyclical, while net equity outflows are procyclical.

Finally, note that the model captures the fact that the persistence of net debt/equity flows is lower than the persistence of GDP and investment: the predicted autocorrelations of net debt and equity flows are close to zero (0.05). This is due to the fact that stock and bond holdings at the end of period t ($S^j_{i,t+1}, b^j_{i,t+1}$) are functions of state variables (capital stocks, NFA and exogenous variables) that are highly persistent; thus, the *first difference* of stock and bond holdings (net flows) has little serial correlation.

The predicted standard deviation, correlation with GDP and autocorrelation of the change of a country's NFA change are 2.20%, -0.26 and 0.10 (corresponding empirical statistics (G7 averages): 3.23%, -0.22, -0.01. Consistent with the data, the model predicts thus that the change of NFA is more volatile than GDP, countercyclical and basically serially uncorrelated. As the current account (CA) is zero (up to first order), NFA changes are *solely* driven by movements in equity and bond prices. NFA thus is predicted to have the time series properties of asset prices. In response to a positive investment efficiency shock, a country is predicted to experience a reduction in its net exports, on impact; however, the present value of its current and future net imports *rises*; as the country's NFA equals the present value of its current and future net imports, the NFA drops, on impact. Thus, the change in NFA is predicted to be countercyclical, as is consistent with the data.

5 Conclusion

This paper departs from two familiar explanations of equity home bias: transaction costs that impede international diversification, and the possibility that terms of trade responses to supply shocks provide international risk sharing (Cole and Obstfeld, 1991), so that households have little incentive to hold diversified portfolios. We study a two-country/two-good RBC model with *frictionless* international trade in stocks and in bonds; there are shocks to total factor productivity and to the efficiency of physical investment. In the setting here, domestic stocks are used to hedge fluctuations in local wage income triggered by shocks to investment spending. Terms of trade risk is hedged using bonds denominated in local goods and in foreign goods. In contrast to related models, the low level of international diversification does not depend on a countercyclical response of the terms-of-trade to supply shocks. Investment efficiency shocks allow the model to generate more realistic volatility in investment, net exports and net foreign assets. With those shocks, our model reproduces the fact that net exports are countercyclical.

APPENDIX

Derivation of static budget constraint: zero-order accurate portfolio

Following Devereux and Sutherland (2006), we express the budget constraint of country i as

$$\begin{aligned} NFA_{i,t+1} &= NX_{i,t} + NFA_{i,t}R_t^{b,i} + \xi_{i,t}, \quad (50) \\ \text{where } NFA_{i,t+1} &\equiv p_{i,t}^S(S_{i,t+1}^i - 1) + p_{j,t}^S S_{j,t+1}^i + p_{i,t}^b b_{i,t+1}^i + p_{j,t}^b b_{j,t+1}^i, \\ \text{with } j &\neq i, NX_{i,t} \equiv p_{i,t}Y_{i,t} - P_{i,t}C_{i,t} - P_{i,t}^I I_{i,t}. \end{aligned}$$

$NFA_{i,t+1}$ is country i's net foreign asset position at the end of period t, while $NX_{i,t}$ are the country's net exports. Furthermore,

$$\begin{aligned} \xi_{i,t} &\equiv (S_{i,t}^i - 1)p_{i,t-1}^S(R_t^{S,i} - R_t^{b,i}) + S_{j,t}^i p_{j,t-1}^S(R_t^{S,j} - R_t^{b,i}) + b_{j,t}^i p_{j,}^b(R_t^{b,j} - R_t^{b,i}) \\ \text{with } R_t^{S,i} &\equiv (p_{i,t}^S + d_{i,t})/p_{i,t-1}^S \text{ and } R_t^{b,i} \equiv (p_{i,t} + p_{i,t}^b)/p_{i,t-1}^b. \end{aligned}$$

$R_t^{b,i}$ is the (gross) rate of return on bond i, between periods $t-1$and t, while $R_t^{S,i}$ is the gross rate of return on stock i. $\xi_{i,t}$ is the "excess return" on the country's net foreign asset position (between $t-1$and t) relative to the return on bond i . [28]

As in the main text, let variables without time indices represent (deterministic) steady state values, and $\widehat{x_{i,t}} \equiv (x_{i,t} - x_i)/x_i$. Note that $NFA_i = 0$, $NX_i = 0$, $p_H^S = p_F^S$, $p_H^b = p_F^b$ due to the symmetric structure of the two countries; furthermore, $R^{S,H} = R^{S,F} = R^{b,H} = R^{b,F} = 1/\beta$. A linear approximation of (50) around steady state yields thus:

$$NFA_{i,t+1} = NX_{i,t} + NFA_{i,t}/\beta + (S_i^i - 1)p^S\frac{1}{\beta}(\widehat{R_t^{S,i}} - \widehat{R_t^{b,i}}) + S_j^i p^S \frac{1}{\beta}(\widehat{R_t^{S,j}} - \widehat{R_t^{b,i}}) + b_j^i p_j^b \frac{1}{\beta}(\widehat{R_t^{b,j}} - \widehat{R_t^{b,i}}), \quad (51)$$

where $S_i^{i\prime}, S_j^i$ and b_j^i are steady state equity and bond holdings. Symmetry implies $S \equiv S_H^H = S_F^F = 1 - S_F^H = 1 - S_H^F$; $b_H^H = b_F^F = -b_F^H = -b_H^F$. Thus, the linearized budget constraint becomes:

$$NFA_{i,t+1} = NX_{i,t} + NFA_{i,t}/\beta + \widetilde{\xi_{i,t}}, \quad \text{with } \widetilde{\xi_{i,t}} \equiv (S-1)p^S\frac{1}{\beta}(\widehat{R_t^{S,i}} - \widehat{R_t^{S,j}}) + bp_j^b\frac{1}{\beta}(\widehat{R_t^{b,j}} - \widehat{R_t^{b,i}}). \quad (52)$$

Up to a first-order approximation, $E_t(\widehat{R_{t+\tau}^{S,i}} - \widehat{R_{t+\tau}^{S,j}}) = 0$, $E_\tau(\widehat{R_{t+\tau}^{b,j}} - \widehat{R_{t+\tau}^{b,i}}) = 0$ holds for all $\tau > 0$, as can readily be seen by linearizing the Euler equations (20), (21). Solving (52) forward gives thus the

[28] Note that $\xi_{i,t} = S_{i,t}^i(d_{i,t} + p_{i,t}^S) + S_{j,t}^i(d_{j,t} + p_{i,t}^S) + (p_{i,t} + p_{i,t}^b)b_{i,t}^i + (p_{j,t} + p_{j,t}^b)b_{j,t}^i - NFA_{i,t}R_t^{b,i}$. Thus, $\xi_{i,t}$ is the difference between country $i's$ actual net external wealth (including dividend and coupon payments) at the beginning of period t , minus the hypothetical value of $i's$ net external wealth at the beginning of t that would have obtained if i had fully invested her external wealth at the end of $t-1$ in the good i bonds.

following present value budget constraint:

$$E_t \sum_{\tau \geq 0} \beta^\tau(-NX_{i,t+\tau}) = NFA_{i,t}/\beta + (S-1)p^S \frac{1}{\beta}(\widehat{R_t^{S,i}} - \widehat{R_t^{S,j}}) + bp^b \frac{1}{\beta}(\widehat{R_t^{b,j}} - \widehat{R_t^{b,i}}). \tag{53}$$

Solving (21).forward, gives $p_{i,t}^S = E_t \sum_{\tau \geq 1} \beta^\tau (\frac{C_{H,t+\tau}}{C_{H,t}})^{-\sigma} \frac{P_{H,t+\tau}}{P_{H,t}} d_{i,t+\tau}$.Linearizing the formulae for stocks returns, yields $\widehat{R_t^{S,i}} - \widehat{R_t^{S,j}} = (1-\beta)\widetilde{E}_t \sum_{\tau \geq 0} \beta^\tau (\widehat{d_{i,t+\tau}} - \widehat{d_{j,t+\tau}})$, where $\widetilde{E}_t x \equiv E_t x - E_{t-1} x$ (revision of expectation between periods t and $t-1$). Similarly, $\widehat{R_t^{b,j}} - \widehat{R_t^{b,i}} = (1-\beta)\widetilde{E}_t \sum_{\tau \geq 0} \beta^\tau (\widehat{p_{i,t+\tau}} - \widehat{p_{j,t+\tau}})$. (53) can thus be expressed as: [29]

$$E_t \sum_{\tau \geq 0} \beta^\tau(-NX_{i,t+\tau}) = NFA_{i,t}/\beta + (S-1)d\widetilde{E}_t \sum_{\tau \geq 0} \beta^\tau (\widehat{d_{i,t+\tau}} - \widehat{d_{j,t+\tau}}) + bp\widetilde{E}_t \sum_{\tau \geq 0} \beta^\tau (\widehat{p_{i,t+\tau}} - \widehat{p_{j,t+\tau}}). \tag{54}$$

(54) holds if and only if:

$$E_{t-1} \sum_{\tau \geq 0} \beta^\tau(-NX_{i,t+\tau}) = NFA_{i,t}/\beta \quad \text{and} \tag{55}$$

$$\widetilde{E}_t \sum_{\tau \geq 0} \beta^\tau(-NX_{i,t+\tau}) = (S-1)d\widetilde{E}_t \sum_{\tau \geq 0} \beta^\tau (\widehat{d_{i,t+\tau}} - \widehat{d_{j,t+\tau}}) + bp\widetilde{E}_t \sum_{\tau \geq 0} \beta^\tau (\widehat{p_{i,t+\tau}} - \widehat{p_{j,t+\tau}}). \tag{56}$$

We assume that $E_0 \sum_{\tau \geq 0} \beta^\tau(-NX_{i,t+\tau}) = 0$ holds for the initial date $t = 0$. [30] When (56) holds for all subsequent dates ($t \geq 1$), then the present value budget constraint (53) holds likewise for all $t \geq 1$.

Assume that there exists a portfolio (S, b) such that

$$-NX_{i,t} = (S-1)d(\widehat{d_{i,t}} - \widehat{d_{j,t}}) + bp(\widehat{p_{i,t}} - \widehat{p_{j,t}}) \quad \text{at } t \geq 0, \tag{57}$$

for Pareto efficient quantities and prices. Clearly, that portfolio satisfies (56),.so that it also satisfies the present value budget constraint (53).

Up to a first-order approximation, the period t budget constraint under complete markets thus reduces to a static condition, in equilibrium (which makes it much easier to gain intuition about portfolios). (57) is equivalent to

$$P_{i,t}C_{i,t} = w_{i,t} + Sd_{i,t} + (1-S)d_{j,t} + b(p_{i,t} - p_{j,t}) \tag{58}$$

[29] Note that $p^S = d\beta/(1-\beta)$, $p^b = p\beta/(1-\beta)$.

[30] Recall that countries are born with zero external assets, i.e. $NFA_{i,0} = 0$ at at date zero (birth), $t = 0$;if initial capital stocks and exogenous variables at $t = 0$, are identical across countries, then $E_0 \sum_{\tau \geq 0} \beta^\tau(-NX_{i,\tau}) = 0$.

The current account

(55) and (57) imply:

$$NFA_{i,t} = (S-1)\beta E_{t-1} \sum_{\tau \geq 0} \beta^{\tau} d(\widehat{d_{i,t}} - \widehat{d_{j,t}}) + b\beta E_{t-1} \sum_{\tau \geq 0} \beta^{\tau} p(\widehat{p_{i,t}} - \widehat{p_{j,t}}). \tag{59}$$

Note that $p^S(\widehat{p^S_{i,t-1}} - \widehat{p^S_{j,t-1}}) = \beta E_{t-1} \sum_{\tau \geq 0} \beta^{\tau} d(\widehat{d_{i,t+\tau}} - \widehat{d_{j,t+\tau}})$ and $p^b(\widehat{p^b_{i,t-1}} - \widehat{p^b_{j,t-1}}) = \beta E_{t-1} \sum_{\tau \geq 0} \beta^{\tau} p(\widehat{p_{i,t+\tau}} - \widehat{p_{j,t+\tau}})$. Hence,

$$NFA_{i,t} = (S-1)p^S(\widehat{p^S_{i,t-1}} - \widehat{p^S_{j,t-1}}) + bp^b(\widehat{p^b_{i,t-1}} - \widehat{p^b_{j,t-1}}). \tag{60}$$

Linearizing the formula $NFA_{i,t} \equiv p^S_{i,t-1}(S^i_{i,t} - 1) + p^S_{j,t-1} S^i_{j,t} + p^b_{i,t-1} b^i_{i,t} + p^b_{j,t-1} b^i_{j,t}$ gives

$$NFA_{i,t} \equiv (S-1)p^S(\widehat{p^S_{i,t-1}} - \widehat{p^S_{j,t-1}}) + bp^b(\widehat{p^b_{i,t-1}} - \widehat{p^b_{j,t-1}}) + (S^i_{i,t} + S^i_{j,t} - 1)p^S + (b^i_{i,t} + b^i_{j,t})p^b. \tag{61}$$

It follows from (60) and (61) that the value of the country i stock and bond portfolio, evaluated at steady state asset prices is zero:

$$(S^i_{i,t} + S^i_{j,t} - 1)p^S + (b^i_{i,t} + b^i_{j,t})p^b = 0. \tag{62}$$

The period t current account surplus of country i is: $CA^i_t = (S^i_{i,t+1} - S^i_{i,t})p^S_{i,t} + (S^i_{j,t+1} - S^i_{j,t})p^S_{j,t} + (b^i_{i,t+1} - b^i_{i,t})p^b_{i,t} + (b^i_{j,t+1} - b^i_{j,t})p^b_{i,t}$. Linearization of this expression gives: $CA^i_t = (S^i_{i,t+1} - S^i_{i,t} + S^i_{j,t+1} - S^i_{j,t})p^S + (b^i_{i,t+1} - b^i_{i,t} + b^i_{j,t+1} - b^i_{j,t})p^b$. If follows from (62) that $CA^i_t = 0$. Thus, the current account is zero, up to a linear approximation.

- **References**

[1] Backus, D., and G.W, Smith, 1993, Consumption and Real Exchange Rates in Dynamic Economies with Non-traded Goods, Journal of International Economics, 35, 297-316.

[2] Backus, D., P.J Kehoe and F.E Kydland, 1992. International real business cycles. Journal of Political Economy 101, 745-775.

[3] Backus, D., P.J Kehoe and F.E Kydland, 1994. Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?. American Economic Review, vol. 84(1), pages 84-103, March.

[4] Baxter, M. and U. Jermann, 1997, The international portfolio diversification is worse than you think, American Economic Review, 87, 170-80.

[5] Beaudry, P. and F. Portier, 2003, News, Stock Prices and Economic Fluctuations, National Bureau of Economic Research, Working Paper 10548, American Economic Review, forthcoming.

[6] Bergin, P., 2004.

[7] Bottazi, L., P. Pesenti and E. Van Wincoop, 1996, Wages, Profits and the international portfolio puzzle, European Economic Review, 40, 219-254.

[8] Broda, C. and D. Weinstein, 2007, Product Creation and Destruction: Evidence and Price Implications,Mimeo, Columbia University.

[9] Cantor and Mark. 1988, The International Transmission of Real Business Cycles, International Economic Review 29, 493-507.

[10] Castelló M., 2007, A new open economy macroeconomic model with endogenous portfolio diversification and firms entry, European University Institute mimeo.

[11] Cochrane, J., 1994, Shocks, Carnegie-Rochester Conference Series on Public Policy, North Holland, 41, 295-364.

[12] Coeurdacier, N., 2005, Do Trade Costs in Goods Markets Lead to Home Bias in Equities?, Mimeo, ESSEC.

[13] Coeurdacier, N. and Gourinchas P-O, 2008, Home Bias in Goods and Assets: the Role of Bond Trading, mimeo University of Berkeley.

[14] Cole, H., M. Obstfeld, 1991, Commodity trade and international risk sharing: how much do financial markets matter?, Journal of Monetary Economics, 28, 3-24.

[15] Corsetti, G., L. Dedola and S. Leduc, 2007, International Risk-Sharing and the Transmission of Productivity Shocks, Working Paper, European Central Bank, forthcoming Review of Economic Studies.

[16] Corsetti, G. P. Martin, and P. Pesenti, 2007, Productivity, terms of trade and the 'home market effect', Journal of International Economics, Volume 73, Issue 1,99-127.

[17] Dellas, H., B. Diba , F. Collard and A. Stockman, 2007, Home Bias in Goods and Assets, Mimeo, IDEI.

[18] Devereux, M. and A. Sutherland, 2006, Solving for Country Portfolios in Open Economy Macro Models , Mimeo, UBC.

[19] Engel, C. and A. Matsumoto, 2006, Portfolio Choice in a Monetary Open-Economy DSGE Model, National Bureau of Economic Research, Working Paper 12214.

[20] Evans, M. and V. Hnatkovska,2005, International Capital Flows Returns and World Financial Integration, National Bureau of Economic Research, Working Paper 11701.

[21] Evans, M. and V. Hnatkovska, 2007, Solving General Equilibrium Models with Incomplete Markets and Many Financial Assets, mimeo Georgetown University.

[22] Faruqee, H. and J. Lee, 2007, Global Dispersion of Current Accounts: Is the Universe Expanding, mimeo, IMF.

[23] French, K. and J. Poterba, 1991, Investor Diversification and International Equity Markets, American Economic Review, 81, 222-26.

[24] Ghironi, F., Lee, J. and A. Rebucci, 2006, The Valuation Channel of External Adjustment, Mimeo, Boston College.

[25] Gourinchas, P-O and H. Rey, 2005, International Financial Adjustment, National Bureau of Economic Research, Working Paper 11155

[26] Greenwood, Jeremy & Hercowitz, Zvi & Krusell, Per, 2000. The role of investment-specific technological change in the business cycle,European Economic Review, vol. 44(1), pages 91-115, January.

[27] Greenwood, Jeremy & Hercowitz, Zvi & Krusell, Per, 1997. Long-Run Implications of Investment-Specific Technological Change,American Economic Review, American Economic Association, vol. 87(3), pages 342-62

[28] Hau, H. and H. Rey, 2004. Can Portfolio Rebalancing Explain the Dynamics of Equity Returns, Equity Flows and Exchange Rates?. American Economic Review P&P, 94 (2), 126–133.

[29] Heathcote, J. and F. Perri, 2007, The international diversification is not as bad as you think, National Bureau of Economic Research, Working Paper 13483.

[30] Heathcote, J. and F. Perri, 2004, Financial Globalization and Real Regionalization, Journal of Economic Theory, 119, 207-243.

[31] Heathcote, J. and F. Perri, 2002, Financial Autarky and International Business Cycles, Journal of Monetary Economics, 49, 601-627.

[32] Fisher, J., 2002. Technology Shocks Matter. Working Paper Chicago Fed.

[33] Fisher, J., 2006.The Dynamic Effects of Neutral and Investment-Specific Technology Shocks. Journal of Political Economy, 114 No. 3., pp. 413-52.

[34] Justiniano and Primiceri, 2006. The Time Varying Volatility of Macroeconomic Fluctuations, The American Economic Review, forthcoming, NBER working paper No. 12022

[35] Justiniano, Primiceri and Tambalotti, 2007. Investment Shocks and Business Cycles. mimeo Northwestern

[36] Kollmann, R., 2006a, A Dynamic General Equilibrium Model of International Portfolio Holdings: Comment, Econometrica, 74, 269-273.

[37] Kollmann, R., 2006b, International Portfolio Equilibrium and the Current Account, Centre for Economic Policy Research, Working Paper 5512.

[38] Kollmann, R., 1996, Incomplete Asset Markets and the Cross-Country Consumption Correlation Puzzle, Journal of Economic Dynamics and Control, 20, 945-962.

[39] Kollmann, R., 1998, US Trade Balance Dynamics: The Role of Fiscal Policy and Productivity Shocks and of Financial Market Linkages Journal of International Money and Finance, 17, 637-69.

[40] Kollmann, R., 1995, Consumption, Real Exchange Rates and the Structure of International Asset Markets, Journal of International Money and Finance, 1995, 14, 191-211.

[41] Kollmann, R., 1991, Essays on International Business Cycles, PhD Dissertation, Economics Department, University of Chicago.

[42] Kraay, A., N. Loayza, L. Serven and J. Ventura, 2005. Country Portfolios. Journal of the European Economic Association, 3 (4), 914–945.

[43] Lane, P, and G.M. Milesi-Ferretti, 2006a, The External Wealth of Nations Mark II, IMF Working Paper 06-69.

[44] Lane, P, and G.M. Milesi-Ferretti, 2006b, Europe and Global Imbalances, forthcoming in Economic Policy.

[45] Lane, P, and G.M. Milesi-Ferretti, 2005, A Global Perspective on External Positions, IIIS Discussion Paper 79, Trinity College Dublin.

[46] Lane, P. and G.M. Milesi-Feretti, 2003, International Financial Integration, IMF Staff Papers, 50., 82-113.

[47] Lane, P. and J. Shambaugh, 2007, Financial Exchange Rates and International Currency Exposures, mimeo.

[48] Lewis, K., 1999, Explaining Home Bias in Equities and Consumption, Journal of Economic Literature, 37, 571-608.

[49] Lucas, R., 1982, Interest Rates and Currency Prices in a Two-Country World, Journal of Monetary Economics, 10, 335-359.

[50] Matsumoto, A., 2007, The Role of Nonseparable Utility and Nontradeables in International Business Cycle and Portfolio Choice, IMF working paper 7163.

[51] Obstfeld, M., 2006, International Risk Sharing and the Costs of Trade, Ohlin Lecture, Stockholm School of Economics.

[52] Obstfeld and Rogoff, 1996, Foundations of International Macroeconomics, Cambridge, MA: MIT Press.

[53] Obstfeld M. and K. Rogoff, 2000, The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?, NBER Macroeconomics Annual, 339-390.

[54] Pavlova, A. and R. Rigobon, 2004, Asset Prices and Exchange Rates, Review of Financial Studies, forthcoming.

[55] Pavlova, A. and R. Rigobon, 2007, An Asset-Pricing View of External Adjustment, LBS Working Paper.

[56] Summers, L., 1981.

[57] Sercu, P. and R. Vanpée, 2007, Home Bias in International Equity Portfolios: A Review, Working Paper, Leuven School of Business and Economics.

[58] Tesar, L. and I. Werner, 1995, Home Bias and High Turnover, Journal of International Money and Finance 14, 467-92.

[59] Tille, C., 2005, Financial Integration and the Wealth Effect of Exchange Rate Fluctuations, Federal Reserve Bank of New York Staff Report 226.

[60] Tille, C. and E. van Wincoop, 2007, International Capital Flows, National Bureau of Economic Research, Working Paper 12856.

[61] Warnock, F., 2002, Home Bias and High Turnover Reconsidered, Journal of International Money and Finance 21, 795-805.

[62] Warnock, F. and E. van Wincoop, 2006, Is Home Bias in Assets Related to Home Bias in Goods?, National Bureau of Economic Research, Working Paper 12728.

Table 4. Cyclical properties of international financial positions (G7 countries)

	US	*JA*	*GE*	*FR*	*UK*	*IT*	*CA*	*Mean*
Standard deviations (%)								
GDP	1.58	2.94	1.67	1.61	2.12	1.76	2.80	2.07
Investment	7.17	7.66	6.08	7.40	7.20	5.07	7.65	6.89
Net exports	0.72	0.63	0.85	0.87	1.81	1.61	1.50	1.14
Δ (Net foreign assets)	2.36	2.60	2.63	4.33	5.02	2.67	3.03	3.23
Δ (Net foreign bond assets)	0.85	1.60	2.88	2.37	3.18	2.59	1.91	2.20
Δ (Net foreign equity assets)	2.27	3.20	1.37	4.69	4.20	2.35	2.74	2.97
Current account	0.77	0.62	1.73	0.75	1.35	1.34	1.17	1.11
Net bond outflow	0.88	1.25	2.49	1.76	2.24	1.92	1.45	1.71
Net equity outflow	0.90	1.02	1.59	1.67	1.75	1.70	1.06	1.38
Terms of trade	1.72	7.61	4.35	3.43	1.88	3.88	3.49	3.77
Correlations with domestic GDP								
Net exports	**-0.38**	**-0.56**	**-0.29**	**-0.52**	**-0.56**	**-0.48**	0.01	-0.39
Δ (Net foreign assets)	**-0.27**	-0.00	**-0.24**	-0.18	**-0.28**	-0.10	**-0.46**	-0.22
Δ (Net foreign bond assets)	**0.37**	**-0.23**	**-0.38**	**-0.50**	**-0.38**	**-0.32**	-0.22	-0.24
Δ (Net foreign equity assets)	**-0.43**	**0.20**	**0.31**	0.11	-0.07	0.17	**-0.45**	-0.02
Current account	**-0.44**	**-0.48**	**-0.54**	-0.32	**-0.74**	**-0.44**	0.18	-0.40
Net bond outflow	**0.52**	-0.06	**-0.35**	**-0.59**	**-0.54**	**-0.55**	0.00	-0.22
Net equity outflow	**-0.77**	-0.08	0.07	**0.55**	0.04	0.20	**-0.22**	-0.03
Terms of trade	0.13	**0.30**	0.06	-0.06	**-0.55**	0.29	**0.41**	0.08
Autocorrelations								
GDP	**0.68**	**0.84**	**0.68**	**0.72**	**0.76**	**0.71**	**0.78**	0.74
Δ (Net foreign assets)	0.03	**-0.42**	0.00	-0.13	-0.14	-0.01	**0.58**	-0.01
Δ (Net foreign bond assets)	**0.27**	0.13	0.12	0.09	**0.14**	0.10	0.12	0.14
Δ (Net foreign equity assets)	**0.26**	**-0.23**	0.12	-0.17	-0.16	0.17	0.16	0.02
Current account	**0.71**	**0.46**	**0.66**	**0.67**	**0.70**	**0.73**	**0.55**	0.64
Net bond outflow	**0.65**	**0.26**	**0.66**	0.11	0.17	**0.39**	-0.01	0.32
Net equity outflow	**0.58**	-0.00	**0.41**	**0.35**	-0.17	**0.50**	-0.08	0.23
Other correlations								
Δ (Gross foreign equity assets) & Δ (Gross foreign equity liabil.)	**0.87**	0.03	**0.89**	**0.71**	**0.78**	**0.58**	**0.62**	0.64
Δ (Net foreign equity assets) & Δ (Net foreign bond assets)	-0.09	**-0.48**	**-0.39**	**-0.39**	-0.01	**-0.36**	-0.15	-0.27
Net equity outflow & Net bond outflow	**-0.52**	**-0.68**	**-0.70**	**-0.78**	**-0.63**	**-0.77**	**-0.69**	-0.68

Notes: Data are annual, 1984-2004, and were Hodrick-Prescott filtered (GDP,I: logged). **Underlined correlations are statistically significant at a 10% level** (two-sided test, GMM based, assuming 4-th order serial correlation in residuals). JA: Japan, GE: Germany, FR: France, IT: Italy, CA: Canada.

Table 5. Model predictions

	Shocks to:			
	θ_H,θ_F χ_H,χ_F	θ_H,θ_F	χ_H,χ_F	Data (G7)
	(1)	(2)	(3)	(4)
Standard deviations (%)				
GDP	1.86	1.65	0.87	2.07
Investment	8.33	4.79	6.73	6.89
Net exports/GDP	1.04	0.24	1.03	1.14
Δ (Net foreign assets)	2.20	1.39	1.70	3.23
Δ (Net foreign bond assets)	5.30	3.71	3.78	2.20
Δ (Net foreign equity assets)	3.12	2.32	2.08	2.97
Current account	0.00	0.00	0.00	1.11
Net bond outflow	3.22	2.39	2.15	1.71
Net equity outflow	3.22	2.39	2.15	1.38
Terms of trade	1.93	0.86	1.74	3.77
Correlations with domestic GDP				
Net exports/GDP	-0.07	0.08	-0.13	-0.39
Δ (Net foreign assets)	-0.26	-0.31	-0.19	-0.22
Δ (Net foreign bond assets)	-0.24	-0.29	-0.16	-0.24
Δ (Net foreign equity assets)	0.23	0.27	0.13	-0.02
Current account	--	--	--	-0.40
Net bond outflow	-0.27	-0.29	-0.20	-0.22
Net equity outflow	0.27	0.29	0.20	-0.03
Terms of trade	-0.22	-0.54	-0.07	0.08
Autocorrelations				
GDP	0.59	0.55	0.75	0.74
Δ (Net foreign assets)	0.10	-0.02	0.20	-0.01
Δ (Net foreign bond assets)	0.02	-0.07	0.14	0.14
Δ (Net foreign equity assets)	-0.02	-0.09	0.09	0.02
Current account	--	--	--	0.64
Net bond outflow	0.05	-0.06	0.23	0.32
Net equity outflow	0.05	-0.06	0.23	0.23
Other correlations				
Δ (Gross foreign equity assets) & Δ (Gross foreign equity liabilities)	0.31	0.31	0.33	0.64
Δ (Net foreign equity assets) & Δ (Net foreign bond assets)	-0.99	-0.99	-0.99	-0.27
Net equity outflow & Net bond outflow	-1.00	-1.00	-1.00	-0.68
Steady state portfolio				
S	0.79	0.79	0.26	
B	0.26	0.26	-0.26	