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**Robert Kollmann,** Université de Paris XII and CEPR

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Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

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# ABSTRACT

## International Portfolio Equilibrium and the Current Account*

This paper analyses the determinants of international asset portfolios, using a neoclassical dynamic general equilibrium model with home bias in consumption. For plausible parameter values, the model explains the fact that typical investors hold most of their wealth in domestic assets (portfolio home bias). In the model, the current account balance (change in net foreign assets) is mainly driven by fluctuations in equity prices; the current account is predicted to be highly volatile and to exhibit low serial correlation; changes in a country's foreign equity assets and liabilities are predicted to be highly positively correlated. The paper constructs current account series that include external capital gains/losses, for 17 OECD economies. The behaviour of those series confirms the theoretical predictions.

JEL Classification: F2, F3 and G1
Keywords: consumption and portfolio home bias, current account and international portfolio holdings

Robert Kollmann
Department of Economics
University of Paris XII
61, Av. du Général de Gaulle
F-94010 Créteil Cedex
FRANCE

Tel: (33 6) 08 16 73 24
Email: robert_kollmann@yahoo.com

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# 1. Introduction

The liberalization of international capital markets in the 1980s has been accompanied by a rise in foreign capital flows, and in current account imbalances. However, typical investors continue to hold most of their wealth in domestic assets, and most of the capital stock in a given country is owned by local investors--despite the fact that international diversification reduces risk. E.g., among OECD countries, the ratio of foreign equity liabilities to the domestic physical capital stock ranged between 5% (Germany) and 14% (UK), in 1997 (see Table 1). That "portfolio home bias" is one of the key puzzles in international finance.

This paper shows that a *simple* neoclassical model with free capital flows can explain portfolio home bias, provided consumption home bias is incorporated, i.e. the fact that the bulk of private consumption consists of locally produced goods. The model is also broadly consistent with key features of the behavior of new current account measures that include external capital gains/losses.

The model assumes two countries, indexed by $i$=1,2, and two freely traded, non-storable goods. Country $i$ is inhabited by a representative household, and receives an endowment of good $i$. Endowments follow Markov processes. Each household consumes both goods, but has a preference for the local good, and thus devotes most of her spending to that good. In the baseline version of the model, households have constant relative risk aversion in terms of a CES aggregate of the two goods. The following assets can be traded: a bond, and two stocks, each of which is a claim to one of the endowments. The asset market is effectively complete.

Equilibrium portfolios hinge on the coefficient of relative risk aversion, and on the elasticity of substitution between domestic and imported goods. Estimates of these parameters suggest that domestic and imported goods are substitutes (in the sense that the cross-partial derivative of the utility function with respect to these goods is negative), but that the substitution elasticity between these goods does not exceed unity (at least not very much). Consider the effect of a rise in the good 1 endowment (received by country 1). Under consumption home bias, it is efficient to *lower* the locally consumed fraction of good 1 (in response to the endowment shock), if the two goods are substitutes. When the elasticity of substitution does not exceed unity, the good 1 price drops so strongly that the *value* of the good 1 endowment falls (relative to the value of the good 2 endowment); thus, it is optimal for country 1 to consume a smaller share of good 1, in states of the world in which the (relative) *value* of the dividend of the country 1 stock (=good 1 endowment) is lower. The local stock thus provides a hedge for variations in the optimal locally consumed endowment share--the optimal allocation can be implemented if each country holds a share of the local stock that *exceeds* the locally consumed endowment share. For plausible parameter values, the model generates a realistic degree of portfolio home bias.

Conceptually, a country's current account balance is the change of its net foreign assets, during a period. In the model, the current account is largely driven by fluctuations in equity prices; the current account is predicted to be highly volatile and to have low serial correlation. The intuition for the latter prediction is that, in equilibrium, a country's net asset position at date $t$ is a function of the vector of endowments at $t$; when endowment fluctuations are persistent (as assumed here), the current account is hence approximately i.i.d.

The current account series published by statistical agencies do *not* take into account capital gains/losses on external assets and liabilities--those official series only measure the net *flow* of external assets acquired by a country. To evaluate the predictions described in the preceding paragraph, the paper constructs current account series that include capital gains/losses, for 17 OECD economies, by taking first differences of new measures of net foreign assets (complied by BEA and IMF) that reflect market prices of foreign assets; those current account measures are highly volatile, and their autocorrelations are typically close to zero, which confirms the model predictions. The new current account measure, normalized by domestic output, is less volatile for the US than for other OECD countries. Calibrated versions of the model here capture this finding, and suggest that it is due to the fact that the US has less volatile output than the remaining OECD economies, and that its trade share is lower.

Empirically, there is a high positive correlation between changes in a country's foreign equity assets and changes in its external liabilities. This fact too is captured by the model, as the model predicts that equity prices and returns are highly positively correlated across countries, as a country's terms of trade are positively correlated with the *foreign* endowment.

This paper bridges two important strands in international macroeconomics and finance: the literature on international portfolio choice, and the literature on current accounts. [1]

Lucas' (1982) classic paper considers equity portfolios in a two-country world with tradable goods, and preferences that are identical across countries; in equilibrium, all households hold identical equity portfolios, as this permits full risk sharing.

In order to generate differences in portfolios across countries, Dellas and Stockman (1989) and Baxter et al. (1998) develop two-country models in which some consumption goods are *non-traded* (an extreme form of consumption home bias); however, *no* home bias is assumed for traded goods: preferences for tradables are postulated to be *identical* across countries;[2] those models predict that equities of non-traded good firms are held locally, while holdings of traded good equities are fully diversified internationally, which is counterfactual.[3] In reality, there are few goods (at a broad aggregation level) that are not traded. The model here assumes that *all* goods are tradable and are subject to home bias.

Obstfeld and Rogoff (2000) too consider a world in which all goods are traded; in their model, preferences are identical across countries, and consumption home bias arises because of transport costs for goods (by contrast, in paper here: consumption bias in *preferences*). These authors compute portfolios for the special case (which permits a closed form solution) in which relative risk aversion equals the inverse of the substitution elasticity between local and imported goods; in that case, realistic consumption and portfolio home bias only arises when the elasticity of substitution is large, and the risk aversion coefficient is implausibly low (0.2 or less). [4]

Several authors have argued that equity home bias is due to the non-traded nature of human capital,[5] and/or greater costs of investing abroad than locally (greater informational barriers or agency problems).[6] In order to focus sharply on the effects of consumption home bias, I assume a frictionless world in which all assets are traded. It remains to be seen whether the human capital/investment cost stories can explain the current account facts described above.

Several recent empirical studies have shown that capital gains/losses greatly affect (net) foreign asset positions (NFA), and noted that the new current account measure (change in

[1] For surveys of these literatures, see e.g. Dumas (1994) and Obstfeld and Rogoff (1996), respectively.

[2] In Dellas and Stockman (1989), utility is additively separable in non-tradables, and a term that depends on the vector of tradables produced by all countries; (sub-)utility from tradables is *identical* across all countries. Baxter et al. (1998) assume that domestic and foreign tradables are homogenous.

[3] Empirically, there is home bias for manufacturing equity (manufactured goods: traded); see, e.g., Kang and Stulz (1995) who document home bias in Japanese manufacturing; see also Kollmann (2006).

[4] Uppal's (1993) *one*-good model with transport costs too requires implausibly low risk aversion to generate equity home bias. Coeurdacier (2005) solves a two-good transport cost model with unrestricted risk aversions and substitution elasticities; equity home bias can arise if frictions in financial markets are assumed.

[5] When wage income is negatively correlated with profits, then domestic equity may be a better hedge against local wage fluctuations than foreign equity. Several studies argue that empirically this condition is met; e.g. Bottazzi et al. (1996), Heathcote and Perri (2003), Julliard (2004), Engel and Matsumoto (2005); for a divergent view, see Baxter and Jermann. (1997).

[6] See e.g. Van Nieuwerburgh and Veldkamp (2005), Ahearne et al. (2004), Tirole (2003), Stulz (2005).

NFA) can differ significantly from conventional measures.[7] *However, none of those previous papers has documented and analyzed quantitatively the cyclical behavior (volatility, serial correlation, correlation with output) of the new current account measure.*

Prior research has often viewed it as a stylized fact that current accounts are persistent and countercyclical, and sought to develop models consistent with those features (see, e.g., Bergin (2004), Obstfeld and Rogoff (1996) and the references therein). The current account measures that include capital gains/losses show little persistence (as mentioned above), and are much less countercyclical than conventional current account measures (the new measure for the US, 1977-2004, is acyclical). Also, prior theoretical analyses of current accounts typically assume that international financial markets are restricted to bonds, and thus incomplete; [8] by contrast, asset markets are (effectively) complete, in the model here.

For tractability, previous macroeconomic analyses of portfolio home bias have often used models with restrictive assumptions regarding preferences (see above), and/or two-period models. This paper uses a *numerical* solution technique that allows to dispense with these features. It exploits the fact that a sequence of portfolios supports an efficient equilibrium if and only if, at the beginning of each date $t$, a household's financial wealth $(F_t)$ equals the present value $(W_t)$ of the household's efficient consumption spending at dates $s \geq t$, evaluated using the Arrow-Debreu pricing kernel. Taking a linear approximation of the condition $F_t = W_t$ in terms of the date $t$ vector of endowments yields a system of equations that can be solved for portfolio holdings at the end of *t-1.* It would be straightforward to apply this method to more complex models, provided asset markets are effectively complete.

Section 2 describes the portfolio and current account data. Sect. 3 presents the model and the solution method. Sections 4 and 5 discuss model predictions. Section 6 concludes.

## 2. Empirical evidence: equity and consumption home bias; current accounts

### 2.1. Home bias

Foreign equity holdings have grown during the past 30 years, but equity home bias remains sizable. Table 1 documents this for a sample of 18 OECD economies. Based on the Kraay et al. (2005) dataset (that reports capital stocks and external assets for 1966-1997), Col. 1 reports the ratio of a country's foreign equity liability, FEL (defined as foreign direct investment (FDI) liabilities plus portfolio equity liabilities) divided by the physical capital stock in the country, in 1997; that ratio ranged between 5% (Germany, Italy) and 14% (Switzerland, UK), with a median value of 7%. The corresponding median ratio was 2% in 1973.

Cols. 2-5 report ratios of countries' FEL and foreign equity assets, FEA, to GDP, in 1997 and 2003, using FEL and FEA data taken from the IMF's IIP (international investment positions) database. (FEA: sum of FDI and portfolio equity assets.) The median FEL/GDP ratio was 0.32 [0.56] in 1997 [2003]. With two exceptions (Switzerland, Netherlands), the FEL/GDP and FEA/GDP ratios are smaller than unity. The physical capital stock/GDP ratio is in the range between 3 and 5, in industrialized economies. This suggests that, in almost all countries, markedly less than one third of the domestic physical capital stock is owned by foreigners.

[7] See i.a. Kraay et al. (2005), Lane and Milesi-Ferretti (2001, 2005), and Gourinchas and Rey (2005); those 4 papers also present independent estimates of external positions. For descriptions and analyses of valuation effects, see also Kim (2002), Tille (2003, 2004), Hau and Rey (2004), Devereux and Saito (2005), Ghironi et al. (2005) and Backus et al. (2005). Cantor and Mark (1988) provide 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).

[8] A notable exception is Mercereau (2003, 2005) who studies a model of a small open economy with trade in stocks and bonds; empirically, that model performs better than a bonds-only structure.

"Consumption home bias" refers to the fact that consumption incorporates a larger share of domestic inputs than of imported inputs. The ratio of *total* imports ($M$) to (private) consumption ($C$) ranged between 19% (US) and 113% (Netherlands), in 2003 (median ratio: 55%). However, the $M/C$ ratio overstates the imported component of consumption, as $M$ includes foreign goods that are used for physical investment *(I)*, or incorporated into government consumption (G) and exports ($X$). Under the assumption that the imported content of $C$ is similar to the imported content of $I+G+X$, the ratio $M/[C+I+G+X]$ is an estimate of the imported component of $C$. Col. 6 in Table 1 shows that $M/[C+I+G+X]$ ranged between 12% (US) and 35% (Netherlands), in 2003, with a median value of 22%.

## 2.2. Current accounts, international business cycles

Tables 2 shows descriptive statistics for the US current account, output and real exchange rate; the current account is based on 1976-2004 portfolio data from BEA (2005). Table 3 shows current account statistics for 17 OECD countries based on IIP data; for most countries, the IIP sample begins in the 1980s, and ends in 2003. (Table 3 also shows results for the US; the IIP US sample is shorter, 1980-03; results for the US are comparable across the BEA and IIP series.) The BEA and IIP databases valuate external assets and liabilities at market prices. All data in Tables 2 and 3 are annual.

Conceptually, a country's current account balance is the change of its net foreign asset holdings (NFA), during a period (Obstfeld and Rogoff (1996, p.5)). The current account series published by statistical agencies do not conform to this notion: those series only measure the net *flow* of assets acquired by a country, and do *not* take into account external capital gains/losses (on assets acquired in the past).

This paper studies a current account measure that includes external capital gains/losses: the first difference of the BEA and IIP NFA series (that reflect market prices).

Let $NFA_{t+1}$, $NB_{t+1}$, $FEA_{t+1}$ and $FEL_{t+1}$ be a country's NFA, net foreign bond holdings, foreign equity assets and foreign equity liabilities, respectively, at the end of year $t$, with $NFA_{t+1} \equiv FEA_{t+1} - FEL_{t+1} + NB_{t+1}$.[9] The measure of the current account considered here is:

$$CA_t \equiv \Delta NFA_{t+1} = ECA_t + BCA_t, \quad \text{where } ECA_t \equiv \Delta FEA_{t+1} - \Delta FEL_{t+1}, \quad BCA_t \equiv \Delta NB_{t+1}, \qquad (1)$$

with $\Delta x_{t+1} \equiv x_{t+1} - x_t$, for any variable $x_t$. $ECA_t$ and $BCA_t$ are the equity and bond components of the current account, respectively. Tables 2 and 3 also consider the conventional current account measure (taken from IFS) that does *not* include external capital gains/losses, denoted $CA_t^{bkv}$.[10]

The model here abstracts from investment and government purchases; unless stated otherwise, my empirical "output" measure ($Y_t$) is GDP net of investment and government purchases ($Y_t \equiv GDP_t - I_t - G_t$). For each country, I construct a measure of "foreign" output that equals total output in 20 other OECD economies.

The data sources provide assets and liabilities in current US dollars. In Table 2, the US current account and its components are expressed in units of US output, and normalized by a fitted geometric trend of US output. In Table 3, country *i*'s current account is expressed in units of foreign output, and normalized by a geometric trend fitted to *i*'s output (in units of foreign output); the use of foreign output as numéraire for current accounts (in Table 3) is motivated

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9 The empirical $NB_{t+1}$ series is constructed as $NB_{t+1} \equiv NFA_{t+1} - FEA_{t+1} + FEL_{t+1}$ from $NFA_{t+1}, FEA_{t+1}, FEL_{t+1}$ data.

10 The superscript *bkv* stands for "bookvalue": $CA_t^{bkv}$ is the first difference of a NFA measure that valuates assets acquired before $t$ at *bookvalues*.

by the model calibrations below.[11] (The empirical statistics in Table 3 are robust to using country *i* output or US output as numéraires).

Output and real exchange rates are logged.[12] Unless stated otherwise, all statistics are based on HP-filtered series (smoothing parameter: 400). See the Appendix for more detailed data definitions.

*Behavior of the US current account, BEA data (Table 2)*

For the US, the standard deviation of the (HP filtered) new current account measure $CA_t$ (3.48%) is larger than that of output $GDP_t - I_t - G_t$ (1.57%); the autocorrelation of $CA_t$ (0.04), and the correlations of $CA_t$ with domestic output (0.01) and with foreign output (0.00) are close to zero and *not* statistically significant; see Cols. 1-4, Panel (a) of Table 2. Similar results obtain when $GDP_t$ is used as the output measure (Cols. 5-7, Panel (a)), and when the current account is *not* HP filtered (Panel (b)).[13] The US real exchange rate, $RER_t$, is more volatile than $CA_t$; output and the real exchange rate are persistent (standard deviation of $RER_t$: 9.99%; autocorrelations of output and $RER_t$: 0.67, 0.76).

The behavior of the conventional current account measure $CA_t^{bkv}$ differs markedly from that of $CA_t$: its standard deviation (1.47%) is less than half of that of $CA_t$; $CA_t^{bkv}$ fluctuations are persistent (autocorrelation: 0.78). The correlations of $CA_t$ and $CA_t^{bkv}$ with domestic $GDP_t - I_t - G_t$ are both close to zero. (The correlation of $CA_t^{bkv}$ with domestic $GDP_t$ (-0.41) is negative, and highly statistically significant; the correlation of $CA_t$ with $GDP_t$ (-0.21) is likewise negative, but smaller in absolute value, and statistically insignificant.)

Prior research has often viewed it as a stylized fact that current accounts are persistent and countercyclical, and sought to develop models consistent with those features (see, e.g., Bergin (2004), Obstfeld and Rogoff (1996) and the references therein). The US $CA_t$ measure shows little persistence, and is acyclical (or, at least, much less countercyclical than conventional current account measures).

Fluctuations in the US $CA_t$ series are mainly driven by its equity component, $ECA_t$: the standard deviation of $ECA_t$ (3.10%) is markedly larger than that of the bond component $BCA_t$ (1.77%); the correlation between $ECA_t$ and $BCA_t$ is close to zero. Changes in US foreign equity assets and liabilities $(\Delta FEA_t, \Delta FEL_t)$ are more volatile than $ECA_t$, and highly positively correlated with each other (standard deviations of $\Delta FEA_t$ and of $\Delta FEL_t$, and correlation: 6.5%, 5.3%, 0.88, respectively). $ECA_t, \Delta FEA_t, \Delta FEL_t$ are basically uncorrelated with output, and their autocorrelations are low.

*Current account behavior in 17 OECD economies, IIP data (Table 3)*

The results for the other OECD countries show many similarities to the US results: for *all* countries, $CA_t$ is more volatile than output, and more volatile than $CA_t^{bkv}$; in nearly all cases, changes in a country's foreign equity assets and liabilities are positively correlated, and $CA_t^{bkv}$

11 Versions of the theoretical model that assume two countries of unequal size assume that output of the *larger* country is used as numéraire.

12 A country's real exchange rate $(RER_t)$ is a weighted average of consumption based bilateral exchange rates vis-à-vis the other OECD countries. A rise in a country's $RER_t$ represents a real depreciation of its currency.

13 When *GDP* is used as the output measure, then the *CA* series is normalized by trend *GDP*, and the standard deviation of the (normalized) *CA* series is thus *smaller* than when the output measure *GDP-I-G* is used.

is highly persistent. For most countries, the autocorrelation of $CA_t$ (and of its components) is close to zero, and statistically insignificant (at a 10% level); the median (and mean) autocorrelation of $CA_t$ is -0.08.[14]

The median and mean values of the correlations between $CA_t$ and its components with domestic and foreign *GDP-I-G* are likewise close to zero (Panel (a), Table 3). Those correlations vary widely across countries, but are mostly not statistically significant; e.g. the correlations between $CA_t$ and domestic *GDP-I-G* range between -0.55 and 0.69, with a standard deviation (across countries) of 0.41 (median correlation: 0.03).[15]

A striking difference between the US and the other OECD countries is that current accounts (and their components) are markedly more volatile in the non-US countries (median standard deviation of non-US $CA_t$: 7.20%).

# 3. The model

## 3.1. Goods and preferences

The economy starts at date $t=0$ and lasts until $T>0$. Time is discrete. There are two countries, $i=1,2$, each inhabited by a representative household. Each country receives an endowment of a distinct traded good. $Y_{i,t}>0$ is i's endowment at *t*. Let $y_t \equiv (Y_{1,t}, Y_{2,t})'$. $\ln(y_t)$ follows the process

$$\ln(y_t) = \ln(y_{t-1}) + \varepsilon_t, \tag{2}$$

where $\varepsilon_t \equiv (\varepsilon_{1,t}, \varepsilon_{2,t})'$ is a normally distributed (vector) white noise.

Country $i$'s preferences are described by

$$E_0 \sum_{t=0}^{T} \beta^t U(C_t^i), \quad \text{with } U(C) = (1-\sigma)^{-1}[C^{1-\sigma} - 1], \ \sigma > 0 \tag{3}$$

where $U(C)$ is a utility function, and $C_t^i$ is an index of *i*'s consumption at $t$:

$$C_t^i = [\alpha_i^{1/\phi}(c_{i,t}^i)^{(\phi-1)/\phi} + (1-\alpha_i)^{1/\phi}(c_{j,t}^i)^{(\phi-1)/\phi}]^{\phi/(\phi-1)} \text{ with } j \neq i \text{ and } 0.5 < \alpha_i < 1, \ \phi > 0. \tag{4}$$

$c_{j,t}^i$ is $i's$ consumption of good $j$.[16] The parameter $\phi$ is the elasticity of substitution between goods. Note that the local good has greater weight in the consumption index than the imported good--i.e. there is "consumption home bias".

## 3.2. Markets, budget constraints, decision problems

There is trade in goods, in stocks that represent shares in the endowment processes, and in a one-period riskless bond. Good 1 is used as a numéraire (the bond is denominated in the numéraire). Country *i* household faces the budget constraint

$$\sum_{j=1}^{2} P_{j,t} S_{j,t+1}^i + A_{t+1}^i + \sum_{j=1}^{2} p_{j,t} c_{j,t}^i = \sum_{j=1}^{2} S_{j,t}^i (P_{j,t} + p_{j,t}\delta_{j,t}) + A_t^i (1+r_t), \text{ for } 0 \le t \le T \tag{5}$$

where $p_{j,t}$ is the price of good $j$ (with $p_{1,t} \equiv 1$) and $P_{j,t}$ is the (ex-dividend) price of stock *j* in period *t*; $S_{j,t+1}^i$ is the number of shares of stock *j* owned by country *i*, at the end of period *t*

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[14] Faruquee and Lee (2005) confirm some of the key findings here for a sample of 100 countries: in that larger sample too, *CA* is markedly more volatile and less persistent than conventional current accounts.

[15] Correlations of *CA* with domestic GDP are mostly negative--only about half of the negative correlations are statistically significant (see Panel (b), Table 3); the correlations of $CA^{bkv}$ with domestic *GDP* too are mostly negative, but are larger in absolute value, and are almost all highly statistically significant; see Panel (b), Table 3.

[16] Model variants with $\sigma=1$ and $\phi=1$ use $U(C_t^i)=\ln(C_t^i)$ and $C_t^i = (c_{i,t}^i/\alpha_i)^{\alpha_i}(c_{j,t}^i/(1-\alpha_i))^{1-\alpha_i}$, respectively (these expressions are the limits of (3) and (4) for $\sigma \to 1$ and $\phi \to 1$).

(beginning of $t$+1), while $A^i_{t+1}$ represents $i's$ bond holdings at the end of t. $r_t$ is the interest rate between $t-1$ and $t$. Country $i$'s initial stock and bond holdings are exogenously given by $S^i_{1,0}, S^i_{2,0}, A^i_0(1+r_0)$. The supply of each type of share is unity: $S^i_{j,t}=1$ represents 100% ownership of the "tree" that generates the good $j$ endowment.

At $t$, the choice variables of households 1 and 2 are: $D^1_t=(S^1_{1,t+1},S^1_{2,t+1},A^1_{t+1},c^1_{1,t},c^1_{2,t})$ and $D^2_t=(S^2_{1,t+1},S^2_{2,t+1},A^2_{t+1},c^2_{1,t},c^2_{2,t})$, respectively. Household $i$ selects a process $\{D^i_t\}^T_{t=0}$ that maximizes (3) subject to (5) and to the (no-Ponzi) condition that final wealth has to be zero:

$$A^i_{T+1} + \sum_{j=1}^{2} P_{j,T} S^i_{j,T+1} = 0. \qquad (6)$$

The following equations are first-order conditions of countries' decision problems:

$$1 = E_t \rho^i_{t,t+1}(p_{j,t+1}Y_{j,t+1}+P_{j,t+1})/P_{j,t} \quad \text{for } i=1,2;\ \ j=1,2;\ \ 0\le t\le T-1. \qquad (7)$$

$$1=(1+r_{t+1})E_t\rho^i_{t,t+1} \quad \text{for } i=1,2;\ \ j=1,2;\ \ 0\le t\le T-1. \qquad (8)$$

$$p_{2,t} = \{[\alpha_1/(1-\alpha_1)][c^1_{2,t}/c^1_{1,t}]\}^{-1/\phi} = \{[(1-\alpha_2)/\alpha_2][c^2_{2,t}/c^2_{1,t}]\}^{-1/\phi} \quad \text{for } 0\le t\le T. \qquad (9)$$

$\rho^i_{t,t+s} \equiv \beta^s[\partial U(C^i_{t+s})/\partial c^i_{1,t+s}]/[\partial U(C^i_t)/\partial c^i_{1,t}]$ (for $0\le t,t+s\le T$) is $i$'s marginal rate of substitution between consumption of good 1 at $t$ and at $t+s$.

### 3.3. Equilibrium

Given initial values $S^1_{1,0}, S^1_{2,0}, A^1_0(1+r_0), S^2_{1,0}=1-S^1_{1,0}, S^2_{2,0}=1-S^1_{2,0}, A^2_0=-A^1_0$, a competitive equilibrium is a process $\{c^1_{1,t},c^1_{2,t},c^2_{1,t},c^2_{2,t},p_{2,t},r_{t+1},P_{1,t},P_{2,t},S^1_{1,t+1},S^1_{2,t+1},A^1_{t+1},S^2_{1,t+1},S^2_{2,t+1},A^2_{t+1}\}^T_{t=0}$ with these properties:

(i) (5)-(9) hold.

(ii) Markets clear: $c^1_{j,t}+c^2_{j,t}=Y_{j,t}$; $S^1_{j,t+1}+S^2_{j,t+1}=1$; $A^1_{t+1}+A^2_{t+1}=0$ for $j$=1,2 and $0\le t\le T$. (10)

### 3.4. Efficient allocations

This paper focuses on equilibria that are Pareto efficient (i.e. that ensure full risk sharing)--henceforth the term "equilibrium" refers to an *efficient* equilibrium. An efficient allocation is the solution of the following social planning problem:

$$Max \quad (1-\Lambda)E_0\sum_{s=0}^{T}\beta^s U(C^1_s) + \Lambda E_0\sum_{s=0}^{T}\beta^s U(C^2_s) \ \text{ w.r.t. } \{c^1_{1,t},c^1_{2,t},c^2_{1,t},c^2_{2,t}\}^T_{t=0}$$

$$\text{s.t. } c^1_{1,t}+c^2_{1,t}=Y_{1,t},\ c^1_{2,t}+c^2_{2,t}=Y_{2,t} \text{ at } 0\le t\le T, \qquad (11)$$

for some constant $0\le\Lambda\le1$. [17] A key first-order condition of this problem is that the marginal utility of each good is perfectly correlated across countries,

$$(1-\Lambda)\partial U(C^1_t)/\partial c^1_{j,t} = \Lambda\partial U(C^2_t)/\partial c^2_{j,t}, \text{ for } j=1,2 \text{ and } 0\le t\le T. \qquad (12)$$

(11),(12) uniquely pin down the efficient consumptions $c^1_{1,t},c^1_{2,t},c^2_{1,t},c^2_{2,t}$.

### 3.5. Decentralizing an efficient allocation

Let $\{c^{1*}_{1,t}(\Lambda),c^{1*}_{2,t}(\Lambda),c^{2*}_{1,t}(\Lambda),c^{2*}_{2,t}(\Lambda)\}^T_{t=0}$ be an efficient allocation, for some $\Lambda>0$. I now show how to construct a process $\{p^*_{2,t}(\Lambda),r^*_{t+1}(\Lambda),P^*_{1,t}(\Lambda),P^*_{2,t}(\Lambda),S^{1*}_{1,t+1},S^{1*}_{2,t+1},A^{1*}_{t+1},S^{2*}_{1,t+1},S^{2*}_{2,t+1},A^{2*}_{t+1}\}^T_{t=0}$, such that $\{c^{1*}_{1,t}(\Lambda),c^{1*}_{2,t}(\Lambda),c^{2*}_{1,t}(\Lambda),c^{2*}_{2,t}(\Lambda),p^*_{2,t}(\Lambda),r^*_{t+1}(\Lambda),P^*_{1,t}(\Lambda),P^*_{2,t}(\Lambda),S^{1*}_{1,t+1},S^{1*}_{2,t+1},A^{1*}_{t+1},S^{2*}_{1,t+1},S^{2*}_{2,t+1},A^{2*}_{t+1}\}^T_{t=0}$ is an equilibrium, for appropriate assignments of initial asset holdings $S^{i*}_{j,0}, A^{i*}_0(1+r^*_0)$, $i$=1,2; $j$=1,2.

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[17] When $\Lambda=0$ or $\Lambda=1$, the social planning problem is trivial: one country consumes the entire endowments of both goods; the subsequent discussion assumes $0<\Lambda<1$.

All variables pertaining to an efficient equilibrium are designed by an asterisk; equilibrium consumptions and prices are written as functions of $\Lambda$.

$p^*_{2,t}(\Lambda), r^*_{t+1}(\Lambda)$ are found by substituting the efficient consumptions into the first-order conditions (8), (9): $p^*_{2,t}(\Lambda)=\{\frac{\alpha_1}{1-\alpha_1}[c^{1*}_{2,t}(\Lambda)/c^{1*}_{1,t}(\Lambda)]\}^{-1/\phi}$, $(1+r^*_{t+1}(\Lambda)) = 1/[E_t\rho^*_{t,t+1}(\Lambda)]$, where $\rho^*_{t,t+s}(\Lambda)$ is the Arrow-Debreu pricing kernel: $\rho^*_{t,t+s}(\Lambda)\equiv\rho^{1*}_{t,t+s}(\Lambda)=\rho^{2*}_{t,t+s}(\Lambda)$. If agents can freely dispose of stocks, then stock prices are zero at the terminal date: $P^*_{j,T}=0$. Iterating (7) forward, using $P^*_{j,T}=0$ gives: $P^*_{j,t}(\Lambda)=E_t\sum_{s=1}^{T-t}\rho^*_{t,t+s}(\Lambda)p^*_{j,t+s}(\Lambda)Y_{j,t+s}$ for $j=1,2$, $0\leq t\leq T-1$.

Let $e^{i*}_t(\Lambda)\equiv\sum_{j=1}^{2} p^*_{j,t}(\Lambda)c^{i*}_{j,t}(\Lambda)$ denote $i$'s efficient consumption spending at $t$. The equilibrium portfolios $\{S^{1*}_{1,t+1},S^{1*}_{2,t+1},A^{1*}_{t+1},S^{2*}_{1,t+1},S^{2*}_{2,t+1},A^{2*}_{t+1}\}_{t=-1}^{T}$ have to satisfy the budget constraint

$$\sum_{j=1}^{2} S^{i*}_{j,t+1}P^*_{j,t}(\Lambda)+A^{i*}_{t+1}+e^{i*}_t(\Lambda)=\sum_{j=1}^{2} S^{i*}_{j,t}\widetilde{P^*_{j,t}}(\Lambda)+A^{i*}_t(1+r^*_t(\Lambda)) \text{ for i=1,2 and } 0\leq t\leq T, \quad (13)$$

where $\widetilde{P^*_{j,t}}(\Lambda)\equiv p^*_{j,t}(\Lambda)Y_{j,t}+P^*_{j,t}(\Lambda)$. Let $W^{i*}_t(\Lambda)\equiv E_t\sum_{s=0}^{T-t}\rho^*_{t,t+s}(\Lambda)e^{i*}_{t+s}(\Lambda)$ denote the present value (at $t$) of $i$'s efficient consumption spending $\{e^{i*}_{t+s}\}_{s=0}^{T-t}$. (13) holds if and only if $W^{i*}_t(\Lambda)$ equals $i$'s wealth at $t$:

$$W^{i*}_t(\Lambda) =\sum_{j=1}^{2} S^{i*}_{j,t}\widetilde{P^*_{j,t}}(\Lambda) +A^{i*}_t(1+r^*_t(\Lambda)) \quad \text{for } 0\leq t\leq T. \quad (14a)$$

A proof of the equivalence between (13) and (14a) can be based on Section B of Kollmann (2005b) (where a closely related model is solved), and on Campbell and Viceira (2002, Ch. 5.2). When $\{S^{1*}_{1,t+1},S^{1*}_{2,t+1},A^{1*}_{t+1}\}_{t=-1}^{T}$ satisfies (14a) for $i$=1, then $\{S^{2*}_{1,t+1},S^{2*}_{2,t+1},A^{2*}_{t+1}\}_{t=-1}^{T}$ with $S^{2*}_{j,t+1}=1-S^{1*}_{j,t+1}$ ($j$=1,2) and $A^{2*}_{t+1}=-A^{1*}_{t+1}$ satisfies (14a) for $i$=2, and vice versa.

$c^{i*}_{j,t}(\Lambda), p^*_{2,t}(\Lambda)$ and $e^{i*}_t(\Lambda)$ are time-invariant functions of $y_t$: $c^{i*}_{j,t}(\Lambda)=c^{i*}_j(y_t,\Lambda)$, $p^*_{2,t}(\Lambda)=p^*_2(y_t,\Lambda)$, $e^{i*}_t(\Lambda)=e^{i*}(y_t,\Lambda)$. Thus, $r^*_t(\Lambda)$ is a time-invariant function of $y_{t-1}$, $r^*_t(\Lambda)=r^*(y_{t-1},\Lambda)$, while $W^{i*}_t(\Lambda)$ and $\widetilde{P^*_{j,t}}(\Lambda)$ are functions of $\Lambda, y_t$ and $t$: $W^{i*}_t(\Lambda)=W^{i*}(y_t,\Lambda,t)$, $\widetilde{P^*_{j,t}}(\Lambda)=\widetilde{P^*_j}(y_t,\Lambda,t)$. (14a) can thus be written as:

$$W^{i*}(y_t,\Lambda,t) = \sum_{j=1}^{2} S^{i*}_{j,t}\widetilde{P^*_j}(y_t,\Lambda,t) + A^{i*}_t(1+r^*(y_{t-1},\Lambda)) \quad \text{for } 0\leq t\leq T. \quad (14b)$$

Any initial portfolio $S^{i*}_{1,0}, S^{i*}_{2,0}, A^{i*}_0(1+r^*_0)$ that satisfies (14b) for $t$=0 is suitable for equilibrium:

$$W^{i*}(y_0,\Lambda,0) =\sum_{j=1}^{2} S^{i*}_{j,0}\widetilde{P^*_j}(y_0,\Lambda,0) + A^{1*}_0(1+r^*_0)\,. \quad (14c)$$

The portfolio $S^{i*}_{1,t}, S^{i*}_{2,t}, A^{i*}_t$ (for $0<t\leq T$) is chosen at $t$–1, i.e. *before* $y_t$ is known. In general, there are no values of $S^{i*}_{1,t}, S^{i*}_{2,t}, A^{i*}_t$ such that (14b) holds exactly, for *any* realization of $y_t$. Here, I solve for $S^{i*}_{1,t}, S^{i*}_{2,t}, A^{i*}_t$ that ensure that a first-order Taylor expansion of (14b) (with respect to $y_t$) holds for arbitrary $y_t$. That portfolio has to satisfy the following three equations:

$$W^{i*}(\overline{y_t},\Lambda,t)=\sum_{j=1}^{2} S^{i*}_{j,t}\widetilde{P}^*_j(\overline{y_t},\Lambda,t)+A^{i*}_t(1+r^*(y_{t-1},\Lambda)), \quad (15a)$$

$$D_1W^{i*}(\overline{y_t},\Lambda,t) =\sum_{j=1}^{2} S^{i*}_{j,t}D_1\widetilde{P}^*_j(\overline{y_t},\Lambda,t),\ D_2W^{i*}(\overline{y_t},\Lambda,t)=\sum_{j=1}^{2} S^{i*}_{j,t}D_2\widetilde{P}^*_j(\overline{y_t},\Lambda,t), \quad (15b)$$

where $D_kW^{i*}(\overline{y_t},\Lambda,t)$ and $D_k\widetilde{P}^*_j(\overline{y_t},\Lambda,t)$ (for $k$=1,2) are the derivatives of $W^{i*}(\overline{y_t},\Lambda,t)$ and $\widetilde{P}^*_j(y_t,\Lambda,t)$ with respect to $Y_{k,t}$, evaluated at the endowment vector $\overline{y_t}$. Below, I use the point of linearization $\overline{y_t}=y_{t-1}$. The discrete time model can be viewed as an approximation to a continuous time model; in continuous time, the solution here would be exact. [18] As shown in the Appendix, equilibrium bond holdings are zero ($A_t^{i*}=0$), when the period utility exhibits constant relative risk aversion (CRRA), as assumed in the baseline model (see (3)). [19]

### 3.6. Characterizing efficient equilibria for exogenous initial asset holdings

The analysis below assume that, initially, bond holdings are zero and each country fully owns the local stock: $A_0^i=0, S_{i,0}^i=1$ for $i$=1,2. It follows from (14c) that an equilibrium exists, relative to those initial holdings, if there is a value of $\Lambda$ for which $W^{1*}(\Lambda, y_0, 0) = \widetilde{P_1^*}(\Lambda, y_0, 0)$. This pins down $\Lambda$. [20]

## 4. Equilibrium portfolios in a two-periods economy ($T$=1)

This Section considers the two-period case, as analytical results can be derived for that case.

### 4.1. Analytical results

With CRRA utility, $A_1^{i*}=0$ holds, and when $T$=1 (14b) becomes:

$$c_1^{1*}(y_1,\Lambda)+p_2^*(y_1,\Lambda)c_2^{1*}(y_1,\Lambda) = S_1^{1*}Y_{1,1}+S_2^{1*}p_2^*(y_1,\Lambda)Y_{2,1}, \text{ for } i=1, t=1, \tag{16}$$

where $S_j^{1*}\equiv S_{j,1}^{1*}$. Let $\mu^{i*}(y_t,\Lambda)\equiv c_i^{i*}(y_t,\Lambda)/Y_{i,t}$ and $v^*(y_t,\Lambda)\equiv Y_{1,t}/[Y_{2,t}p_2^*(y_t,\Lambda)]$ denote, respectively, the efficient locally consumed share of good $i$ and the ratio of the country 1 endowment, divided by the value of the country 2 endowment. Dividing (16) by $p_2^*(y_1,\Lambda)Y_{2,1}$ gives:

$$\mu^{1*}(y_1,\Lambda)v^*(y_1,\Lambda)+[1-\mu^{2*}(y_1,\Lambda)] = S_1^{1*}v^*(y_1,\Lambda)+S_2^{1*}. \tag{17}$$

A linear approximation of (17), around $\overline{y_1}=y_0$ gives:

$$\widehat{\mu_1^{1*}}\,\overline{\mu_1^{1*}}+\overline{\mu_1^{1*}}\,\widehat{v_1^*}-\widehat{\mu_1^{2*}}\,\overline{\mu_1^{2*}}/\overline{v_1^*} = S_1^{1*}\widehat{v_1^*}, \tag{18}$$

where $\widehat{x_1}\equiv(x(y_1)-\overline{x_1})/\overline{x_1}$, denotes the relative deviation of $x(y_1)$ from $\overline{x_1}\equiv x(\overline{y_1})$, for any quantity $x(y_1)$ that is a function of $y_1$. Assume, without loss of generality, that the locally consumed fraction of country $i$'s endowment, at $t$=0, equals the home bias preference parameter $\alpha_i$ (see (4)): $\alpha_i=\mu^{i*}(y_0,\Lambda)$; in other terms (noting that $\overline{\mu_1^{i*}}\equiv\mu^{i*}(\overline{y_1},\Lambda)=\mu^{i*}(y_0,\Lambda)$) assume:

$$\alpha_i=\overline{\mu_1^{i*}} \quad \text{for i=1,2.} \tag{19}$$ [21]

(9) implies: $[1-\mu^{2*}(y_1,\Lambda)]/\mu^{2*}(y_1,\Lambda)=((1-\alpha_1)(1-\alpha_2)/(\alpha_1\alpha_2))\mu^{1*}(y_1,\Lambda)/[1-\mu^{1*}(y_1,\Lambda)]$; hence, $\mu^{2*}(y_1,\Lambda)$ is a decreasing function of $\mu^{1*}(y_1,\Lambda)$. A linear approximation yields (using (19)):

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[18] In continuous-time complete-markets models, portfolios are set in such a way that the diffusion term of agents' wealth equals the diffusion term of the present value of efficient consumption spending--this ensures that wealth supports efficient spending; see, e.g., Campbell and Viceira (2002, Sect. 5.2) and Kollmann (2005b; 2006, p.271). The logic behind (15a) is analogous: up to a first order approximation, (15a) ensures that the date $t$ innovation to financial wealth equals the innovation to the present value of efficient spending.

[19] Note that, as markets are (effectively) complete, one can solve for prices and quantities *before* solving for portfolios. Under incomplete markets, prices, quantities *and* portfolios would have to determined *jointly*; see, e.g., Evans and Hnatkoskva (2005) and Hnatkovska (2005) who solve international finance models with incomplete markets, using second order approximations.

[20] $\Lambda=\frac{1}{2}$ holds when $\alpha_1=\alpha_2$ and the distribution of endowments is symmetric across countries.

[21] (19) is merely used to simplify the presentation. One can ensure that (19) holds, using suitable transformations of utility functions and normalizations of physical quantities; see Appendix. When $\alpha_i\neq\overline{\mu_1^{i*}}$, then the key portfolio equations (24a)-(25) below continue to hold, except that $\alpha_i$ has to be replaced by $\overline{\mu_1^{i*}}$, in those equations.

$$\widehat{\mu_1^{2*}} = -\widehat{\mu_1^{1*}}\,(1-\alpha_2)/(1-\alpha_1)\,. \tag{20}$$

Substitution of (20) into (18) (using (19)) produces:

$$\widehat{\mu_1^{1*}}\,\left[\alpha_1 + (\alpha_2/\overline{v_1^*})(1-\alpha_2)/(1-\alpha_1)\right] + \alpha_1 \widehat{v_1^*} = S_1^{1*}\,\widehat{v_1^*}\,. \tag{21}$$

As initial foreign asset holdings are zero, the intertemporal budget constraint (14b) implies that the present value of net exports is zero: $NX^{1*}(y_0,\Lambda)+E_0\rho_{0,1}^* NX^{1*}(y_1,\Lambda)=0$, where $NX^{1*}(y_t,\Lambda) \equiv (1-\mu^{1*}(y_t,\Lambda))Y_{1,t} - (1-\mu^{2*}(y_t,\Lambda))p^*(y_t,\Lambda)Y_{2,t}$ are country 1 net exports at $t$. As (log) endowments follow random walks (see (2)), net exports at $t$=0 are zero, up to a (log)linear approximation: $NX^{1*}(y_0,\Lambda)\cong 0$. Thus,

$$(1-\alpha_1)\overline{v_1^*} - (1-\alpha_2) = 0\,.\text{[22]} \tag{22}$$

(22) implies that (21) can be expressed as:

$$\widehat{\mu_1^{1*}}\,(\alpha_1+\alpha_2) + \alpha_1\widehat{v_1^*} = S_1^{1*}\,\widehat{v_1^*}. \tag{23}$$

With CRRA utility, the functions $\mu^{1*}(y_1,\Lambda)$ and $v^*(y_1,\Lambda)$ are homogenous of degree 0 in $y_1$, and thus, $\mu^{1*}(y_1,\Lambda)$ and $v^*(y_1,\Lambda)$ can be expressed as functions of the ratio of the endowments $z_1 \equiv Y_{1,1}/Y_{2,1}$. A linear approximation of the risk sharing condition (12) gives (using (19), (22); see Appendix):

$$\widehat{\mu_1^{1*}} = \Gamma_\mu\,\widehat{z_1}\,,\text{ with } \Gamma_\mu \equiv -\frac{(1-\sigma\phi)(1-\alpha_1)(1-\alpha_1-\alpha_2)}{(1-\sigma\phi)(1-\alpha_1-\alpha_2)^2+\sigma\phi}\,. \tag{24a}$$

The $t$=1 price of good 2 is: $p_{2,1}^* = \{\frac{\alpha_1}{1-\alpha_1}[(1/z_1)(1-\mu_1^{2*})/\mu_1^{1*})]\}^{-1/\phi}$. Linearization of $v_1^* = z_1/p_{2,1}^*$ gives:

$$\widehat{v_1^*} = \Gamma_v\,\widehat{z_1}\,,\ \text{with } \Gamma_v \equiv [\phi - 1 - \Gamma_\mu \frac{(1-\alpha_1-\alpha_2)}{(1-\alpha_1)}]/\phi. \tag{24b}$$

The efficient allocation cannot be supported by existing assets when $\Gamma_\mu \neq 0, \Gamma_v = 0$, i.e. when the efficient locally consumed fraction of endowments at $t$=1 is affected by endowment shocks, while the ratio of the *values* of the endowments is unaffected. Portfolios are indeterminate when $\Gamma_\mu = 0, \Gamma_v = 0$. In all other cases the unique solution for the locally owned share of stock 1 is (from (23)):

$$S_1^{1*} = \alpha_1 + (\alpha_1+\alpha_2)\,\Gamma_\mu\,/\Gamma_v\,. \tag{25}$$

A similar reasoning shows that $S_2^{2*} = \alpha_2 + \overline{v_1^*}(\alpha_1+\alpha_2)\,\Gamma_\mu\,/\Gamma_v\,.$

When $\Gamma_\mu = 0$, the efficient allocation can be supported if country *i* holds a share $\alpha_i$ of its local stock ($S_i^{i*} = \alpha_i$), as that portfolio ensures that the dividend income generated by *i*'s holding of the local [foreign] stock equals *i*'s purchases of the local [foreign] good.

Note that $S_2^{2*} - \alpha_2 = \overline{v_1^*}(S_1^{1*} - \alpha_1)$. Thus, $S_2^{2*}$ exceeds $\alpha_2$ if and only if $S_1^{1*}$ exceeds $\alpha_1$. $S_i^{i*} > \alpha_i$ occurs if $\Gamma_\mu/\Gamma_v > 0$, while $S_i^{i*} < \alpha_i$ if $\Gamma_\mu/\Gamma_v < 0$. Hence, the locally owned equity share is greater [smaller] than the degree of consumption home bias if $\mu^{i*}(y_1,\Lambda)$ co-moves *positively* [*negatively*] with the relative value of the country *i* endowment at $t$=1. Intuitively: if it is efficient for country *i* to consume a larger share of its endowment, in states of the world (at $t$=1) in which the relative value of the dividend of the local stock (=local endowment) is high

[22] (22) holds *exactly* when $\alpha_1 = \alpha_2$, $Y_{1,0} = Y_{2,0}$ and the distribution of endowments at t=1 is symmetric across countries. However, even when (22) does not hold exactly, that term $(1-\alpha_1)\overline{v_1^*} - (1-\alpha_2)$ is of second order (it can be made arbitrarily small by setting the variance of endowment shocks sufficiently close to zero), and equilibrium portfolios only differ by a second order quantity from the portfolios derived below.

(i.e. if $\Gamma_\mu/\Gamma_\nu>0$), then the local stock provides a hedge for fluctuations in the (optimal) local consumption share, and the efficient allocation can be implemented if country $i$ holds a local equity share that exceeds $\alpha_i$.

## 4.2. Calibration

Which of these cases is empirically most relevant? Figures 1 and 2 illustrate how $S_i^i$, is related to $\sigma$ and $\phi$, for two model **variants** characterized by different degrees of consumption home bias and relative country sizes $(\alpha_1,\alpha_2,\overline{\nu_1^*})$.

In **variant 1** (Fig. 1)**,** two (initially) equal sized countries are assumed: $z_0=\overline{\nu_1^*}=1$; the two countries can be interpreted as the US and an aggregate of the remaining OECD economies; I set $\alpha_1=\alpha_2=0.9$, as US consumption home bias is about 10% (see Table 1).

In **variant 2** (Fig. 2), country 2 is much smaller than country 1; country 2 represents the median country among the 15 smallest OECD economies ("G15") considered in Table 3;[23] country 1 represents the rest of the OECD. The median G15 economy (ranked by output) accounts for 1.38% of aggregate OECD output. $z_0$ and $\alpha_2$ are set at $z_0=1/0.014$ and $\alpha_2=0.8$, as the G15 median imports/(C+G+I+X) ratio is 20%. $\alpha_1$ is set at $\alpha_1=1\text{-}(1\text{-}\alpha_2)/\mathrm{z}_0=0.997$; this entails that terms of trade are unity in the initial period ($p_0=1$), and that country 2's initial share of the world endowment is 1.38%: $p_0^*Y_{2,0}/[Y_{1,0}+p_0^*Y_{2,0}]=0.0138$.

The two thick lines in the Figures show combinations of $\phi,\sigma$ for which $\Gamma_\mu=0$ and $\Gamma_\nu=0$ hold, respectively. The $\Gamma_\mu=0$ locus is downward sloping, while the $\Gamma_\nu=0$ locus is upward sloping.

(i) (24a) shows that $\Gamma_\mu=0$ holds when $1/\sigma=\phi$; $\Gamma_\mu<0$ when $1/\sigma<\phi$; $\Gamma_\mu>0$ when $1/\sigma>\phi$. Note that a linear approximation of risk sharing condition (12) gives:

$$[(1-\sigma\phi)/\phi]\,\widehat{C_1^{1*}}-\widehat{c_{j,1}^{1*}}/\phi=[(1-\sigma\phi)/\phi]\,\widehat{C_1^{2*}}-\widehat{c_{j,1}^{2*}}/\phi,\quad \text{for } j=1,2. \tag{26}$$

where the left-hand [right-hand] side is the marginal utility of good $j$ in country 1 [country 2] at $t$=1 (expressed as a relative deviation from marginal utility evaluated at $\overline{y_1}$); see Appendix.

When $1/\sigma=\phi$, utility functions are additively separable in the two goods;[24] (26) shows that, in that case, good $j$ consumption (for $j$=1,2) is perfectly correlated across countries, $\widehat{c_{j,1}^{1*}}=\widehat{c_{j,1}^{2*}}$, which implies $\widehat{c_{j,1}^{i*}}=\widehat{Y_{j,1}}$ for $i$=1,2.[25] When $1/\sigma=\phi$, an increase in the good 1 endowment at $t$=1, $Y_{1,1}$, thus raises each countries' good 1 consumption by the same proportion, and hence the fraction of the local endowment that is consumed in country 1 is constant, $\Gamma_\mu=0$;

[23] G15 consists of the countries listed in Table 3, less the two "giants", US and Japan. The largest G15 countries are Germany (8% of OECD output), and the UK and France (6%).

[24] (3) and (4) imply that $U(C_1^i)=\alpha_i^{1/\phi}(c_{i,1}^i)^{(\phi-1)/\phi}+(1-\alpha_i)^{1/\phi}(c_{j,1}^i)^{(\phi-1)/\phi}$ $(j\neq i)$ when $1/\sigma=\phi$.

[25] This follows from the linearized resource constraints: when (19) and (22), hold, then $\alpha_i\widehat{c_{i,1}^{i*}}+(1-\alpha_j)\widehat{c_{i,1}^{j*}}=\widehat{Y_{i,1}}$, $j\neq i$.

this ensures that marginal utilities of good 1 are perfectly correlated across countries. Note that a shock to the good 1 endowment has no effect on good 2 consumptions, when $1/\sigma=\phi$. [26]

To understand why $\Gamma_\mu<0$ holds when $1/\sigma<\phi$, i.e. when the two goods are substitutes (in the sense that $\partial^2 U(C_1^i)/\partial c_{1,1}^i \partial c_{2,1}^i<0$), consider again the effect of an increase in the good 1 endowment at $t=1$ $(Y_{1,1})$; if both countries increased their good 1 consumption at $t=1$ by the same proportion, holding good 2 consumptions constant (as is optimal when $1/\sigma=\phi$, see above), this would raises the *aggregate* country 1 consumption index, $C_1^1$, more strongly (in relative terms) than the country 2 index, $C_1^2$, because good 1 has a greater weight in $C_1^1$, due to consumption home bias;[27] when $1/\sigma<\phi$, the marginal utilities of *both* goods would then fall *more* (in relative terms) in country 1 than in country 2 (see (26)). To preclude that divergence of marginal utilities across countries, country 1 consumption of good 1 consumption has to rise less than the good 1 endowment, i.e. the fraction of the good 1 endowment consumed in country 1 has to fall ($\Gamma_\mu<0$).
A similar argument explains why $\Gamma_\mu>0$ when $1/\sigma>\phi$, i.e. when the goods are complements.

(ii) (24a,b) imply that $\Gamma_v=0$ holds when $\sigma=1/[\phi+(1-\phi)/(1-\alpha_1-\alpha_2)^2]$. [28] $\Gamma_v<0$ holds when an increase in $z_1$ lowers $v_1^*$; this occurs for $(\sigma,\phi)$ pairs located to the left of the $\Gamma_v=0$ locus; for those $(\sigma,\phi)$ pairs, an increase in the country 1 endowment raises the relative price of good 2 so much that the relative *value* of the country 1 endowment falls.

The $\Gamma_\mu=0$ and $\Gamma_v=0$ loci cross at the point $\sigma=\phi=1$. Thus, portfolios are indeterminate when $\sigma=\phi=1$.[29] The efficient allocation cannot be implemented for parameters on the $\Gamma_v=0$ locus, with the exception of the point $\sigma=\phi=1$. The sign of $S_i^i$ changes when the $\Gamma_v=0$ locus is crossed in $(\sigma,\phi)$ space. By selecting points sufficiently close to that locus, arbitrary large absolute values of $S_i^i$ can be generated. $S_i^i=\alpha_i$ holds for parameters on the $\Gamma_\mu=0$ locus.

$\Gamma_v<0$, $\Gamma_\mu<0$ holds for $(\sigma,\phi)$ pairs that are *simultaneously* above the $\Gamma_\mu=0$ and $\Gamma_v=0$ loci; $\Gamma_v>0$, $\Gamma_\mu>0$ holds for pairs that are *simultaneously* below those loci; for those two sets of $(\sigma,\phi)$ pairs, the locally owned equity share exceeds the degree of consumption home bias: $S_i^i>\alpha_i$.

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[26] When $1/\sigma=\phi$ the efficient equilibrium can be supported *exactly* by stocks, not just up to a linear approximation. For $1/\sigma=\phi$, (12) implies $\mu^{1*}(y_1,\Lambda)=\alpha_1/[\alpha_1+(\Lambda/(1-\Lambda))^{-\phi}(1-\alpha_2)]$, $\mu^{2*}(y_1,\Lambda)=\alpha_2/[\alpha_2+((1-\Lambda)/\Lambda)^{-\phi}(1-\alpha_1)]$; as these terms do not depend on $y_1$, the efficient allocation is implemented *exactly* by $S_{1,1}^{1*}=\mu^{1*}(y_1,\Lambda)$, $S_{2,1}^{1*}=1-\mu^{2*}(y_1,\Lambda)$.

[27] When (19), (22) hold, then $\widehat{C_1^1}=\alpha_1\widehat{c_{1,1}^1}+(1-\alpha_1)\widehat{c_{2,1}^1}$ and $\widehat{C_1^2}=(1-\alpha_2)\widehat{c_{2,1}^2}+\alpha_2\widehat{c_{2,1}^2}$ (see Appendix): the elasticity of $C_1^1$ with respect to $c_{1,1}^1$ exceeds the elasticity of $C_1^2$ w.r.t. $c_{1,1}^2$, because $\alpha_1>1-\alpha_2$.

[28] The denominator of that expression is zero for $\phi=\phi^\dagger\equiv 1/[1-(1-\alpha_1-\alpha_2)^2]$; $\phi<\phi^\dagger$ holds for empirically plausible $\phi,\alpha_i$.

[29] When $\sigma=\phi=1$, utility functions are logarithmic in the two goods: $U_t^i=\alpha_i \ln c_{i,t}^i+(1-\alpha_i)\ln c_{j,t}^i-\ln(\alpha_i^{\alpha_i}(1-\alpha_i)^{1-\alpha_i})$, $j\neq i$; for those preferences, the equilibrium is efficient, even under financial autarky, as shown by Cole and Obstfeld (1991).

Under the plausible assumption (see below) that $1/\sigma<\phi$ holds, and that $\phi$ does not exceed unity "too" much, the locally owned equity share exceeds the degree of consumption home bias, in both model variants: $S_i^i>\alpha_i$, as can be seen from Figures 1 and 2.

Portfolios are symmetric across countries ($S_1^1=S_2^2$) in model variant 1. In variant 2, by contrast, portfolios are not symmetric, $S_1^1\neq S_2^2$: the larger country (country 1) holds roughly 100% of the local stock, except when $\sigma,\phi$ is close to the $\Gamma_\nu=0$ locus, i.e. except when the absolute value of $\Gamma_\mu/\Gamma_\nu$ is large. (For variant 2, Fig. 2 thus shows the locally held equity share in country 2 $S_2^2$.) The $\Gamma_\nu=0$ loci are virtually identical in variants 1 and 2;[30] the $\Gamma_\mu=0$ loci are *exactly* identical. Both variants thus generate locally held equity shares that exceed the degree of consumption home bias, for roughly the same values of $\sigma$ and $\phi$.

Estimates of $\sigma$ in the range of 2 (or greater) are common for industrialized countries (e.g., Barrionuevo (1992)); $\phi$ corresponds to the price elasticity of a country's (aggregate) import and export demand functions.[31] Hooper and Marquez (1995) survey a large number of studies that estimated (long run) price elasticities of aggregate trade flows, for the US, Japan, Germany, the UK and Canada; the median estimates (post-Bretton Woods era) of $\phi$ for those countries are 0.97, 0.80, 0.57, 0.6, and 1.01, respectively (median estimate across all 5 countries: 0.88); 80% of all estimates are smaller than 1.2. One of the most comprehensive empirical studies on trade elasticities is Bayoumi (1999), who uses data on 420 bilateral trade flows between 21 industrialized countries; under the restriction (not rejected statistically) that elasticities are identical for all county pairs, the estimated (long run) price elasticity ranges between 0.38 and 0.89 (depending on model specification).[32]

Assume $\sigma=2$. Then model variant 1 predicts locally held equity shares ($S_1^1=S_2^2$) of 0.93, 1.06 and 1.30, for $\phi=0.6$, $\phi=0.9$ and $\phi=1.2$, respectively; in variant 2, the corresponding values of $S_1^1$ are 0.99, 1.002 and 1.008, while those of $S_2^2$ are 0.86, 1.12 and 1.62, respectively (for $\phi=0.6$, $\phi=0.9$ and $\phi=1.2$). Note that for $\phi=0.9$ and $\phi=1.2$ more than 100% of the domestic stock is held locally (and countries hold short positions of foreign stock).

## 5. Infinite horizon economy

This Section considers an infinite horizon model ($T\to\infty$). That model is solved using globally accurate methods. A non-linear equation solver is used to compute consumptions and terms of trade at date *t*, as functions of the vector of endowments $y_t$. With an infinite horizon, the present value of country i's efficient consumption spending process, $W_t^{i*}$, and the stock price

[30] This is due to the fact that $\alpha_1+\alpha_2$ is roughly identical across the two variants.

[31] Country *i* imports are $c_{i,t}^j=(1-\alpha_i)(p_{j,t}/P_t^i)^{-\phi}C_t^i$ $(j\neq i)$, where $P_t^i\equiv[\alpha_i p_{i,t}^{1-\phi}+(1-\alpha_i)p_{j,t}^{1-\phi}]^{1/(1-\phi)}$ is *i*'s CPI.

[32] Price elasticities at a disaggregated industry level are typically higher (in the range of 5) than the elasticity of *aggregate* trade flows (Obstfeld and Rogoff (2000, p.345)). Kollmann (2001a,b; 2002; 2004; 2005a) presents models in which the sectoral price elasticity exceed the aggregate elasticity; there, the quantities $c_{i,t}^i$ and $c_{j,t}^i$ in *i's* consumption aggregator (4) are *indices* of differentiated domestic and imported intermediate goods, respectively: $c_{k,t}^i=\{\int_0^1 \tilde{c}_{k,t}^i(s)^{(\psi-1)/\psi}ds\}^{\psi/(\psi-1)}$ $(k=i,j)$, where $\tilde{c}_{k,t}^i(s)$ is the quantity of the type $s\in[0,1]$ intermediate produced by country *k* and consumed by *i*. $\psi$ is the own-price demand elasticity for individual varieties. If all producers located in the same country receive identical endowment shocks, then the degree of equity home bias depends on the aggregate elasticity $\phi$ (and not on $\psi$).

(cum-dividend) $\widetilde{P^*_{j,t}}$ are time invariant functions of the vector of endowments at *t*: $W^{i*}_t(\Lambda)=W^{i*}(y_t,\Lambda)$, $\widetilde{P^*_{j,t}}(\Lambda)=\widetilde{P^*_j}(y_t,\Lambda)$. I compute those functions using numerical integration, based on the non-linear solutions for consumptions and terms of trade. I then obtain derivatives of $W^{i*}(y_t,\Lambda)$ and $\widetilde{P^*_j}(y_t,\Lambda)$, at $\overline{y_t}\equiv y_{t-1}$, using a finite difference procedure; those derivatives determine country *i*'s stock holdings $S^{i*}_{1,t+1}, S^{i*}_{2,t+1}$ at the end of period *t* (see (15b)). Note that a linear approximation is *solely* used to compute portfolios.[33] See the Appendix for further discussions of computational aspects.

### 5.1. Calibration

I again consider the two model variants described above: **variant 1** (calibrated to the US vs. an aggregate of the remaining OECD economies) assumes $\alpha_1=\alpha_2=0.9, Y_{1,0}=Y_{2,0}=1,$ while **variant 2** (in which country 2 is calibrated to a "representative" country in the set of 15 small OECD economies, G15) uses $\alpha_1=0.997, \alpha_2=0.8, Y_{1,0}=1, Y_{2,0}=0.014$. In both variants, one period represents one year in calendar time; as is common in business cycle models calibrated to annual data, $\beta=0.96$ is assumed (which implies that the steady state annual equity return is 4%). The risk aversion parameter is set at $\sigma=2$. Three values of the elasticity of substitution $\phi$ are considered: $\phi=0.6$, $\phi=0.9$, $\phi=1.2$.

The empirical standard deviations of the annual log growth rates of US and aggregate non-US output are 1.32% and 1.28%, respectively, and the correlation between these growth rates is 0.5 (sample period: 1972-2004). **Variant 1** thus sets $std(\varepsilon^1_t)=std(\varepsilon^1_t)=0.013$, $corr(\varepsilon^1_t,\varepsilon^2_t)=0.5$.

For G15 countries, the median standard deviations of the log growth rates of domestic and of foreign output are 2.12% and 1.12%, respectively; thus, domestic output is more volatile than foreign output. The median correlation between domestic and foreign output growth rates is 0.4 (the median correlation between HP filtered domestic and foreign log output is 0.41; see Table 3). **Variant 2** hence assumes $std(\varepsilon^1_t)=0.011; std(\varepsilon^2_t)=0.021$; $corr(\varepsilon^1_t,\varepsilon^2_t)=0.4$.

### 5.2. Stochastic simulations

Tables 4 and 5 show predicted statistics for model variants 1 and 2, respectively. For variant 1, results for country 1 variables are reported; for variant 2, results for the small country (*i*=2) are shown. The model statistics for variant 1 [variant 2] are averages of statistics computed for 50 simulation runs of 28 [21] periods each (28: length of the BEA data set; 21: the median number of data years for G15 countries). In both Tables, Cols. 1-9 show predictions generated for the baseline CRRA utility function (3); Cols. Cols. 10-12 show results for a model version with a constant absolute risk aversion (CARA) utility function. Cols 13-15 report empirical statistics.[34]

The theoretical current account variables of country 1 are defined as: $\Delta FEA^1_{t+1}=P_{2,t}S^1_{2,t+1}-P_{2,t-1}S^1_{2,t}$, $\Delta FEL^1_{t+1}=P_{1,t}S^2_{1,t+1}-P_{1,t-1}S^2_{1,t}$, $ECA^1_t=\Delta FEA^1_t-\Delta FEL^1_t$, $BCA^1_t=A^1_{t+1}-A^1_t$,

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[33] The point of linearization used to compute portfolio choices at *t* $(\overline{y_t})$ is time-varying. A constant point of linearization would entail larger approximation errors, and it would generate constant portfolios, whereas the approach here captures time-variation in portfolios.

[34] The empirical statistics are US statistics (in Table 4) and median statistics for the G15 countries (Table 5); the empirical statistic for $S^i_{i,t}$ (locally held share of domestic equity) correspond to 1 minus the ratio of countries' foreign equity liabilities to their physical capital stocks reported in Col. 1 of Table 1.

$CA_t^1 = ECA_t^1 + BCA_t^1$. For country 2: $\Delta FEA_{t+1}^2 = -\Delta FEA_{t+1}^1$, $\Delta FEL_{t+1}^2 = -\Delta FEL_{t+1}^1$, $ECA_t^2 = -ECA_t^1$, $BCA_t^2 = -BCA_t^1$, $CA_t^2 = -CA_t^1$. I also define a "conventional" current account measure for country $i$ based on book (historical) values of assets/liabilities acquired in the past: $CA_t^{bkv,i}$. [35] Theoretical statistics for country i's asset holdings and current accounts are based on simulated series normalized by a fitted (deterministic) trend of country i's output. [36] All series are HP filtered (smoothing parameter: 400). Output and the (consumption based) real exchange rate (RER) series are logged (before filtering).

***Model variant 1 (equal sized countries), Table 4***

Like the two-period model $(T=1)$, the infinite horizon model can generate sizable equity home bias. In fact, share holdings in the infinite horizon economy are *very* close to those in the two-period economy. Under CRRA utility, bond holdings are zero; the variability of share holdings $(S_{i,t}^i)$ is essentially zero: there are virtually no stock trades. Thus, in the model, fluctuations of the current account measure $CA_t^1$ (that includes capital gains/losses) are almost fully due to changes in equity *prices*; the conventional current account $CA_t^{bkv,1}$ is basically constant (at zero). The predicted standard deviation of the real exchange rate is likewise smaller than that seen in the data.

The specifications in Table 4 predict a standard deviation of $CA_t^1$ that represents between 28% and 83% of the standard deviation of the empirical US current account measure; the version with $\phi=0.6$--that matches best the US equity home bias--explains 49% of the empirical standard deviation.

The model captures the low empirical autocorrelation of the US current account $CA_t^{US}$, and its low correlation with domestic and foreign output.[37] In the model, net foreign assets $(NFA_{t+1}^1)$ at the end of period $t$ are solely a function of endowments at $t$; as log endowments are assumed to follow random walks, $CA_t^1\ (\equiv \Delta NFA_{t+1}^1)$ is thus approximately i.i.d; the predicted autocorrelation of the HP filtered $CA_t^1$ series is -0.09, [38] which is not significantly different (at a 10% level) from the empirical autocorrelation, 0.04. The predicted correlations between $CA_t^1$ and domestic output (0.22 when $\phi=0.6$; -0.22 when $\phi=0.9$ and $\phi=1.2$) are likewise not significantly different from the empirical correlation, 0.01.

In the model, changes in foreign equity assets and liabilities $(\Delta FEA_t^1, \Delta FEL_t^1)$ are more volatile than $CA_t^1$ and output, which is consistent with the data. The predicted correlation between $\Delta FEA_t^1$ and $\Delta FEL_t^1$, about 0.9, is close to the empirical correlation (0.88); that high predicted correlation is due to the fact that the cross-country correlation of stock returns is about 0.9. A rise in the country 1 endowment raises the country 1 stock price (and return), and the relative price of the country 2 good; therefore, the price of the country 2 stock (in units of good 1) rises too. Thus, the cross-country correlation of stock returns exceeds that of output. [39]

To generate asset trade, I consider the CARA utility function: $U(C) = -\exp(-\sigma C)$, with

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[35] $CA_t^{bkv,1} \equiv P_{2,t}\Delta S_{2,t+1}^1 - P_{1,t}\Delta S_{1,t+1}^2 + \Delta A_{t+1}^1$, and $CA_t^{bkv,2} = -CA_t^{bkv,1}$ Note: $CA_t^1 - CA_t^{bkv,1} = \Delta P_{2,t} S_{2,t}^1 - \Delta P_{1,t} S_{1,t}^2$.

[36] The simulated current account series are normalized in the same manner as the empirical series.

[37] In variant 1, the correlation between the current account and foreign output is very close to the negative of the correlation between the current account and domestic output. Only the latter is reported $(\rho_Y)$.

[38] An HP filtered i.i.d. series has an autocorrelation of $-0.1$ (for smoothing parameter set at 400).

[39] Coeurdacier and Guibaud (2005) and Pavlova and Rigobon (2005) also discuss models in which endogenous terms of trade responses induce sizable cross-country correlations of stock returns.

$\sigma$=2.[40] Cols. 10-12 show results for the CARA specification with $\phi$=0.6. That specification generates non-negligible stock trades, and sizable fluctuations in the bond component of the current account, $BCA_t^1$ (predicted standard deviations of $S_{1,t}^1$ and $BCA_t^1$: 0.17% and 3.22%, respectively; empirical standard deviation of $BCA$ for the US: 1.77%). Under CARA utility, the current account and its components remain volatile, and (approximately) i.i.d.

*Impulse responses*

Panel (a) of Table 6 shows *impact* effects of one-standard-deviation endowment innovations, for each of the specifications of model variant 1 considered in Table 4. As endowments follow random walks, the responses of consumption, net exports, prices and asset holdings in all periods after the shock equal the impact responses; by contrast the responses of the current account (and its components) are zero *after* the shock.

A positive endowment shock in country $i$ raises final good consumption in both countries--but $C^i$ rises more strongly than $C^j$ $(j\neq i)$, due to consumption home bias. The parameters considered here entail that a positive country $i$ endowment shock lowers country $i$'s local consumption share $\mu^{i*}(y_t,\Lambda)$, and that it increases $\mu^{j*}(y_t,\Lambda)$ $(j\neq i)$; thus, the shock raises country $i$'s exports $(c_i^{j*})$, and it lowers $i$'s imports $c_j^{i*}$. It also lowers the relative price of good $i$. Country $i$ net exports fall (in response to the increase in $i$'s endowment) when $\phi$=0.6 (low elasticity of substitution between goods); net exports rise for $\phi$=0.9 and $\phi$=1.2. Under CRRA utility, stock holdings $(S_{1,t}^{1*},S_{2,t}^{2*})$ show (virtually) zero responses to endowment shocks.

The intertemporal budget constraint (14b) implies that $i$'s net foreign assets at the end of $t$, $NFA_{t+1}^{i*}$, equal the negative of the present value of $i$'s net exports at dates $s>t$: $NFA_{t+1}^{i*}=-E_t\sum_{s=1}\rho_{t,t+s}^{*}NX_{t+s}^{i*}$. A shock that permanently lowers $i$'s net exports thus triggers a rise in $i$'s net foreign assets and, on impact, it increases $i$'s current account. Equilibrium share holdings are structured in a manner that delivers that response of net foreign assets.

Consider the case of a one-standard-deviation country 1 endowment shock, under CRRA utility and $\phi$=0.6 (Row **I**, Panel (a1) of Table 6); the shock lowers the net exports and raises the current account of country 1 by 0.07% and 1.90% of pre-shock output, respectively. Each country holds 7% of the foreign stock. The prices of stocks 1 and 2 rise by 1.3% and 2.4%, respectively. (The relative price of good 2 rises strongly (+2.45%); this explains why the stock price, expressed in units of good 1, rises more strongly in country 2 than in country 1.) Thus, the country 1 net foreign assets increases.

With CARA utility, the responses of consumption, prices, net exports and the current account are almost the same as in the CRRA case; however, the equity vs. bond *composition* of the current account adjustment differs noticeably: e.g., in the non-CRRA case with $\phi$=0.6, a positive shock to country $i$ productivity triggers a rise in $i$'s bond holdings by an amount that represents 3.5% of pre-shock output; see Panel (a4), Table 6 (the bond component of the current account is zero under CRRA preferences).

***Model variant 2 (country 2 smaller than country 1), Table 5***

In model variant 2, the predicted standard deviations of the small country's current account (normalized by small country trend output) are 5.2%, 2.94% and 8.7%, respectively, when $\phi$=0.6, $\phi$=0.9 and $\phi$=1.2 are assumed (CRRA utility). (Median empirical standard deviation of

[40] In variant 1, consumption equals unity in the initial period, in both countries (as $Y_{1,0}=Y_{2,0}=1$); under CARA utility, the coefficient of relative risk aversion $(\sigma C_{i,t})$ in the initial period thus equals two, the value assumed in the baseline CRRA specification.

G15 current accounts: 7.4%.) For a given value of $\phi$, the standard deviation of the small country's current account (normalized by its trend output) in variant 2 is thus about 3 times larger than the standard deviation of the country 1 ("US") current account in variant 1. The model captures thus the fact that the (normalized) current accounts of G15 economies are more volatile than the US current account. Note that the small country (in variant 2) has more volatile endowment shocks, and that its trade share is larger (compared to the trade share of country 1 in variant 1); thus, its terms of trade, and its net exports (normalized by domestic output) are predicted to be more volatile--hence, its current account is more volatile as well. [41]

Predicted correlations of the current account with domestic and foreign output are larger (in absolute value) in variant 2 than in variant 1, but lie in the range of empirical correlations observed for G15 countries. [42]

As in model variant 1, there is (almost) no trade in stocks when CRRA utility is assumed (and zero trade in bonds). Again, the stock holdings generated by the infinite horizon CRRA model are very similar to those predicted by the two-period model. The small country holds 86%, 112% and 161% of the domestic stock, when $\phi$=0.6, $\phi$=0.9 and $\phi$=1.2, respectively. The large economy (rest of the world) holds close to 100% of its local stock.

The CARA specification again generates sizable fluctuations in the bonds component of the current account (e.g., when $\phi$=0.6 the standard deviation of the normalized country 2 bond component of the current account is 10.04%). [43] Panel (b) in Table 6 reports impact responses for variant 2. The responses are qualitatively similar to those in variant 1.

## 6. Conclusion

This paper has analyzed international asset portfolios, using a neoclassical dynamic general equilibrium model with home bias in consumption. For plausible parameter values, the model explains the fact that typical investors hold most of their wealth in domestic assets (portfolio home bias). The model also captures key aspects of current account measures that include capital gains/losses on external assets: those current account measures are highly volatile and have low serial correlations; changes in a country's foreign equity assets and liabilities are highly positively correlated, and changes in net foreign *equities* holdings are an important source of current account fluctuations.

[41] It appears that the *elasticities* of the terms of trade and of exports and imports with respect to (domestic and foreign) endowments are roughly identical across model variants 1 and 2. Holding constant the standard deviation of endowment shocks, the standard deviation of net exports (normalized by domestic output) is roughly proportional to the trade share--which helps to understand the greater volatility of the small country's net exports (and current account).

[42] For example, when $\phi$=0.6, the correlations of the country 2 current account with domestic and foreign output are 0.39 and -0.08, respectively (correlations with foreign output not shown in Table 5). In the neighborhood of the initial endowment vector, CA is approximately a linear function of the *difference* between the two countries' output innovations; the current account is more closely correlated with country 2 output, as that output is more volatile (than country 1 output).

[43] The CARA specification for variant 2 assumes that, in both countries the coefficient or relative risk aversion is two, in the initial period. This is achieved by assuming that the utility functions of countries 1 and 2 are $U^1(C^1)=-\exp(-2C^1)$, and $U^2(C^2)=-\exp(-2C^2/0.014)$, respectively. (Consumption in the initial period are: $C_0^1=1, C_0^2=0.014$.)

# Appendix

## A.1. Data sources, definitions of variables (Tables 2 and 3)

Let G21 denote the set of 17 OECD countries listed in Table 3, plus Belgium, Ireland, Mexico and Norway (no current account series for these countries are constructed because of gaps in portfolio data). The portfolio data (for US) used in Table 2 are from BEA (2005). The portfolio data used in Table 3 (17 OECD economies) are from the IMF's IIP database. All other data are from International Financial Statistics (IMF).

Empirical statistics (standard deviations etc.) for real exchange rates pertain to *CPI based* real exchange rates. Country *i*'s CPI based real exchange rate, $RER_{i,t}$, is a geometric weighted average of bilateral CPI based real exchange rates between *i* and the other G21 countries (weights: mean output shares, 1973-03): $RER_{i,t} \equiv \prod_{j \in \mathrm{G21}, j \neq i} (RER_{i/j,t})^{\Omega_{i,j}}$. $RER_{i/j,t} \equiv e_{i/j,t} CPI_{j,t}/CPI_{i,t}$ is the real exchange rate between countries *i* and *j*; $e_{i/j,t}$ is the currency *i* price of one unit of currency *j*; $CPI_{j,t}$ is *j*'s CPI. The $\Omega_{i,j}>0$ weights sum to unity. A rise in $RER_{i,t}$ represents a real *depreciation* of currency *i* (vis-à-vis the rest of the G21).

Foreign output is aggregated using real exchange rates based on GDP deflators; $RER^{GD}_{i/j,t}$ and $RER^{GD}_{i,t}$ denote the bilateral real exchange rate between countries *i* and *j*, and the real exchange rate between *i* and the rest of the G21, based on GDP deflators. [44]

In Tables 2 and 3, country *i*'s output, $Y_{i,t}$, is defined as *i*'s nominal *GDP-I-G* ($GDP^{nom}_{i,t} - I^{nom}_{i,t} - G^{nom}_{i,t}$), divided by *i*'s GDP deflator, $P^{GD}_{i,t}$: $Y_{i,t} \equiv (GDP^{nom}_{i,t} - I^{nom}_{i,t} - G^{nom}_{i,t})/P^{GD}_{i,t}$. Note that *GDP-I-G* is deflated using the GDP deflator, as no specific deflator tailored to *GDP-I-G* is available. [45]

Foreign output from country *i*'s perspective, $Y^*_{i,t}$, is total output in the rest of the G21, aggregated at real exchange rates (based on GDP deflators) in a reference year $T_0$:

$$Y^*_{i,t} \equiv \sum_{j \in \mathrm{G21},\, j \neq i} [(GDP^{nom}_{j,t} - I^{nom}_{j,t} - G^{nom}_{j,t})/P^{GD}_{j,t}] \times RER^{GD}_{i/j,T_0}.$$

Table 2 sets $T_0$=1990, while Table 3 uses $T_0$=1993 (median years in respective samples).

***Table 2, US Current account***

In Table 2, the US current account and its components are expressed in units of US output. Steps in computation: (i) US assets and liabilities $NFA_t, FEA_t, FEL_t, NB_t$ at the end of year *t* (provided in US dollars by the BEA) are deflated using the US GDP deflator; [46] (ii) the deflated series are first-differenced, as in equation (1), to construct $CA_t$, $\Delta FEA_{t+1}$, $\Delta FEL_{t+1}$, $ECA_t$ and $BCA_t$; (iii) the first-differenced series are normalized by a fitted geometric trend of US output.

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[44] Definitions analogous to those of $RER_{i/j,t}$ and $RER_{i,t}$ (CPI's in formulae are replaced by GDP deflators).

[45] In Cols. 5-7 of Table 2, and in Panel (b) of Table 3, the output measure is real *GDP* (there, $GDP^{nom} - I^{nom} - G^{nom}$ in the formulae for domestic and foreign output is replaced by $GDP^{nom}$).

[46] The empirical $NB_{t+1}$ series is constructed as $NB_{t+1} \equiv NFA_{t+1} - FEA_{t+1} + FEL_{t+1}$ from $NFA_{t+1}, FEA_{t+1}, FEL_{t+1}$ data.

A US dollar series on the conventional current account $CA_t^{bkv}$ (that does not include capital gains/losses) is taken from IFS. In Table 2, the IFS series is deflated using the US GDP deflator, and normalized by the fitted geometric trend of US output.

***Table 3 (17 OECD economies):***
In Table 3, the statistics on the country *i* current account (and its components) are expressed in units of foreign output. Steps in computation: (i) Country *i* assets and liabilities at the end of year *t* (provided in US dollars by IIP) are expressed in country *i* currency using the bilateral nominal (end-of-year) exchange rate between *i* and the US ($e_{i/US,t}$), deflated by *i*'s GDP deflator, and then divided by the real exchange rate between *i* and the rest of the G21 at *t*, $RER_{i,t}^{GD}$ (this expresses the stocks assets and liabilities in units of foreign output). (ii) The resulting series are first-differenced, as in (1), to construct $CA_t, \Delta FEA_{t+1}, \Delta FEL_{t+1}, ECA_t, BCA_t$ for country *i*; (iii) the first differences are normalized by a fitted geometric trend of *i* output expressed in units of foreign output $(Y_{i,t}/RER_{i,t})$.

A US dollar series on country *i*'s conventional current account measure, $CA_t^{bkv}$, is taken from IFS. In Table 3, the measure is expressed in units of foreign output. Specifically, the IFS series for country *i* is expressed in country *i* currency using the bilateral nominal exchange rate between *i* and the US, deflated by *i*'s GDP deflator, and then divided by the real exchange rate between *i* and the rest of the G21 ($RER_{i,t}^{GD}$), and normalized by the fitted geometric trend of country *i* output expressed in units of foreign output $(Y_{i,t}/RER_{i,t})$.

## A.2. Proof that bond holdings are zero under CRRA utility

Under CRRA utility, the efficient consumptions $c_j^{i*}(y_t,\Lambda)$ are homogeneous of degree 1 (HD1) in the vector of endowment, $y_t \equiv (Y_{1,t}, Y_{2,t})$; see Sect. A.5. below. The equilibrium price of good 2, $p_2^*(\mathrm{y_t},\Lambda)$, is homogenous of degree 0 (HD0) in $y_t$, as that price is a function of the ratio of country *i*'s good 1 consumption divided by *i*'s good 2 consumption (see (9)). Therefore, $e^{i*}(\mathrm{y_t},\Lambda)$ and $p_2^*(\mathrm{y_t},\Lambda)\mathrm{Y}_{2,t}$ are HD1 in $y_t$.

The equilibrium stock and bond holdings for periods $0<t\leq T$ are found by solving (15a), (15b). From Sect. 3.5, $W^{i*}(y_t,\Lambda,t) \equiv E_t \sum_{s=0}^{T-t} \beta^s \omega^*(y_{t+s},\Lambda)/\omega^*(y_t,\Lambda) e_t^{i*}(y_{t+s},\Lambda)$, where $\omega^*(y_{t+s},\Lambda)$ is the marginal utility of good 1 at $t+s$. When the utility function is CRRA (see (3)), then $\omega^*(y_{t+s},\Lambda) = (C_t^{1*})^{(1-\sigma\phi)/\phi}(c_{1,t}^{1*}/\alpha_1)^{-1/\phi}$, which implies that $\omega^*(y_{t+s},\Lambda)$ is homogenous of degree $-\sigma$ in $y_{t+s}$ ($C_{t+s}^1$ is HD1 in $(c_{1,t+s}^1, c_{2,t+s}^1)$, and thus HD1 in $y_{t+s}$).

Note that $y_{t+s} = y_t \mathcal{E}_{t,t+s}$, for $s>1$, where $\mathcal{E}_{t,t+s} \equiv \exp(\sum_{j=1}^{s} \varepsilon_{t+j})$. Thus $\omega^*(y_{t+s},\Lambda)/\omega^*(y_t,\Lambda) = \omega^*(y_t \mathcal{E}_{t,t+s},\Lambda)/\omega^*(y_t,\Lambda)$ and $e_t^{i*}(y_{t+s},\Lambda) = e_t^{i*}(y_t \mathcal{E}_{t,t+s},\Lambda)$, which shows that $\omega^*(y_{t+s},\Lambda)/\omega^*(y_t,\Lambda)$ and $e_t^{i*}(y_{t+s},\Lambda)$ are HD0 and HD1 in $y_t$, respectively. Thus, $W^{i*}(y_t,\Lambda,t)$ is HD1 in $y_t$. Similar reasoning shows that $\widetilde{P}_j^*(y_t,\Lambda,t)$ is HD1 in $y_t$. Euler's theorem thus implies:

$$W^{i*}(\overline{y_t},\Lambda,t) = D_1 W^{i*}(\overline{y_t},\Lambda,t)\overline{Y_{1,t}} + D_2 W^{i*}(\overline{y_t},\Lambda,t)\overline{Y_{2,t}}, \quad \widetilde{P}_j^*(\overline{y_t},\Lambda,t) = D_1 \widetilde{P}_j^*(\overline{y_t},\Lambda,t)\overline{Y_{1,t}} + D_2 \widetilde{P}_j^*(\overline{y_t},\Lambda,t)\overline{Y_{2,t}},$$

where (as in Sect. 3.5) $D_k W^{i*}(\overline{y_t},\Lambda,t)$ and $D_k \widetilde{P}_j^*(\overline{y_t},\Lambda,t)$ (for $k=1,2$) are the derivatives of $W^{i*}(\overline{y_t},\Lambda,t)$ and $\widetilde{P}_j^*(y_t,\Lambda,t)$ with respect to $Y_{k,t}$, evaluated at $\overline{y_t} \equiv (\overline{Y_{1,t}}, \overline{Y_{2,t}})'$. Substitute these expressions into (15a). The resulting expression and (15b) imply that $A_t^{i*}=0$.

## A.3. Transformations/normalizations that ensure that (19) holds.

Assume that the locally consumed fraction of the country $i$ endowment, in the initial period $t$=0, $\overline{\mu^{i*}}\equiv\mu^{i*}(y_0,\Lambda)$ differs from $i$'s preference parameter $\alpha_i$. The utility function (3) and the consumption aggregator (4) can be written as:

$$U_t^i=(1-\sigma)^{-1}[(Z_i)^{1/(1-\phi)}(\widetilde{C_t^i})^{1-\sigma}-1] \quad \text{for } i=1,2, \text{ with}$$

$$\widetilde{C_t^i}=[\alpha_i^{1/\phi}Z_i^{1/\phi}k_i^{(\phi-1)/\phi}(c_{i,t}^i/k_i)^{(\phi-1)/\phi}+(1-\alpha_i)^{1/\phi}Z_i^{1/\phi}k_j^{(\phi-1)/\phi}(c_{j,t}^i/k_j)^{(\phi-1)/\phi}]^{\phi/(\phi-1)} \text{ for } j\neq i,$$

where $Z_1,Z_2,k_1,k_2$ are arbitrary positive constants. Let's pick these constants in such a way that

$$\alpha_1 Z_1\, k_1^{\phi-1}=\overline{\mu^{1*}},\ (1-\alpha_1)Z_1k_2^{(\phi-1)}=(1-\overline{\mu^{1*}}),\ (1-\alpha_2)Z_2k_1^{(\phi-1)}=(1-\overline{\mu^{2*}}),\ \alpha_2 Z_2\, k_2=\overline{\mu^{2*}}.$$

(This requires that $k_1/k_2=\{[\overline{\mu^{1*}}/\alpha_1][(1-\alpha_1)/(1-\overline{\mu^{1*}})]\}^{1/(\phi-1)}$ and $Z_1/Z_2=[\overline{\mu^{1*}}/\alpha_1][(1-\alpha_2)/(1-\overline{\mu^{2*}})]$ hold.)
Under these conditions, $i$'s consumption aggregator can be written as

$$\widetilde{C^i}\equiv[(\widetilde{\alpha_i})^{1/\phi}(\widetilde{c_{i,t}^i})^{(\phi-1)/\phi}+(1-\widetilde{\alpha_i})^{1/\phi}(\widetilde{c_{j,t}^i})^{(\phi-1)/\phi}]^{\phi/(\phi-1)},\ j\neq i, \text{ with } \widetilde{\alpha_i}\equiv\overline{\mu^{i*}},$$

where $\widetilde{c_{q,t}^i}\equiv c_{q,t}^i/k_q$ $(q=1,2)$ is $i$'s consumption of good $q$, normalized by the constant $k_q$.

(19) holds for the reformulated consumption aggregator: the consumption home bias parameter of that aggregator equals the consumption share $\overline{\mu^{i*}}$. (In the normalized economy, the resource constraint is replaced by $\widetilde{c_{1,t}^1}+\widetilde{c_{1,t}^2}=\widetilde{Y_{1,t}}$, $\widetilde{c_{2,t}^1}+\widetilde{c_{2,t}^2}=\widetilde{Y_{2,t}}$, where $\widetilde{Y_{i,t}}\equiv Y_{i,t}/k_i$.)

## A.4. Derivation of equation (24a)

Country $i$'s marginal utility of good $j$ consumption is $\partial U(C_t^i)/\partial c_{j,t}^i=(C_t^i)^{(1-\sigma\phi)/\phi}(c_{j,t}^i/\kappa_j^i)^{-1/\phi}$, where $\kappa_j^i$ is a constant ($\kappa_1^1=\alpha_1$, $\kappa_2^1=1-\alpha_1$, $\kappa_1^2=1-\alpha_2$, $\kappa_2^2=\alpha_2$). Substitution of this expression into the risk sharing equation (12) gives:

$$(1-\Lambda)(C^{1*}(y_t,\Lambda))^{(1-\sigma\phi)/\phi}(c_j^{1*}(y_t,\Lambda)/\kappa_j^1)^{-1/\phi}=\Lambda(C^{2*}(y_t,\Lambda))^{(1-\sigma\phi)/\phi}(c_j^{2*}(y_t,\Lambda)/\kappa_j^2)^{-1/\phi} \text{ for j=1,2.} \quad (A.1)$$

Consider the two-period model ($T$=1), and linearize the preceding equation, for the final period $t$=1. This gives equation (26) in the text:

$$[(1-\sigma\phi)/\phi]\,\widehat{C_1^{1*}}-\widehat{c_{j,1}^{1*}}/\phi=[(1-\sigma\phi)/\phi]\,\widehat{C_1^{2*}}-\widehat{c_{j,1}^{2*}}/\phi, \quad \text{for } j=1,2. \quad (26)$$

(Recall from Sect. 4.1 that $\widehat{x_1}\equiv(x(y_1)-\overline{x_1})/\overline{x_1}$, denotes the relative deviation of $x(y_1)$ from $\overline{x_1}\equiv x(\overline{y_1})$, for any quantity $x(y_1)$ that is a function of $y_1$, the vector of endowment in period $t$=1; the point of linearization is the vector of endowments at $t$=0: $\overline{y_1}\equiv(\overline{Y_1},\overline{Y_2})'=y_0$.)

(4) implies that $\widehat{C_1^{1*}}=\lambda_1\widehat{c_{1,1}^{1*}}+(1-\lambda_1)\widehat{c_{2,1}^{1*}}$, where $\lambda_1\equiv\overline{c_{1,1}^{1*}}/(\overline{c_{1,1}^{1*}}+\overline{p_{2,1}^{*}}\,\overline{c_{2,1}^{1*}})$ is the share of good 1 in country 1 consumption expenditures, at the endowment vector $\overline{y_1}$. Net exports are zero, at the point of linearization; see (22). Thus: $\overline{c_{1,1}^{2*}}=\overline{p_{2,1}^{*}}\,\overline{c_{2,1}^{1*}}$, where the left- and right-hand sides are country 1's exports and imports, respectively, in units of good 1. Thus, $\lambda_1=\overline{c_{1,1}^{1*}}/(\overline{c_{1,1}^{1*}}+\overline{c_{1,1}^{2*}})=\overline{c_{1,1}^{1*}}/\overline{Y_1}$. By assumption, the fraction of the good $i$ endowment consumed in country $i$ is $\alpha_i$, at the point of linearization (see (19)); thus $\overline{c_{1,1}^{1*}}=\alpha_1\overline{Y_1}$, which implies that $\lambda_1=\alpha_1$. Hence, $\widehat{C_1^{1*}}=\alpha_1\widehat{c_{1,1}^{1*}}+(1-\alpha_1)\widehat{c_{2,1}^{1*}}$. Similarly, $\widehat{C_1^{2*}}=(1-\alpha_2)\widehat{c_{1,1}^{2*}}+\alpha_2\widehat{c_{2,1}^{2*}}$. Substituting these expressions into (26) gives:

$$[(1-\sigma\phi)/\phi]\,\{\alpha_1\widehat{c_{1,1}^{1*}}+(1-\alpha_1)\widehat{c_{2,1}^{1*}}\}-\widehat{c_{j,1}^{1*}}/\phi=[(1-\sigma\phi)/\phi]\,\{(1-\alpha_2)\widehat{c_{1,1}^{2*}}+\alpha_2\widehat{c_{2,1}^{2*}}\}-\widehat{c_{j,1}^{2*}}/\phi, \text{ for } j=1,2. \quad (A.2)$$

Note that $c_1^{1*}(y_t,\Lambda)=\mu^{1*}(y_t,\Lambda)Y_{1,t}$, $c_2^{1*}(y_t,\Lambda)=(1-\mu^{2*}(y_t,\Lambda))Y_{2,t}$,

$$c_1^{2*}(y_t,\Lambda)=(1-\mu^{1*}(y_t,\Lambda))Y_{1,t}, \quad c_2^{2*}(y_t,\Lambda)=\mu^{2*}(y_t,\Lambda)Y_{2,t}. \tag{A.3}$$

Linearization of these expressions (using (19)) gives:

$$\widehat{c_{1,1}^{1*}}=\widehat{\mu_1^{1*}}+\widehat{Y_{1,1}},\ \widehat{c_{2,1}^{1*}}=-(\alpha_2/(1-\alpha_2))\widehat{\mu_1^{2*}}+\widehat{Y_{2,1}},\ \widehat{c_{1,1}^{2*}}=-(\alpha_1/(1-\alpha_1))\widehat{\mu_1^{1*}}+\widehat{Y_{1,1}},\quad \widehat{c_{2,1}^{2*}}=\widehat{\mu_1^{2*}}+\widehat{Y_{2,1}}. \tag{A.4}$$

Substitution of (A.4) into (A.2) for good 1 ($j$=1) gives:

$$(1-\sigma\phi)\ \{\alpha_1\widehat{\mu_1^{1*}}-\alpha_2[(1-\alpha_1)/(1-\alpha_2)]\widehat{\mu_1^{2*}}\} =$$

$$(1-\sigma\phi)\ \{-\alpha_1[(1-\alpha_2)/(1-\alpha_1)]\widehat{\mu_1^{1*}}+\alpha_2\widehat{\mu_1^{2*}}\}+(1/(1-\alpha_1))\widehat{\mu_1^{1*}}+(1-\sigma\phi)(1-\alpha_1-\alpha_2)\widehat{z_1}, \tag{A.5}$$

where $\widehat{z_1}\equiv\widehat{Y_1}-\widehat{Y_2}$. Substitution of $\widehat{\mu_1^{2*}}=-\widehat{\mu_1^{1*}}(1-\alpha_2)/(1-\alpha_1)$ (see (20)) into (A.5) gives (24a).

## A.5. Infinite horizon model: non-linear solution method

Substituting (4) and (A.3) into risk sharing condition (12) (or into (A.1)) gives, for good 1 ($j$=1):

$$(1-\Lambda)[\alpha_1^{1/\phi}(\mu^{1*}(y_t,\Lambda))^{(\phi-1)/\phi}+(1-\alpha_1)^{1/\phi}(1-\mu^{2*}(y_t,\Lambda))^{(\phi-1)/\phi}z_t^{(1-\phi)/\phi}]^{(1-\sigma\phi)/(\phi-1)}\alpha_1^{1/\phi}(\mu^{1*}(y_t,\Lambda))^{-1/\phi}=$$
$$\Lambda[(1-\alpha_2)^{1/\phi}(1-\mu^{1*}(y_t,\Lambda))^{(\phi-1)/\phi}+\alpha_2^{1/\phi}(\mu^{2*}(y_t,\Lambda))^{(\phi-1)/\phi}z_t^{(1-\phi)/\phi}]^{(1-\sigma\phi)/(\phi-1)}(1-\alpha_2)^{1/\phi}(1-\mu^{1*}(y_t,\Lambda))^{-1/\phi}, \tag{A.6}$$

where $z_t\equiv Y_{1,t}/Y_{2,t}$. (9) implies that $((1-\alpha_1)/\alpha_1)(c_1^{1*}(y_t,\Lambda)/c_2^{1*}(y_t,\Lambda))=(\alpha_2/(1-\alpha_2))(c_1^{2*}(y_t,\Lambda)/c_2^{2*}(y_t,\Lambda))$; using (A.3), this can be used to express $\mu^{2*}(y_t,\Lambda)$ as a decreasing function of $\mu_t^{1*}(y_t,\Lambda)$:

$$\mu^{2*}(y_t,\Lambda)=1/\{1+((1-\alpha_1)(1-\alpha_2)/(\alpha_1\alpha_2))\mu^{1*}(y_t,\Lambda)/[1-\mu^{1*}(y_t,\Lambda)]\}. \tag{A.7}$$

Substitution of this expression into (A.6) gives an equation in $\mu^{1*}(y_t,\Lambda)$ and $z_t$. As no analytical solution exists, I solve that equation numerically (bisection method) to determine $\mu^{1*}(y_t,\Lambda)$, for given values of $y_t\equiv(Y_{1,t},Y_{2,t})'$. Once $\mu^{1*}(y_t,\Lambda)$ is known, $\mu^{2*}(y_t,\Lambda)$ and the consumptions can be computed using (A.7) and (A.3).

Note: the equation that pins down $\mu^{1*}(y_t,\Lambda)$ depends on the ratio of endowments $z_t$ (and not on $Y_{1,t}$ and $Y_{2,t}$ per se); thus, $\mu^{1*}(y_t,\Lambda)$ is homogenous of degree 0 in $y_t$, and (A.3) implies that date *t* consumptions are likewise homogenous of degree 1 in $y_t$. (This fact is used in Section A.2. above.)

The function $W^{i*}(y_t,\Lambda)$ (required to compute portfolio at end of period *t*-1) is defined by:

$$W^{i*}(y_t,\Lambda)\equiv E_t\sum_{s=0}^{\infty}\beta^s\omega^*(y_{t+s},\Lambda)/\omega^*(y_t,\Lambda)e_t^{i*}(y_{t+s},\Lambda), \tag{A.8}$$

where $\omega^*(y_{t+s},\Lambda)\equiv(C^{1*}(y_{t+s},\Lambda))^{(1-\sigma\phi)/\phi}(c_1^{1*}(y_{t+s},\Lambda)/\alpha_1)^{-1/\phi}$ is country i's marginal utility of good 1 at $t$+$s$ (see Sections 3.5 and A.2). The method described above allows to compute $\omega^*(y_{t+s},\Lambda)$ and $e_t^{i*}(y_{t+s},\Lambda)$ for an arbitrary endowment vector $y_{t+s}$. I compute the expected value $E_t[\omega^*(y_{t+s},\Lambda)e_t^{i*}(y_{t+s},\Lambda)]$ by numerical integration (monomial formulae described in Judd (1998, p.275)), using the fact that the conditional distribution of $\ln y_{t+s}$ (given date *t* information) is normal with mean $E_t\ln y_{t+s}=\ln y_t$ and covariance matrix $s\cdot V_\varepsilon$, where $V_\varepsilon=E\varepsilon_t\varepsilon_t'$. I truncate the series (A.8) by only using terms $0\leq s\leq 350$ (using a larger number of terms does not affect the results). The computation of the stock price (cum-dividend) $\widetilde{P_j^*}(y_t,\Lambda)$ proceeds similarly.

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**Table 1. Data: external equity holdings and trade shares**

| | (Foreign equity liabilities)/ (capital stock) | (Foreign equity assets)/GDP | | (Foreign equity liabilities)/GDP | | Imports/ (C+I+G+X) |
|---|---|---|---|---|---|---|
| | 1997 | 1997 | 2003 | 1997 | 2003 | 2003 |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* |
| Australia | 0.11 | 0.39 | 0.37 | 0.45 | 0.56 | 0.17 |
| Austria | 0.05 | 0.13 | 0.36 | 0.17 | 0.30 | 0.34 |
| Canada | 0.06 | 0.36 | 0.48 | 0.27 | 0.35 | 0.25 |
| Switzerland | 0.14 | 1.26 | 1.81 | 1.23 | 1.63 | 0.26 |
| Germany | 0.03 | 0.26 | 0.48 | 0.18 | 0.38 | 0.23 |
| Denmark | 0.09 | 0.30 | 0.74 | 0.26 | 0.56 | 0.26 |
| Spain | 0.07 | 0.11 | 0.38 | 0.27 | 0.53 | 0.22 |
| Finland | 0.06 | 0.20 | 0.62 | 0.32 | 0.80 | 0.23 |
| France | 0.07 | 0.50 | 0.74 | 0.44 | 0.63 | 0.19 |
| UK | 0.14 | 0.61 | 0.95 | 0.58 | 0.78 | 0.21 |
| Italy | 0.03 | 0.13 | 0.34 | 0.10 | 0.12 | 0.19 |
| Japan | --- | 0.10 | 0.13 | 0.07 | 0.14 | 0.09 |
| Netherlands | 0.12 | 0.88 | 1.51 | 0.95 | 1.21 | 0.35 |
| Norway | 0.16 | --- | --- | --- | --- | 0.21 |
| New Zealand | 0.11 | 0.19 | 0.25 | 0.65 | 0.57 | 0.22 |
| Portugal | 0.09 | 0.11 | 0.30 | 0.32 | 0.53 | 0.26 |
| Sweden | 0.13 | 0.54 | 0.89 | 0.50 | 0.64 | 0.27 |
| US | 0.05 | 0.35 | 0.42 | 0.31 | 0.37 | 0.12 |
| **Median** | **0.07** | **0.29** | **0.48** | **0.32** | **0.56** | **0.22** |
| **Mean** | **0.09** | **0.37** | **0.63** | **0.42** | **0.59** | **0.22** |

Notes: "Capital stock" (Col.1): physical capital stock; Foreign equity assets (liabilities): sum of FDI assets (liabilities) and portfolio equity assets (liabilities); C: private consumption; G: government purchases; I: physical investment; X: exports. Data sources: Col. (1) based on data from Kraay et al. (2005); portfolio data for Cols. (2)-(6) are from the International Investment Positions (IIP) data base (IMF). GDP, C, G, I, X data are from IFS.

## Table 2. Properties of BEA data on US international investment position, 1976-2004

### *(a) HP filtered series*

| | *Output measure: GDP-I-G* | | | | *Output measure: GDP* | | |
|---|---|---|---|---|---|---|---|
| | Std (%) | $\rho(.,Y)$ | $\rho(.,Y^*)$ | $\rho_{-1}$ | Std (%) | $\rho(.,Y)$ | $\rho(.,Y^*)$ |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* |
| $Y$ | 1.57 (.28) | **1.00 (.00)** | **0.52 (.10)** | **0.67 (.10)** | 2.08 (.24) | **1.00 (.00)** | 0.54 (.10) |
| $RER$ | 9.99 (1.56) | **-0.51 (.14)** | **-0.50 (.12)** | **0.76 (.04)** | 9.99 (1.56) | -0.21 (.20) | **-0.55 (.13)** |
| $CA$ | 3.48 (.53) | 0.01 (.15) | 0.00 (.17) | 0.04 (.08) | 2.26 (.35) | -0.11 (.13) | -0.15 (.16) |
| $\Delta FEA$ | 6.52 (1.83) | -0.09 (.11) | -0.06 (.17) | 0.19 (.15) | 4.29 (1.22) | 0.01 (.08) | **-0.27 (.11)** |
| $\Delta FEL$ | 5.34 (1.57) | -0.01 (.07) | -0.04 (.15) | 0.27 (.17) | 3.51 (1.04) | **0.10 (.06)** | -0.12 (.09) |
| $ECA$ | 3.10 (.53) | -0.16 (.15) | -0.04 (.20) | **0.26 (.11)** | 2.02 (.35) | -0.15 (.18) | **-0.37 (.09)** |
| $BCA$ | 1.77 (.25) | **0.30 (.11)** | 0.08 (.10) | **0.25 (.11)** | 1.12 (.15) | 0.03 (.19) | **0.36 (.11)** |
| $CA^{bkv}$ | 1.47 (.19) | 0.08 (.11) | 0.14 (.21) | **0.78 (.05)** | 0.94 (.12) | **-0.41 (.09)** | **0.40 (.10)** |
| $\rho(ECA, BCA)$ | | -0.05 (.13) | | | | -0.05 (.13) | |
| $\rho(\Delta FEA, \Delta FEL)$ | | **0.88 (.05)** | | | | **0.88 (.05)** | |

### *(b) Unfiltered balance of payments variables*

| | *Output measure: GDP-I-G* | | | | *Output measure: GDP* | | |
|---|---|---|---|---|---|---|---|
| | Std (%) | $\rho(.,Y)$ | $\rho(.,Y^*)$ | **Autocorr.** | Std (%) | $\rho(.,Y)$ | $\rho(.,Y^*)$ |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* |
| $CA$ | 3.79 (.57) | 0.01 (.16) | 0.01 (.15) | 0.19 (.12) | 2.46 (.38) | -0.10 (.15) | -0.13 (.14) |
| $\Delta FEA$ | 6.82 (1.57) | -0.07 (.14) | -0.01 (.19) | 0.24 (.15) | 4.49 (1.09) | 0.01 (.11) | **-0.24 (.11)** |
| $\Delta FEL$ | 5.64 (1.46) | 0.01 (.10) | 0.01 (.15) | **0.34 (.19)** | 3.71 (1.02) | 0.09 (.08) | -0.09 (.10) |
| $ECA$ | 3.28 (.52) | -0.17 (.17) | -0.05 (.21) | **0.31 (.15)** | 2.15 (.36) | -0.14 (.18) | **-0.36 (.09)** |
| $BCA$ | 2.67 (.52) | 0.23 (.20) | 0.08 (.22) | **0.66 (.06)** | 1.73 (.34) | 0.02 (.22) | **0.25 (.12)** |
| $CA^{bkv}$ | 2.25 (.27) | 0.04 (.16) | 0.19 (.25) | **0.89 (.04)** | 1.47 (.18) | -0.27 (.17) | **0.31 (.12)** |
| $\rho(ECA, BCA)$ | | -0.20 (.20) | | | | -0.21 (.20) | |
| $\rho(\Delta FEA, \Delta FEL)$ | | **0.88 (.04)** | | | | **0.88 (.04)** | |

Notes: Columns labeled Std**%**, $\rho(.,Y), \rho(.,Y^*), \rho_{-1}$ denote: standard deviations (in %), correlation with domestic output, correlation with foreign output, autocorrelation. $\rho(x,y)$: correlation between $x$ and $y$.

All data are annual. $Y$: output; $RER$: real exchange rate (consumption based). $CA$: current account (includes capital gains/losses); $\Delta FEA$: change in foreign equity assets; $\Delta FEL$: change in foreign equity liabilities; $ECA \equiv \Delta FEA - \Delta FEL$ [$BCA$]: equity [bond] component of current account; $CA^{bkv}$: conventional current account. Sample periods--current account: 1977-04; output, real exchange rate: 1972-04. Statistics for $CA, \Delta FEA, \Delta FEL, ECA, BCA, CA^{bkv}$ pertain to series that were expressed in units of US output, and normalized by a fitted geometric trend of US output.

Figures in parentheses are standard errors (GMM based, assuming 5-th order serial correlation in residuals). Underlined correlations are statistically significant at 10% level (two-sided test). Panel (a) [Panel (b)] uses current account variables that were HP filtered [not filtered]; in both Panels, $Y$ and $RER$ were logged and HP filtered.

## Table 3. Properties of IIP data for 17 OECD economies (*HP filtered series*)

### *(a) Output measure: GDP-I-G*

| | *t1* | *Y* | *CA* | *ΔFEA* | *ΔFEL* | *ECA* | *BCA* | $CA^{bkv}$ | *Y* | *CA* | *ΔFEA* | *ΔFEL* | *ECA* | *BCA* | $CA^{bkv}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ***Standard deviations (%)*** | | | | | | | ***Autocorrelations*** | | | | | | |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* | *(9)* | *(10)* | *(11)* | *(12)* | *(13)* | *(14)* | *(15)* |
| AU | 86 | 1.88 | 9.53 | 4.82 | 8.57 | 5.38 | 5.23 | 2.24 | **0.38** | -0.04 | -0.30 | **-0.25** | -0.02 | -0.07 | 0.04 |
| AT | 80 | 2.29 | 5.85 | 4.07 | 2.68 | 3.12 | 5.93 | 2.43 | **0.48** | **-0.38** | -0.13 | **-0.42** | **0.34** | -0.22 | **0.56** |
| CA | 72 | 2.98 | 5.05 | 3.29 | 3.88 | 2.55 | 4.35 | 2.44 | **0.69** | -0.23 | **0.30** | 0.13 | -0.03 | -0.30 | 0.29 |
| CH | 83 | 1.61 | 11.34 | 13.07 | 21.16 | 15.41 | 15.76 | 2.15 | **0.56** | **-0.28** | -0.00 | **-0.33** | **-0.63** | **-0.34** | -0.01 |
| DE | 80 | 1.79 | 4.10 | 3.94 | 4.09 | 2.30 | 4.72 | 2.62 | **0.58** | 0.07 | **0.36** | 0.22 | **0.27** | 0.23 | **0.74** |
| DK | 91 | 1.40 | 9.88 | 10.53 | 9.65 | 6.54 | 6.25 | 2.97 | 0.09 | **-0.31** | -0.20 | **-0.64** | -0.05 | **-0.25** | **0.56** |
| ES | 81 | 1.94 | 5.13 | 5.56 | 5.53 | 6.16 | 3.66 | 3.03 | **0.45** | **0.37** | **0.31** | **0.19** | 0.18 | 0.18 | **0.74** |
| FI | 86 | 3.53 | 55.18 | 8.16 | 60.44 | 57.69 | 8.17 | 5.10 | **0.59** | **0.30** | 0.06 | **0.31** | **0.25** | -0.11 | **0.76** |
| FR | 89 | 1.09 | 6.94 | 14.06 | 14.39 | 7.49 | 5.09 | 1.30 | 0.07 | -0.07 | 0.09 | 0.21 | -0.13 | 0.18 | **0.52** |
| UK | 80 | 2.02 | 8.57 | 13.86 | 11.05 | 7.64 | 3.86 | 2.46 | **0.53** | -0.17 | 0.09 | **0.36** | -0.19 | 0.08 | **0.67** |
| IT | 86 | 2.38 | 5.19 | 7.00 | 2.43 | 7.25 | 5.78 | 2.60 | **0.65** | 0.07 | **0.22** | 0.09 | 0.08 | **0.34** | **0.69** |
| JA | 95 | 2.32 | 6.44 | 1.17 | 8.61 | 7.87 | 2.41 | 1.18 | **0.59** | **-0.39** | -0.08 | **-0.24** | **-0.28** | 0.15 | **0.60** |
| NL | 82 | 3.35 | 16.28 | 11.02 | 10.56 | 10.36 | 13.58 | 2.21 | **0.48** | **-0.44** | -0.10 | **0.54** | -0.15 | **-0.14** | **0.48** |
| NZ | 90 | 4.06 | 20.08 | 6.53 | 13.88 | 12.85 | 12.62 | 4.61 | **0.28** | -0.08 | 0.02 | **0.40** | **0.25** | **-0.32** | **0.38** |
| PT | 96 | 4.32 | 4.48 | 3.99 | 9.29 | 10.82 | 8.21 | 6.07 | **0.42** | 0.06 | -0.19 | -0.18 | 0.19 | 0.10 | **0.45** |
| SW | 82 | 3.14 | 7.47 | 10.69 | 10.58 | 8.52 | 11.40 | 3.39 | **0.48** | 0.11 | -0.05 | 0.24 | 0.09 | 0.14 | **0.59** |
| US | 80 | 1.57 | 4.94 | 7.44 | 7.51 | 3.48 | 2.53 | 2.01 | **0.67** | -0.02 | 0.05 | 0.23 | 0.09 | -0.01 | **0.79** |
| **Median** | | 2.29 | 6.94 | 7.00 | 9.29 | 7.49 | 5.78 | 2.46 | 0.48 | -0.08 | 0.02 | 0.19 | 0.08 | -0.01 | 0.56 |
| **Mean** | | 2.45 | 10.97 | 7.60 | 12.01 | 10.32 | 7.03 | 2.87 | 0.47 | -0.08 | 0.02 | 0.05 | 0.02 | -0.02 | 0.52 |

| | ***Corr (ECA, BCA)*** | ***Corr (ΔFEA, ΔFEL)*** | *CA* | *ΔFEA* | *ΔFEL* | *ECA* | *BCA* | $CA^{bkv}$ | *Y* | *CA* | *ΔFEA* | *ΔFEL* | *ECA* | *BCA* | $CA^{bkv}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ***Corrs. with domestic output*** | | | | | | ***Correlations with foreign output*** | | | | | | |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* | *(9)* | *(10)* | *(11)* | *(12)* | *(13)* | *(14)* | *(15)* |
| AU | **0.61** | **0.81** | **0.69** | **-0.43** | **-0.67** | **0.68** | **0.56** | **0.57** | **0.56** | **0.48** | -0.37 | **-0.46** | **0.41** | **0.46** | 0.20 |
| AT | **-0.29** | **0.64** | **0.40** | **-0.17** | **-0.21** | -0.04 | **0.42** | **0.65** | 0.10 | -0.21 | -0.01 | -0.14 | **0.10** | -0.27 | -0.34 |
| CA | -0.00 | **0.75** | **0.19** | 0.18 | 0.15 | 0.00 | **0.22** | 0.24 | -0.03 | 0.11 | -0.01 | -0.18 | **0.26** | -0.01 | **-0.64** |
| CH | **-0.73** | **0.68** | 0.03 | **0.22** | **0.32** | **-0.25** | **0.26** | 0.20 | 0.22 | **-0.34** | 0.01 | 0.02 | -0.02 | **-0.22** | -0.26 |
| DE | **-0.49** | **0.83** | **-0.42** | **-0.30** | **-0.27** | -0.03 | **-0.35** | **-0.30** | **0.52** | 0.18 | 0.20 | 0.04 | 0.26 | 0.02 | -0.03 |
| DK | 0.19 | **0.79** | **0.48** | 0.20 | **0.20** | 0.02 | **0.74** | **0.28** | **0.36** | 0.01 | **0.32** | **0.39** | -0.05 | 0.06 | 0.08 |
| ES | **-0.55** | **0.36** | 0.15 | 0.03 | -0.10 | **0.11** | 0.02 | -0.05 | **0.73** | 0.15 | 0.07 | 0.00 | 0.06 | 0.11 | **-0.34** |
| FI | **-0.37** | **0.39** | 0.16 | **0.56** | -0.10 | 0.18 | -0.23 | **0.61** | 0.04 | **-0.12** | 0.05 | 0.07 | -0.07 | **-0.35** | -0.41 |
| FR | **-0.44** | **0.86** | **-0.36** | **-0.51** | -0.32 | **-0.35** | 0.02 | 0.12 | **0.46** | **0.34** | 0.09 | -0.03 | 0.24 | 0.11 | 0.20 |
| UK | 0.00 | **0.83** | **-0.29** | 0.19 | **0.42** | **-0.25** | -0.14 | -0.07 | **0.51** | -0.08 | -0.05 | 0.01 | -0.11 | 0.03 | **-0.45** |
| IT | **-0.70** | 0.07 | **0.42** | 0.08 | 0.14 | 0.02 | **0.34** | 0.36 | **0.53** | -0.07 | 0.07 | -0.10 | 0.11 | **-0.20** | -0.30 |
| JA | **-0.69** | **0.67** | -0.02 | **0.49** | 0.18 | -0.12 | **0.33** | **0.31** | **0.46** | **0.38** | -0.14 | -0.29 | **0.30** | -0.03 | **-0.20** |
| NL | -0.09 | **0.54** | **-0.41** | -0.26 | **0.45** | **-0.74** | 0.07 | 0.19 | 0.12 | -0.14 | -0.20 | 0.05 | -0.27 | 0.02 | **-0.39** |
| NZ | 0.24 | **0.38** | -0.08 | 0.11 | -0.10 | 0.17 | -0.31 | **0.34** | **0.57** | **0.52** | **-0.51** | **-0.78** | **0.58** | **0.24** | **0.43** |
| PT | **-0.92** | -0.19 | **-0.55** | **-0.90** | **0.56** | **-0.81** | **0.77** | **0.37** | 0.09 | **0.60** | **0.85** | **-0.64** | **0.87** | **-0.81** | 0.11 |
| SW | **-0.75** | **0.67** | 0.09 | 0.22 | **0.34** | **-0.15** | 0.17 | **0.76** | 0.11 | -0.21 | 0.09 | -0.03 | 0.15 | -0.25 | **-0.61** |
| US | **0.33** | **0.89** | -0.06 | -0.03 | 0.08 | **-0.25** | **0.22** | **0.23** | **0.49** | -0.14 | -0.07 | 0.00 | -0.17 | -0.04 | 0.19 |
| **Median** | -0.37 | 0.67 | 0.03 | 0.07 | 0.14 | -0.04 | 0.22 | 0.28 | 0.46 | 0.01 | 0.01 | -0.03 | 0.11 | 0.02 | -0.26 |
| **Mean** | -0.27 | 0.59 | 0.02 | -0.02 | 0.06 | -0.10 | 0.18 | 0.28 | 0.34 | 0.08 | 0.02 | -0.12 | 0.15 | -0.06 | -0.16 |

**Table 3 ctd.---**

## *(b) Output measure: GDP*

| | *Output:* | | *Corrs. with domestic output* | | | | | | *Correlations with foreign output* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *%Std* | *Autocor.* | *CA* | *ΔFEA* | *ΔFEL* | *ECA* | *BCA* | $CA^{bkv}$ | *Y* | *CA* | *ΔFEA* | *ΔFEL* | *ECA* | *BCA* | $CA^{bkv}$ |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* | *(9)* | *(10)* | *(11)* | *(12)* | *(13)* | *(14)* | *(15)* |
| AU | 1.70 | **0.53** | -0.11 | 0.03 | 0.05 | -0.05 | -0.14 | **-0.35** | **0.57** | **0.39** | -0.29 | **-0.46** | **0.46** | **0.23** | 0.00 |
| AT | 1.64 | **0.38** | 0.07 | 0.01 | -0.25 | **0.22** | -0.04 | -0.24 | **0.51** | -0.26 | 0.17 | 0.00 | **0.23** | **-0.38** | -0.30 |
| CA | 2.55 | **0.68** | -0.11 | 0.17 | 0.19 | -0.06 | -0.09 | -0.24 | **0.55** | 0.06 | **0.22** | 0.15 | 0.06 | 0.03 | **-0.53** |
| CH | 2.59 | **0.67** | **-0.28** | **-0.29** | **-0.17** | -0.01 | **-0.18** | **-0.38** | **0.51** | **-0.43** | -0.04 | -0.06 | 0.04 | **-0.35** | -0.18 |
| DE | 1.96 | **0.63** | **-0.25** | -0.01 | -0.24 | **0.42** | **-0.43** | **-0.52** | **0.68** | **0.40** | 0.20 | 0.12 | 0.13 | 0.28 | 0.21 |
| DK | 1.92 | **0.53** | -0.12 | **0.37** | **0.32** | 0.11 | **-0.32** | **-0.84** | **0.43** | **0.17** | **0.59** | **0.60** | 0.06 | 0.19 | 0.02 |
| ES | 2.71 | **0.77** | **-0.51** | 0.18 | **0.38** | -0.17 | **-0.42** | **-0.87** | **0.53** | -0.08 | **0.30** | 0.32 | -0.01 | -0.09 | **-0.47** |
| FI | 4.21 | **0.80** | -0.06 | **0.43** | 0.04 | 0.01 | **-0.54** | **-0.25** | **0.31** | **-0.13** | **0.40** | 0.10 | -0.05 | **-0.58** | **-0.47** |
| FR | 1.68 | **0.65** | **-0.36** | **-0.39** | **-0.44** | 0.12 | **-0.68** | **-0.51** | **0.62** | 0.08 | 0.18 | -0.02 | **0.39** | **-0.46** | 0.03 |
| UK | 2.37 | **0.66** | **-0.31** | **0.11** | **0.22** | -0.11 | **-0.46** | **-0.74** | **0.66** | -0.08 | 0.07 | 0.13 | -0.05 | -0.07 | **-0.62** |
| IT | 1.66 | **0.42** | **-0.47** | -0.04 | -0.17 | 0.01 | **-0.44** | **-0.54** | **0.72** | -0.20 | **0.31** | 0.01 | **0.29** | **-0.56** | **-0.45** |
| JA | 2.43 | **0.71** | **0.57** | -0.02 | **-0.54** | **0.59** | -0.41 | **-0.34** | **0.36** | 0.26 | 0.21 | -0.07 | 0.11 | 0.33 | -0.13 |
| NL | 2.26 | **0.64** | -0.03 | -0.06 | **0.37** | **-0.45** | 0.30 | -0.33 | **0.51** | 0.05 | -0.03 | 0.00 | -0.03 | 0.09 | **-0.47** |
| NZ | 2.60 | **0.48** | **-0.80** | **0.30** | **0.62** | **-0.51** | **-0.74** | **-0.30** | 0.01 | **0.59** | 0.01 | **-0.73** | **0.80** | 0.12 | **0.33** |
| PT | 3.10 | **0.56** | **0.59** | **0.54** | **-0.85** | **0.94** | **-0.90** | **-0.45** | **0.65** | **0.47** | **0.72** | **-0.50** | **0.70** | **-0.65** | -0.02 |
| SW | 2.13 | **0.54** | -0.08 | **0.40** | 0.07 | **0.41** | **-0.37** | **0.49** | 0.09 | -0.02 | 0.17 | -0.14 | **0.41** | -0.32 | **-0.50** |
| US | 2.08 | **0.55** | **-0.21** | 0.05 | 0.17 | -0.25 | -0.07 | **-0.42** | **0.49** | **-0.20** | -0.17 | 0.00 | **-0.39** | 0.13 | **0.48** |
| **Median** | 2.26 | 0.63 | -0.12 | 0.05 | 0.05 | 0.01 | -0.41 | -0.38 | 0.51 | 0.05 | 0.18 | 0.01 | 0.11 | -0.07 | -0.18 |
| **Mean** | 2.33 | 0.60 | -0.14 | 0.10 | -0.01 | 0.07 | -0.35 | -0.40 | 0.49 | 0.06 | 0.18 | -0.03 | 0.18 | -0.12 | -0.18 |

Notes: All data are annual. The sample period for current accounts differs across countries: the Col. labeled "t1" in Panel (a) denotes the first year; the sample ends in 2003, except for DK ('01) and SW ('02). Sample period for $CA^{bkv}$ : 1980-2003 (for DK: 1981-2003). Statistics that just involve output are based on 1972-2003 data.

See Appendix and Table 2 for definitions of $CA, \Delta FEA, \Delta FEL, ECA, BCA, CA^{bkv}$; for country *i*, these variables are expressed in units of foreign output, and normalized by a fitted deterministic geometric trend of country *i* output (also expressed in units of foreign output). Columns labeled *Corr(ECA,BCA)* show correlations between *ECA* and *BCA*.

All series were HP filtered (output: logged). Underlined correlations are statistically significant at a 10% level (two-sided test, based on GMM, assuming 5-th order serial correlation in residuals).

AU: Australia; AT: Austria; CA: Canada; CH: Switzerland; DE: Germany; DK: Denmark; ES: Spain; FI: Finland; FR: France; UK: United Kingdom; IT: Italy; JA: Japan; NL: Netherlands; NZ: New Zealand; PT: Portugal; SW: Sweden.

## Table 4. Predictions of model variant 1: two equal sized countries

| | CRRA utility | | | | | | | | | CARA utility | | | DATA (US) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\phi$=0.6 | | | $\phi$=0.9 | | | $\phi$=1.2 | | | $\phi$=0.6 | | | | | |
| | ***(i) Standard deviations, correlations with output, autocorrelations*** | | | | | | | | | | | | | | |
| | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* | *(9)* | *(10)* | *(11)* | *(12)* | *(13)* | *(14)* | *(15)* |
| $Y_1$ | 1.33 | 1.00 | 0.53 | 1.33 | 1.00 | 0.53 | 1.33 | 1.00 | 0.53 | 1.33 | 1.00 | 0.53 | 1.57 | **1.00** | **0.67** |
| $RER_1$ | 1.93 | 0.50 | 0.52 | 1.61 | 0.50 | 0.52 | 1.38 | 0.50 | 0.52 | 1.95 | 0.50 | 0.52 | 9.99 | **-0.51** | **0.76** |
| $CA^1$ | 1.71 | 0.22 | -0.09 | 0.98 | -0.22 | -0.09 | 2.91 | -0.22 | -0.09 | 1.68 | 0.22 | -0.09 | 3.48 | 0.01 | 0.04 |
| $\Delta FEA^1$ | 3.18 | 0.40 | -0.09 | 2.40 | -0.43 | -0.10 | 10.52 | -0.44 | -0.10 | 4.81 | 0.08 | -0.08 | 6.52 | -0.09 | 0.19 |
| $\Delta FEL^1$ | 1.98 | 0.46 | -0.10 | 1.77 | -0.46 | -0.10 | 8.80 | -0.46 | -0.10 | 6.29 | 0.12 | -0.08 | 5.34 | -0.01 | 0.27 |
| $ECA^1$ | 1.71 | 0.22 | -0.09 | 0.98 | -0.22 | -0.09 | 2.91 | -0.22 | -0.09 | 1.54 | -0.22 | -0.09 | 3.10 | -0.16 | **0.26** |
| $BCA^1$ | 0.00 | --- | --- | 0.00 | --- | --- | 0.00 | --- | --- | 3.22 | 0.22 | -0.09 | 1.77 | **0.30** | **0.25** |
| $CA^{bkv,1}$ | 0.00 | -0.13 | -0.06 | 0.00 | 0.13 | -0.06 | 0.00 | -0.13 | -0.06 | 0.03 | -0.01 | -0.13 | 1.47 | 0.08 | **0.78** |
| $S_1^1$ | 0.00 | -0.08 | 0.43 | 0.00 | 0.08 | 0.43 | 0.00 | -0.07 | 0.43 | 0.17 | -0.47 | 0.51 | | | |
| $r_1^S$ | 1.23 | 0.46 | -0.10 | 1.23 | 0.46 | -0.10 | 1.23 | 0.46 | -0.10 | 1.24 | 0.46 | -0.10 | | | |
| | ***(ii) Mean values*** | | | | | | | | | | | | | | |
| $S_1^1$ | | 0.93 | | | 1.06 | | | 1.30 | | | 0.93 | | | 0.95 | |
| $S_1^1$ (***T***=1) | | 0.93 | | | 1.06 | | | 1.30 | | | 0.93 | | | | |
| | ***(iii) Correlations*** | | | | | | | | | | | | | | |
| $\rho(ECA^1, BCA^1)$ | | --- | | | --- | | | --- | | | -0.99 | | | -0.05 | |
| $\rho(\Delta FEA^1, \Delta FEL^1)$ | | 0.87 | | | 0.93 | | | 0.96 | | | 0.99 | | | **0.88** | |
| $\rho(r_1^S, r_2^S)$ | | 0.87 | | | 0.93 | | | 0.96 | | | 0.87 | | | | |

Notes: **The Table shows predictions for country 1 variables.** $\phi$: elasticity of substitution between domestic and imported goods.

$Y_i$: country *i* output, $RER_i$: real exchange rate**;** $CA^i$ : *i*'s current account**;** $\Delta FEA^i$ **:** change in *i*'s foreign equity assets**;** $\Delta FEL^i$ **:** change in i's equity liabilities; $ECA^i \equiv \Delta FEA^i - \Delta FEL^i$: equity component of *i*'s current account; $BCA^i$ : change in *i*'s net foreign bond holdings; $CA^{bkv,i}$ : *i*'s current account at bookvalues; $S_i^i$: fraction of stock issued by country *i* that is held by *i* ( $S_i^i$ (***T***=1)**:** stock holding in two-period model version); $r_i^S$ : return on country *i* stock. The country 1 account (and its components) is normalized by fitted geometric trend of country 1 output.

Cols. 1-12: simulated statistics; Cols. 13-15: empirical statistics for US (from Tables 1 and 2). Underlined statistics are statistically significant at a 10% level. All statistics pertain to series that have been HP filtered. Output and the real exchange rate are logged before filtering. **Std%**: standard deviations (in %); $\rho_Y$ : correlation with country 1 output; $\rho_{-1}$ : autocorrelation.

## Table 5. Predictions of model variant 2: country 2 smaller than country 1

| | **CRRA** utility | | | | | | | | | **CARA utility** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\phi$=0.6 | | | $\phi$=0.9 | | | $\phi$=1.2 | | | $\phi$=0.6 | | | **DATA (G15)** | | |
| ***(i) Standard deviations, correlations with output, autocorrelations*** | | | | | | | | | | | | | | | |
| | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ | **Std%** | $\rho_Y$ | $\rho_{-1}$ |
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* | *(7)* | *(8)* | *(9)* | *(10)* | *(11)* | *(12)* | *(13)* | *(14)* | *(15)* |
| $Y_2$ | 1.97 | 1.00 | 0.47 | 1.97 | 1.00 | 0.47 | 1.97 | 1.00 | 0.47 | 1.97 | 1.00 | 0.47 | 2.29 | 1.00 | 0.48 |
| $RER_2$ | 2.74 | 0.82 | 0.44 | 2.30 | 0.82 | 0.46 | 1.97 | 0.82 | 0.46 | 2.78 | 0.82 | 0.46 | 9.03 | -0.04 | 0.57 |
| $CA^2$ | 5.20 | 0.39 | -0.08 | 2.94 | -0.39 | -0.08 | 8.70 | -0.39 | -0.08 | 5.07 | 0.39 | -0.08 | 7.47 | 0.09 | -0.07 |
| $\Delta FEA^2$ | 3.28 | 0.19 | -0.12 | 3.09 | -0.15 | -0.09 | 15.09 | -0.23 | -0.09 | 18.34 | -0.43 | -0.08 | 7.00 | 0.07 | 0.02 |
| $\Delta FEL^2$ | 6.40 | -0.24 | -0.12 | 4.76 | 0.14 | -0.10 | 17.87 | -0.01 | -0.10 | 13.47 | -0.44 | -0.08 | 9.65 | 0.14 | 0.19 |
| $ECA^2$ | 5.18 | 0.43 | -0.10 | 2.94 | -0.39 | -0.08 | 8.72 | -0.39 | -0.08 | 4.97 | -0.39 | -0.08 | 7.49 | -0.03 | 0.08 |
| $BCA^2$ | 0.02 | --- | --- | 0.00 | --- | --- | 0.03 | --- | --- | 10.04 | 0.39 | -0.08 | 5.93 | 0.17 | -0.07 |
| $CA^{bkv,2}$ | 0.00 | 0.03 | -0.12 | 0.00 | 0.04 | -0.09 | 0.01 | -0.07 | -0.09 | 0.12 | -0.05 | -0.08 | 2.60 | 0.28 | 0.56 |
| $S_2^2$ | 0.00 | -0.79 | 0.44 | 0.01 | -0.83 | 0.46 | 0.07 | 0.81 | 0.45 | 0.44 | 0.98 | 0.47 | | | |
| $r_2^{Stock}$ | 2.04 | 0.17 | -0.12 | 1.58 | -0.12 | -0.10 | 1.29 | -0.02 | -0.10 | 2.05 | -0.20 | -0.09 | | | |
| ***(ii) Mean values*** | | | | | | | | | | | | | | | |
| $S_1^1$ | | 0.99 | | | 1.00 | | | 1.00 | | | 0.99 | | | | |
| $S_2^2$ | | 0.86 | | | 1.12 | | | 1.61 | | | 0.86 | | | 0.91 | |
| $S_1^1$ (***T***=1) | | 0.99 | | | 1.00 | | | 1.00 | | | 0.99 | | | | |
| $S_2^2$ (***T***=1) | | 0.86 | | | 1.12 | | | 1.61 | | | 0.86 | | | | |
| ***(iii) Correlations*** | | | | | | | | | | | | | | | |
| $\rho(ECA^2, BCA^2)$ | | --- | | | --- | | | --- | | | -0.99 | | | -0.37 | |
| $\rho(\Delta FEA^2, \Delta FEL^2)$ | | 0.61 | | | 0.79 | | | 0.87 | | | 0.99 | | | 0.67 | |
| $\rho(r_1^S, r_2^S)$ | | 0.61 | | | 0.77 | | | 0.88 | | | 0.64 | | | | |

Notes: In the first period, country 2's output represents 1.4% of world output. **The Table shows predictions for country 2 variables. (**Variables are expressed in units of the country 1 good.)

$S_i^i$ (***T***=1): stock holdings in two-period model. See Table 4 for definitions of variables. Cols. 1-12: simulated statistics; Cols. 13-15: median empirical statistics for G15 economies (see Tables 1 and 3). Current account is normalized by fitted geometric trend of country **2** output. All statistics pertain to series that have been HP filtered. Output and the real exchange rate were logged before filtering. **Std%**: standard deviations (in %); $\rho_Y$: correlation with country **2** output; $\rho_{-1}$: autocorrelation.

## Table 6. % Impact responses to one-standard-deviation endowment innovations

### (a) Model variant 1: two equal sized countries

| | $C^1$ | $C^2$ | $c_1^2$ | $c_2^1$ | $NX^1$ | $p_2$ | $P_1$ | $P_2$ | $S_1^1$ | $S_2^2$ | $CA^1$ | $\Delta FEA^1$ | $\Delta FEL^1$ | $ECA^1$ | $BCA^1$ | $Y_1$ | $Y_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(a1) CRRA utility, $\phi$=0.6** | | | | | | | | | | | | | | | | | |
| **I)** | 1.14 | 0.16 | 1.48 | -0.17 | -0.07 | 2.45 | 1.30 | 2.45 | 0.00 | 0.00 | 1.90 | 4.07 | 2.16 | 1.90 | 0.00 | 1.30 | 0.00 |
| **II)** | 0.16 | 1.14 | -0.17 | 1.48 | 0.07 | -2.39 | 0.00 | -1.11 | 0.00 | 0.00 | -1.85 | -1.85 | 0.00 | -1.85 | 0.00 | 0.00 | 1.30 |
| **(a2) CRRA utility, $\phi$=0.9** | | | | | | | | | | | | | | | | | |
| **I)** | 1.05 | 0.24 | 1.89 | -0.58 | 0.04 | 2.03 | 1.30 | 2.03 | 0.00 | 0.00 | -1.08 | -3.02 | -1.94 | -1.08 | 0.00 | 1.30 | 0.00 |
| **II)** | 0.24 | 1.05 | -0.58 | 1.89 | -0.04 | -1.99 | 0.00 | -0.71 | 0.00 | 0.00 | 1.06 | 1.06 | 0.00 | 1.06 | 0.00 | 0.00 | 1.30 |
| **(a3) CRRA utility, $\phi$=1.2** | | | | | | | | | | | | | | | | | |
| **I)** | 1.00 | 0.30 | 2.19 | -0.86 | 0.13 | 1.74 | 1.30 | 1.74 | 0.00 | 0.00 | -3.20 | -12.87 | -9.66 | -3.20 | 0.00 | 1.30 | 0.00 |
| **II)** | 0.30 | 1.00 | -0.86 | 2.19 | -0.13 | -1.74 | 0.00 | -0.42 | 0.00 | 0.00 | 3.15 | 3.13 | -0.02 | 3.15 | 0.00 | 0.00 | 1.39 |
| **(a4) CARA utility, $\phi$=0.6** | | | | | | | | | | | | | | | | | |
| **I)** | 1.14 | 0.16 | 1.49 | -0.18 | -0.08 | 2.46 | 1.31 | 2.46 | -0.15 | 0.00 | 1.88 | 4.08 | 5.84 | -1.75 | 3.64 | 1.30 | 0.00 |
| **II)** | 0.16 | 1.14 | -0.18 | 1.49 | 0.08 | -2.40 | 0.00 | -1.12 | 0.31 | 0.17 | -1.84 | -5.92 | -7.58 | 1.65 | -3.50 | 0.00 | 1.30 |

### (b) Model variant 2: country 2 smaller than country 1

| | $C^1$ | $C^2$ | $c_1^2$ | $c_2^1$ | $NX^2$ | $p_2$ | $P_1$ | $P_2$ | $S_1^1$ | $S_2^2$ | $CA^2$ | $\Delta FEA^2$ | $\Delta FEL^2$ | $ECA^2$ | $BCA^2$ | $Y_1$ | $Y_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(b1) CRRA utility, $\phi$=0.6** | | | | | | | | | | | | | | | | | |
| I) | 1.10 | 0.28 | 1.27 | -0.13 | 0.13 | 2.07 | 1.10 | 2.07 | 0.00 | 0.01 | -3.23 | 3.55 | 6.78 | -3.23 | 0.00 | 1.10 | 0.00 |
| II) | 0.01 | 1.57 | -0.31 | 2.37 | -0.24 | -3.83 | 0.00 | -1.79 | 0.00 | -0.01 | 5.96 | 0.16 | -5.80 | 5.96 | 0.00 | 0.00 | 2.12 |
| **(b2) CRRA utility, $\phi$=0.9** | | | | | | | | | | | | | | | | | |
| I) | 1.10 | 0.41 | 1.65 | -0.43 | -0.07 | 1.71 | 1.10 | 1.71 | 0.00 | 0.01 | 1.82 | -3.45 | -5.27 | 1.82 | 0.00 | 1.10 | 0.00 |
| II) | 0.01 | 1.31 | -1.02 | 2.97 | 0.14 | -3.19 | 0.00 | -1.44 | 0.00 | -0.01 | -3.40 | 0.33 | 3.73 | -3.40 | 0.00 | 0.00 | 2.12 |
| **(b3) CRRA utility, $\phi$=1.2** | | | | | | | | | | | | | | | | | |
| I) | 1.09 | 0.51 | 1.92 | -0.64 | -0.22 | 1.46 | 1.10 | 1.46 | 0.00 | -0.04 | 5.39 | -15.47 | -20.86 | 5.39 | 0.00 | 1.10 | 0.00 |
| II) | 0.01 | 1.12 | -1.53 | 3.39 | 0.42 | -2.74 | 0.00 | -0.67 | 0.00 | 0.09 | -10.13 | -2.21 | 7.92 | -10.13 | 0.00 | 0.00 | 2.12 |
| **(b4) CARA utility, $\phi$=0.6** | | | | | | | | | | | | | | | | | |
| I) | 1.10 | 0.28 | 1.27 | -0.13 | 0.13 | 2.08 | 1.10 | 2.08 | 0.00 | 0.08 | -3.21 | 8.16 | 5.08 | 3.08 | -6.29 | 1.10 | 0.00 |
| II) | 0.01 | 1.57 | -0.32 | 2.38 | -0.24 | -3.85 | 0.00 | -1.78 | 0.01 | 0.41 | 5.94 | -21.4 | -15.8 | -5.56 | 11.50 | 0.00 | 2.12 |

Notes: **Rows labeled I): impact responses to one-standard-deviation innovation to country 1 endowment; Rows labeled II): impact responses to one-standard-deviation innovation to country 2 endowment.** The Columns labeled $C^1, C^2$ ... show responses of corresponding variables. $c_i^j$: country *i* consumption of good *j*. $NX^i$ : country 1 net exports (in units of good 1); $p_2$: price of good 2 ($p_1$≡1); $P_i$: price of stock *i*. See Table 4 for definitions of other variables.

Responses of $C^1, C^2, c_1^2, c_2^1, p, P_1, P_2, Y_1, Y_2$ are expressed as relative deviations from "unshocked" path. Responses of $S_1^1, S_2^2$: differences form "unshocked" path. Responses of country ***i*** net exports and current account (and CA components) $NX^i, A^i, CA^i, \Delta FEA^i, \Delta FEL^i, ECA^i, BCA^i$: end of period values, expressed as differences from "unshocked" path, normalized by country ***i*** pre-shock output.

Panels (a1), (a2), (a3), (a4) [(b1), (b2), (b3), (b4)] pertain to the following specifications of model variant 1 [variant 2]: CRRA utility, $\phi$=0.6; CRRA utility, $\phi$=0.9; CRRA utility, $\phi$=1.2; CARA utility, $\phi$=0.6. **(Panels (a1)-(a4) shows responses of country 1 net exports and current account variables, while Panels (b1-(b4) show responses of country 2 net exports and current account.)**

All responses have been multiplied by 100, i.e. expressed in percentage terms.

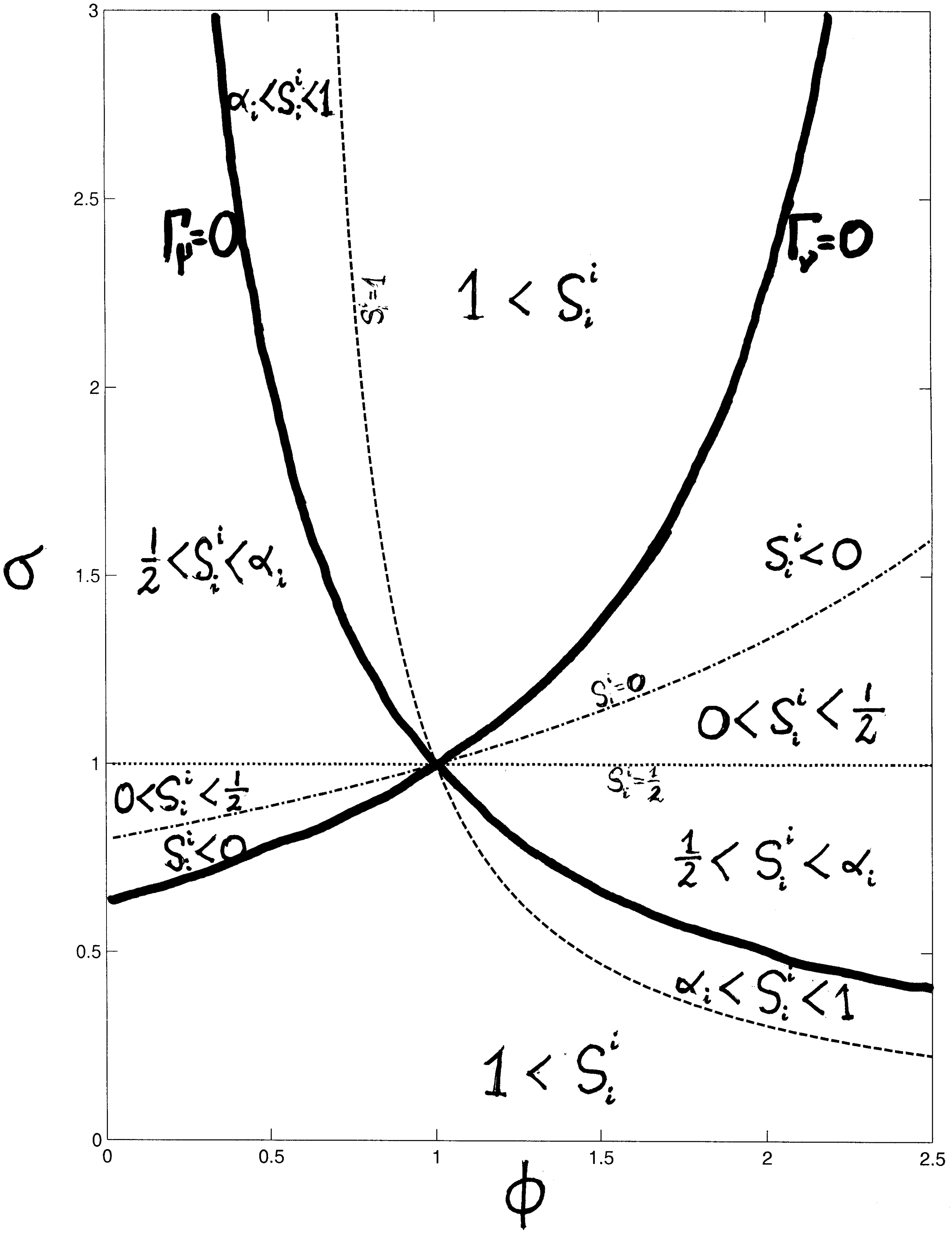


Figure 1. Local stock holding $S_i^i$ ($i$=1,2) for different combinations of $\phi$ (elasticity of substitution between domestic and imported goods) and $\sigma$ (risk aversion coefficient), two-period model with equal sized countries (model variant 1: $\alpha_1=\alpha_2=0.9$).

Downward sloping thick line ▬: $\Gamma_\mu=0$; upward sloping thick line ▬: $\Gamma_\nu=0$;

- - -: $S_i^i$=1; ····: $S_i^i$=0.5; -·-·: $S_i^i$=0.

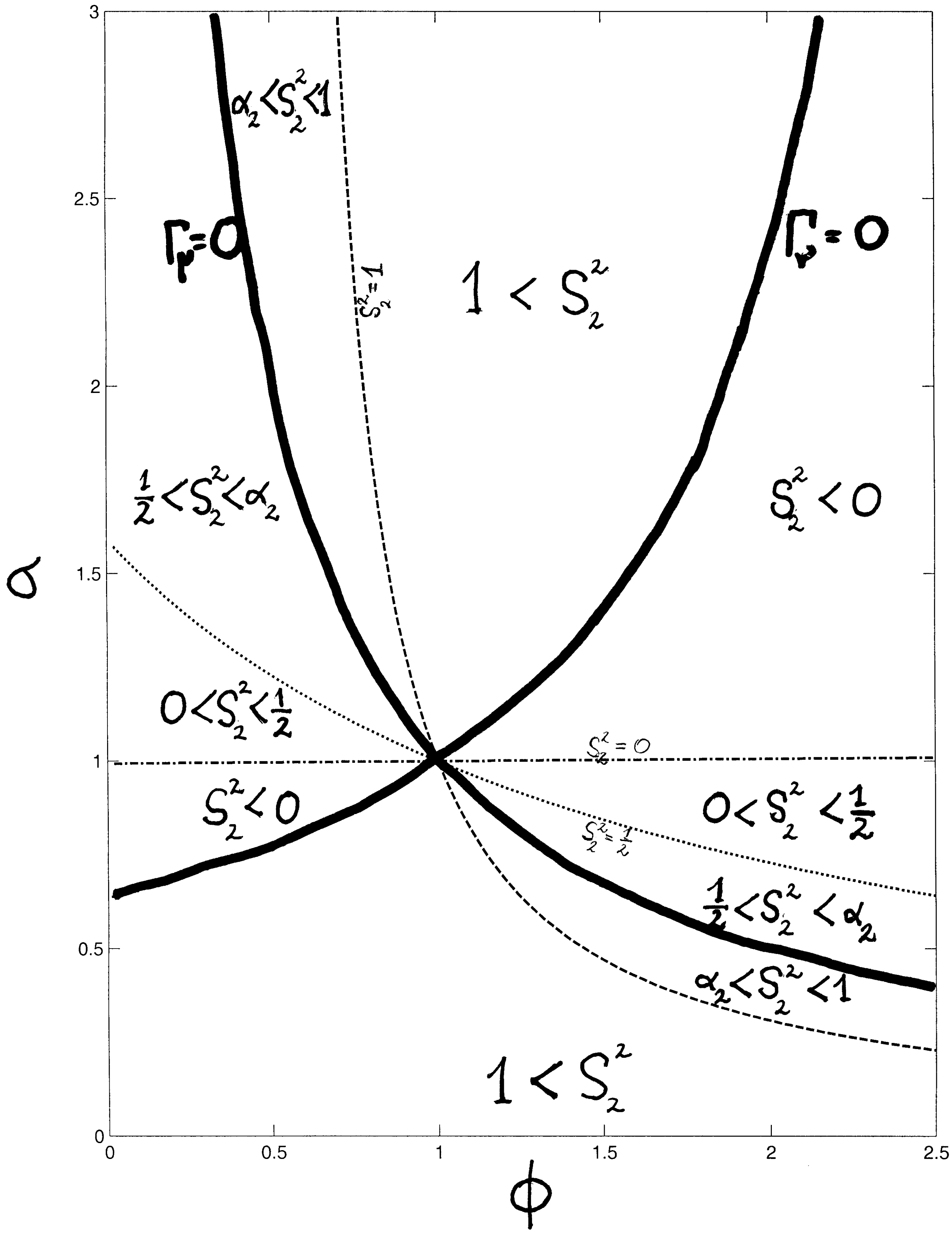


Figure 2. Country 2 local stock holding $S_2^2$ for different combinations of $\phi$ (elasticity of substitution between domestic and imported goods) and $\sigma$ (risk aversion coefficient), two-period model with country 2 smaller than country 1 (model variant 2: $\delta_{2,0}$=0.014$\delta_{1,0}$; $\alpha_1$=0.997, $\alpha_2$=0.8). Downward sloping thick line ▬: $\Gamma_\mu=0$ ; upward sloping thick line ▬: $\Gamma_\nu=0$ ;
- - - : $S_2^2$=1; •••• : $S_2^2$=0.5; -·-·- : $S_2^2$=0.