The Valuation Channel of External Adjustment*

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Abstract

Ongoing financial integration across countries has greatly increased two-way foreign asset holdings, enhancing the scope for a "valuation channel" of external adjustment (i.e., the changes in a country's net foreign asset position due to exchange rate and asset price changes). We examine this channel of adjustment in a dynamic stochastic general equilibrium model with international equity trading. We find that two-way foreign asset holdings are necessary for the emergence of a valuation channel. Its quantitative importance depends on features of the international transmission mechanism such as the size of financial frictions, substitutability across goods, and the persistence of shocks. We also find that the model can replicate key moments of changes in the U.S. net foreign asset position.

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1 Introduction

The cumulative total of the U.S. current account deficits since 1996 would have been sufficient to increase net foreign liabilities to about 30 percent of GDP. Yet, U.S. net foreign liabilities increased to only about 20 percent of GDP over the same period. The difference is due to valuation effects, namely, the effects of asset price and exchange rate movements on the stock of gross assets and liabilities of the United States and the rest of the world. The experience of the United States brings out the point that external adjustment can take place not only through changes in quantity and price of goods and services, but also through changes in asset prices—e.g., Gourinchas and Rey (2005), Obstfeld (2005) and Lane and Milesi-Ferretti (2005).

This paper explores the valuation channel of external adjustment in a two-country dynamic stochastic general equilibrium model (DSGE) with international equity trading. Specifically, we study the conditions that give rise to the valuation channel, as well as the determinants of its relative importance in external adjustment and we illustrate its working.

We introduce two-way international equity trading in an otherwise standard two-country, DSGE model with monopolistic competition and incomplete asset markets. To focus on household's consumption and portfolio behavior, we consider a very simple production structure. Output is produced using only labor subject to country-wide productivity shocks, and labor supply is inelastic. However, product differentiation across countries ensures that the consumption value of a country's output depends on its relative price, which is endogenous to the conditions of the economy. Monopolistic competition, based on product differentiation within countries, generates non-zero profits and firm values (essential for the asset dynamics we focus on) and introduces price-setting power.

Markets are incomplete across countries. The source of incompleteness are two: a financial friction and labor immobility across countries. Specifically, we assume that households can hold non-contingent bonds and shares in firms, but only the latter are traded internationally. Thus, different from most of the literature, we focus on equity rather than bond trading as the key mechanism for international consumption smoothing and risk sharing. Equity trades are subject to financial intermediation costs that enable us to determine endogenously the international distribution of wealth and the composition of country portfolios in and off the steady state. Even in the absence of this financial friction, international trade in shares in firm profits does not replicate complete markets because risk sharing is limited to the profit fraction of income as labor cannot move across countries in response to shocks. So the extent of risk sharing is crucially affected by the distribution of income between profits and labor income in our model.

The portfolio choice of the representative household in our model depends on time-varying expected return differentials adjusted for financial intermediation costs. In the log-linear solution of the model around a deterministic steady state, our portfolio choice is not affected by standard risk diversification motives captured by conditional second moments of asset returns and consumption, although it has implications for the conditional second moments of the data (e.g., Lettau, 2003). Nonetheless, owing to financial intermediation costs, we have a well defined portfolio decision in and off the steady state. Although this setup does not help to explain the contribution of the diversification motive to the recent increase in financial integration, it embeds asset supply considerations that can help explain global external imbalances (e.g., Caballero et al., 2006). Indeed, this set up provides a novel and flexible framework to investigate the return-driven movements of the valuation channel in external adjustment.

Our main results are as follows. In our theoretical analysis, we find that two-way asset trading is necessary for a valuation channel of external adjustment to emerge. However, other traditional frictions and features of the international transmission mechanism, such as the size of financial frictions, substitutability across goods, and the persistence of shocks, determine the magnitude and significance of this channel of adjustment. Relative productivity shocks induce larger asset equity price differentials, and hence valuation changes, the more persistent the shocks, the more substitutable home and foreign goods, the larger financial frictions, and the more impatient households. The degree of substitutability between home and foreign goods, however, has no effect on the relative share of valuation change and the current account in net foreign asset changes. A preliminary quantitative analysis also shows that, for plausible parameter values, the model can match qualitatively the volatility, persistence, and comovement of empirical moments of changes in the U.S. net foreign asset position, especially when the steady state net foreign asset position is different from zero.

Our work is closely related to that of Kim (2002), Tille (2005), Blanchard, Giavazzi, and Sa (2005), Devereux and Saito (2005), and Beigno (2006). All these contributions focus on the role of the exchange rate in the valuation channel. We focus on the role of underlying return differentials, which are quantitatively at least as important as exchange rate movements, as Tille (2005) documents (showing that they are more important than exchange rates for valuation effects in 8 of the last 15 years). Unlike Tille (2005), steady-state net foreign assets are pinned down endogenously, and can differ from zero, in our model. We also have a well defined time-varying portfolio decision off steady state and consider shocks that have effects also when all prices are fully flexible. Like Blanchard et al (2005), we set up a portfolio problem with imperfect asset substitutability, but consider a fully specified DSGE model that enables us to investigate the interaction of portfolio decisions with more traditional mechanisms in the international transmission of shocks. Kim (2002) does not provide a fully specified model of the valuation channel, while

Devereux and Saito (2005) build a finance model with no production. Benigno (2006) and Ghironi, Lee, and Rebucci (2006) provides a normative analysis of valuation effects and their consequences for optimal monetary, the analysis in this paper is positive.

Emphasis on macroeconomic dynamics also distinguishes our model from finance models of international equity trading, which focus on asset pricing at the cost of reducing output dynamics to an exogenous stochastic process (Adler and Dumas, 1983). Pavlova and Rigobon (2003) give more prominence to macroeconomic dynamics, but they do not model firms' decisions explicitly. Our model differs from earlier DSGE models of international real business cycles (RBCs) in that we incorporate differentiated goods and monopolistic competition. Moreover, many international RBC studies did not model international asset trading by assuming complete markets (for instance, Backus, Kehoe, and Kydland, 1992).

A few other papers aim at explaining home bias in portfolio or international financial integration by allowing for international equity trading in standard international macroeconomic models (Engel and Matsumoto, 2005; Heathcote and Perri, 2002 and 2004; and Kollmann, 2005), but they do not focus on the process of external adjustment.

The rest of the paper is organized as follows. Section 2 spells out the structure of the model. Section 3 study the valuation channel in two cases that can be solved analytically. Section 4 illustrates the working of the valuation channel in this setting by means of a numerical example and evaluates the model quantitatively. Section 5 concludes. Technical details are in appendixes.

2 The Model

There are two countries, home and foreign, populated by infinitely lived, atomistic households. World population equals the continuum $[0, 1]$. Home households are indexed by $j \in [0, a)$; foreign households are indexed by $j^* \in [a, 1]$.

There is a continuum of monopolistically competitive firms on $[0, 1]$, each producing a differentiated good. Home firms are indexed by $z \in [0, a)$; foreign firms are indexed by $z^* \in [a, 1]$.

2.1 Households

The representative home household j supplies one unit of labor inelastically in each period in a competitive labor market for the nominal wage rate W_t. As customary, we denote consumption with C and the consumer price index (CPI) with P. Money serves the sole role of unit of account, since we assume that prices and wages are flexible. Therefore, we adopt a cashless specification following Woodford (2003).

The preferences of the representative home household j are:

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{\left(C_s^j\right)^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}, \tag{1}$$

with $0 < \beta < 1$ and $\sigma > 0$.

The representative foreign household j^* maximizes a similar utility function, with the same intertemporal elasticity of substitution but a potentially different discount factor $\beta^* \in (0,1)$, and supplies one unit of labor inelastically in each period in a competitive foreign labor market.

The consumption basket C aggregates sub-baskets of individual home and foreign goods in a CES fashion:

$$C_t^j = \left[a^{\frac{1}{\omega}}\left(C_{Ht}^j\right)^{\frac{\omega-1}{\omega}} + (1-a)^{\frac{1}{\omega}}\left(C_{Ft}^j\right)^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}}, \tag{2}$$

where $\omega > 0$ is the elasticity of substitution between home and foreign goods. The consumption sub-baskets C_H and C_F aggregate individual home and foreign goods, respectively, in a Dixit-Stiglitz fashion with elasticity of substitution $\theta > 1$:

$$C_{Ht}^j = \left[\left(\frac{1}{a}\right)^{\frac{1}{\theta}} \int_0^a \left(c_t^j(z)\right)^{\frac{\theta-1}{\theta}} dz\right]^{\frac{\theta}{\theta-1}}, \quad C_{Ft}^j = \left[\left(\frac{1}{1-a}\right)^{\frac{1}{\theta}} \int_a^1 \left(c_t^j(z^*)\right)^{\frac{\theta-1}{\theta}} dz^*\right]^{\frac{\theta}{\theta-1}}. \tag{3}$$

This structure of consumption preferences implies:

$$P_t = \left[aP_{Ht}^{1-\omega} + (1-a)P_{Ft}^{1-\omega}\right]^{\frac{1}{1-\omega}}$$

where P_H (P_F) is the price sub-index for home (foreign)-produced goods – both expressed in units of the home currency. Letting $p_t(z)$ be the home currency price of good z, we have:

$$P_{Ht} = \left(\frac{1}{a}\int_0^a p_t(z)^{1-\theta} dz\right)^{\frac{1}{1-\theta}}, \quad P_{Ft} = \left(\frac{1}{1-a}\int_a^1 p_t(z^*)^{1-\theta} dz^*\right)^{\frac{1}{1-\theta}}.$$

We assume that the law of one price holds for each individual good: $p_t(z) = \mathcal{E}_t p_t^*(z)$, where $\mathcal{E}_t$ is the nominal exchange rate (the domestic-currency price of a unit of foreign currency) and $p_t^*(z)$ is the foreign currency price of good z.

Consumption preferences are identical across countries. This assumption and the law of one price imply that consumption-based PPP holds: $P_t = \mathcal{E}_t P_t^*$, where P_t^* is the foreign CPI.

Agents in each country can hold domestic, non-contingent bonds denominated in units of the domestic currency, and shares in domestic and foreign firms. Different from most literature, we assume that shares, and not bonds, are traded across countries for international risk sharing and consumption smoothing purposes.

Omitting identifiers for households, firms, and countries, we use x_{t+1} to denote holdings of shares in firms entering period $t+1$, V_t to denote the nominal price of shares during period t, D_t to denote nominal dividends, and B_{t+1} to denote nominal bond holdings entering period $t+1$. Households pay quadratic financial transaction fees to domestic financial intermediaries when they hold share positions that differ from zero.[1] Table 1 summarizes the details of our notation when agent and country identifiers are taken into account.

Table 1. Notation summary
$x_{t+1}^{z,j}$ = share of *home* firm z held by home agent j entering period $t+1$.
$x_{t+1}^{z^*,j}$ = share of *foreign* firm z^* held by home agent j entering period $t+1$.
$x_{*,t+1}^{z,j}$ = share of *home* firm z held by foreign agent j^* entering period $t+1$.
$x_{*,t+1}^{z^*,j}$ = share of *foreign* firm z^* held by foreign agent j^* entering period $t+1$.
V_t^z = price of shares in profits of home firm z starting in period $t+1$.
$V_t^{z^*}$ = price of shares in profits of foreign firm z^* starting in period $t+1$.
D_t^z = dividends paid by home firm z.
$D_t^{z^*}$ = dividends paid by foreign firm z^*.
B_{t+1}^j = stock of *home* bonds held by home agent j entering period $t+1$.
$B_{*,t+1}^{*,j}$ = stock of *foreign* bonds held by foreign agent j^* entering period $t+1$.
$\frac{\gamma_x}{2}\int_0^a \frac{V_t^i}{P_t}\left(x_{t+1}^{z,j}\right)^2 dz$ = *home* intermediation cost of holding shares in home firms.
$\frac{\gamma_{x^*}}{2}\int_a^1 \frac{\mathcal{E}_t V_t^{i^*}}{P_t}\left(x_{t+1}^{z^*,j}\right)^2 dz^*$ = *home* intermediation cost of holding shares in foreign firms.
$\frac{\gamma_x^*}{2}\int_0^a \frac{V_t^i}{P_t}\left(x_{*,t+1}^{z,j}\right)^2 dz$ = *foreign* intermediation cost of holding shares in home firms.
$\frac{\gamma_{x^*}^*}{2}\int_a^1 \frac{\mathcal{E}_t V_t^{i^*}}{P_t}\left(x_{*,t+1}^{z^*,j}\right)^2 dz^*$ = *foreign* intermediation cost of holding shares in foreign firms.

The budget constraint of home household j is:

$$\begin{aligned}
& B_{t+1}^j + \int_0^a V_t^z x_{t+1}^{z,j} dz + \mathcal{E}_t \int_a^1 V_t^{z^*} x_{t+1}^{z^*,j} dz^* + \\
& + \frac{\gamma_x}{2}\int_0^a V_t^z \left(x_{t+1}^{z,j}\right)^2 dz + \mathcal{E}_t \frac{\gamma_{x^*}}{2}\int_a^1 V_t^{z^*}\left(x_{t+1}^{z^*,j}\right)^2 dz^* + P_t C_t^j \\
= \; & (1+i_t) B_t^j + \int_0^a \left(V_t^z + D_t^z\right) x_t^{z,j} dz + \mathcal{E}_t \int_a^1 \left(V_t^{z^*} + D_t^{z^*}\right) x_t^{z^*,j} dz^* + W_t + P_t T_t^j, \qquad (4)
\end{aligned}$$

where the γ's are positive parameters, i_{t+1} (i_{t+1}^*) is the nominal interest rate on holdings of home (foreign) bonds between t and $t+1$, T_t^g is a lump-sum transfer from the government, and T_t^j is a lump-sum transfer from financial intermediaries.

[1] These fees play a central role in pinning down country portfolios and the international distribution of wealth, in and off steady state. Since aggregate bond holdings are zero in equilibrium in each country, financial fees on bond transactions can be omitted without loss of generality.

The financial transaction fees in the budget constraint are rebated to home households in equilibrium.[2] Thus, the lump-sum rebate of financial intermediation fees to household j is:

$$T_t^j = \frac{\gamma_x}{2}\int_0^a \frac{V_t^z}{P_t}\left(x_{t+1}^{z,j}\right)^2 dz + \frac{\gamma_{x^*}}{2}\int_a^1 \frac{\mathcal{E}_t V_t^{z^*}}{P_t}\left(x_{t+1}^{z^*,j}\right)^2 dz^*. \tag{5}$$

Besides pinning down country portfolios and the international distribution of wealth – ensuring steady-state determinacy and model stationarity – these costs of financial intermediation are consistent with Cooley and Quadrini (1999) model of limited participation in financial markets. We allow the scaling parameters of financial fees (γ_x, γ_{x^*}, γ_x^*, $\gamma_{x^*}^*$) to differ across countries and across assets. As we shall see, this has interesting implications for the steady state of the economy. The foreign household's budget constraint is similar.

First-Order Conditions Home household j maximizes (1) subject to (4) taking the seignorage and financial fee transfers as given. The first-order conditions (F.O.C.s) with respect to B_{t+1}^j (domestic bond), $x_{t+1}^{z,j}$ (share of home firm), and $x_{t+1}^{z^*,j}$ (share of foreign firm) are, respectively:

$$\left(C_t^j\right)^{-\frac{1}{\sigma}} = \beta\left(1+i_{t+1}\right)E_t\left[\frac{P_t}{P_{t+1}}\left(C_{t+1}^j\right)^{-\frac{1}{\sigma}}\right], \tag{6}$$

$$\left(C_t^j\right)^{-\frac{1}{\sigma}} V_t^z\left(1+\gamma_x x_{t+1}^{z,j}\right) = \beta E_t\left[\left(C_{t+1}^j\right)^{-\frac{1}{\sigma}}\left(V_{t+1}^z + D_{t+1}^z\right)\frac{P_t}{P_{t+1}}\right], \tag{7}$$

$$\left(C_t^j\right)^{-\frac{1}{\sigma}} V_t^{z^*}\left(1+\gamma_{x^*} x_{t+1}^{z^*,j}\right) = \beta E_t\left[\left(C_{t+1}^j\right)^{-\frac{1}{\sigma}}\left(V_{t+1}^{z^*} + D_{t+1}^{z^*}\right)\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\frac{P_t}{P_{t+1}}\right]. \tag{8}$$

Similar F.O.C.s hold for the foreign household.[3]

2.2 Firms

The representative, monopolistically competitive, home firm z produces output with linear technology using labor as the only input:

$$Y_t^{Sz} = Z_t L_t^z, \tag{9}$$

where Z_t is the aggregate stochastic home productivity.[4]

Home firm z faces demand for its output given by:

$$Y_t^{Dz} = \left(\frac{p_t(z)}{P_{H,t}}\right)^{-\theta}\left(\frac{P_{H,t}}{P_t}\right)^{-\omega} Y_t^W = \left(RP_t^z\right)^{-\theta}\left(RP_t\right)^{\theta-\omega} Y_t^W, \tag{10}$$

[2] We think about the financial intermediaries in the model as local, perfectly competitive firms owned by home households. There is no cross-border ownership of these firms.

[3] We omit transversality conditions.

[4] The assumptions that labor is supplied inelastically and is the only factor of production imply that output of the each country's sub-basket of goods is exogenously determined by productivity. Importantly, however, each country's GDP in units of the world consumption basket is endogenous, as it depends on the relative price of the country's output in terms of consumption, which is determined by the pricing decisions of firms.

where $RP_t^z \equiv \frac{p_t(z)}{P_t}$ is the price of good z in units of the world consumption basket, $RP_t \equiv \frac{P_{H,t}}{P_t}$ is the price of the home sub-basket of goods in units of the world consumption basket, and Y_t^W is aggregate world demand of the consumption basket.

Firm profit maximization results in the pricing equation:

$$RP_t^z = \frac{\theta}{\theta - 1} \frac{w_t}{Z_t}, \tag{11}$$

where $w_t \equiv W_t / P_t$. Since $RP_t^z = RP_t$ at an optimum, labor demand is determined by

$$L_t^z = L_t = RP_t^{-\omega} \frac{Y_t^W}{Z_t}. \tag{12}$$

2.3 Relative Prices, GDP, and Income Distribution

We relegate aggregate equilibrium conditions for household behavior to an appendix and focus here on the determination of some key variables in our model.

Define home aggregate per capita GDP in units of consumption as $y_t \equiv aRP_t Y_t^z / a = RP_t Z_t$ (where we used the equilibrium condition $aL_t^z / a = L_t^z = 1$) and world aggregate per capita GDP as $y_t^W \equiv ay_t + (1 - a) y_t^* = aRP_t Z_t + (1 - a) RP_t^* Z_t^*$. Market clearing in aggregate per capita terms requires $aL_t^z / a = L_t = 1 = RP_t^{-\omega} y_t^W / Z_t$, and similarly in the foreign economy. We thus have a system of two equations in two unknowns that pins down home and foreign relative prices:

$$\begin{aligned} 1 &= RP_t^{-\omega} \frac{aRP_t Z_t + (1 - a) RP_t^* Z_t^*}{Z_t} \\ 1 &= (RP_t^*)^{-\omega} \frac{aRP_t Z_t + (1 - a) RP_t^* Z_t^*}{Z_t^*}. \end{aligned} \tag{13}$$

PPP implies that the real exchange rate is equal to one in all periods. The terms of trade between representative home and foreign goods, instead, change over time and are given by

$$TOT_t = \frac{p_t(z)}{\mathcal{E}_t p_t^*(z^*)} = \frac{P_{H,t}}{\mathcal{E}_t P_{F,t}^*} = \frac{RP_t}{RP_t^*} = \left(\frac{Z_t^*}{Z_t} \right)^{\frac{1}{\omega}}. \tag{14}$$

A positive productivity shock in the home economy causes the terms of trade to deteriorate as increased supply of home goods lowers their relative price. Note that, when $\omega = 1$, the terms of trade move one-for-one with the productivity differential, as in Cole and Obstfeld (1991) and Corsetti and Pesenti (2001).

Given the path of RP_t implied by (13), the real wage that clears the labor market is in turn determined by:

$$w_t = \frac{(\theta - 1) RP_t Z_t}{\theta} = \frac{(\theta - 1) y_t}{\theta}. \tag{15}$$

In a perfectly competitive environment in which $\theta \to \infty$, all GDP per capita would be distributed to domestic labor in the form of wage income. In a monopolistically competitive environment with constant markups, a share $1/\theta$ of GDP is distributed as profits:

$$d_t = y_t - w_t = \frac{1}{\theta} w_t \tag{16}$$

The distribution of GDP between wages and profits will be an important determinant of the properties of our model as we discuss below.

2.4 Steady-State Equity Holdings and Asset Returns

We present the details of the solution for the steady state of the model in appendix. Here, we report some key results on steady-state net foreign assets, and asset holdings, returns, and prices.

Denoting steady-state levels of variables by dropping the time subscript, home net foreign assets are given by:

$$nfa \equiv v^* x^* - \frac{(1-a)}{a} v x_* \tag{17}$$

where the net foreign asset position of the foreign economy satisfies the market clearing constraint $nfa + nfa^* = 0$. Substituting from the appendix, we have that:

$$nfa = \frac{(1-a)}{\theta} \left[\frac{\gamma^*_{x^*}}{\Gamma_1} - \frac{\gamma_x}{\Gamma_2} \right]$$

where:

$$\begin{aligned} \Gamma_1 &= (1-\beta)\left[(1-a)\gamma_{x^*} + a(1-\beta)\gamma^*_{x^*}\right] + \gamma_{x^*}\gamma^*_{x^*} \\ \Gamma_2 &= (1-\beta)\left[(1-a)\gamma_x + a(1-\beta)\gamma^*_x\right] + \gamma_x\gamma^*_x \end{aligned}$$

While the difference in steady-state rates of return on equity is:

$$\frac{d}{v} - \frac{d^*}{v^*} = \frac{1}{\beta(1-a)} \left(\frac{\gamma_x \gamma^*_x}{\gamma_x + \gamma^*_x \frac{a}{1-a}} - \frac{\gamma_{x^*}\gamma^*_{x^*}}{\gamma_{x^*} + \gamma^*_{x^*}\frac{a}{1-a}} \right). \tag{18}$$

Then for $\beta \to 1$, we have that:

$$NFA \to \frac{(1-a)}{\theta} \left(\frac{1}{\gamma_{x^*}} - \frac{1}{\gamma^*_x} \right).$$

Home net foreign assets will be lower the higher the intermediation costs faced by home agents in foreign equity markets, and the lower the intermediation cost faced by foreign agents in home equity markets. The asset position will be zero if $\gamma_{x^*} = \gamma^*_x$, with gross positions of equal value but opposite sign, proportional to the cost of intermediating equity in the foreign country.

Even if $\gamma_{x^*} = \gamma_x^*$, the equity return differential may be different from zero. To be zero, it requires equal intermediation costs across home and foreign equity within each country, with potentially different costs across countries for the same equity ($\gamma_x = \gamma_{x^*}$ and $\gamma_x^* = \gamma_{x^*}^*$), or equal costs across countries for the same equity with potentially different costs across home and foreign equity within each country (if $\gamma_x = \gamma_x^*$ and $\gamma_{x^*} = \gamma_{x^*}^*$).

If $\beta \neq 1$, the net foreign asset position depends on all intermediation costs scale parameters, reflecting the relative convenience of the two equities in the two markets.

3 Valuation Changes and the Transmission of Shocks

In this section we provide a decomposition of changes in net foreign assets into valuation changes and the current account, with valuation changes and the current account further decomposed into their components.[5] We then analyze the determinants of valuation changes and the transmission of relative productivity shocks in two special cases of our model that can be solved analytically in log-linear form.

3.1 Valuation Changes and the Current Account

Home aggregate per capita real net foreign assets entering period $t+1$ are:

$$nfa_{t+1} \equiv v_t^* x_{t+1}^* - v_t x_{*t+1}. \tag{19}$$

Assume for simplicity that the home and foreign economies have equal size ($a = 1/2$) and the steady state of the model is such that $v = v^*$ and $x^* = x_*$. (Throughout, we assume that structural parameters are such that the symmetry properties we appeal to are satisfied.) Log-linearizing (19) and denoting percent deviations from steady-state levels with a hat yields:

$$\widehat{nfa}_{t+1} = (\hat{v}_t^* - \hat{v}_t) + \left(\hat{x}_{t+1}^* - \hat{x}_{*t+1}\right), \tag{20}$$

where $\widehat{nfa}_{t+1} \equiv \mathsf{d}nfa_{t+1}/vx$, reflecting the fact that $nfa = 0$ when $vx_* = v^*x^*$. The change in net foreign assets is then written as:

$$\widehat{nfa}_{t+1} - \widehat{nfa}_t = \left[\left(\hat{v}_t^* - \hat{v}_{t-1}^*\right) - (\hat{v}_t - \hat{v}_{t-1})\right] + \left[\left(\hat{x}_{t+1}^* - \hat{x}_t^*\right) - (\hat{x}_{*t+1} - \hat{x}_{*t})\right]. \tag{21}$$

The first square bracket on the right-hand side of (21) is the valuation change on the existing stock of net foreign assets due to changes in real equity prices. Changes in real equity values, in

[5] As measured in the balance of payments, the current account does not include capital gains on investments, while the international investment position incorporates them. This component of investment income, however, enters the textbook definition of total asset return.

turn, can be decomposed into changes in their nominal determinants (nominal equity prices, the price level, and the exchange rate). Specifically, $\hat{v}_t = \hat{V}_t - \hat{P}_t$ and $\hat{v}_t^* = \hat{V}_t^* - \hat{P}_t^* = \hat{V}_t^* - \left(\hat{P}_t - \widehat{\mathcal{E}}_t\right)$. This decomposition allows us to highlight a difference between our model with equity trading and the more familiar framework with international trade in bonds. In our economy, the nominal components of real equity prices have no independent effect on real equity values (and thus net foreign assets) because all prices involved are fully flexible. In an economy with bond trading, the nominal interest rate between $t-1$ and t is predetermined relative to the price level at t, resulting in a valuation effect of nominal price movements on outstanding bond positions via unexpected movements of *ex post* real interest rates under fully flexible goods prices.[6]

The second square bracket in (21) is the change in net foreign assets due to purchases and sales of assets and liabilities, i.e., portfolio rebalancing. This portfolio rebalancing term corresponds to the current account balance that comprises the income and trade balance. To see this, assume further that the steady state is such that $x = x^* = 1/2$ and $d = d^*$. Log-linearizing the equilibrium budget constraint in aggregate per capita terms and imposing the log-linear asset market equilibrium condition $\hat{x}_{t+1} = -\hat{x}_{*t+1}$, we obtain:

$$\left(\hat{x}_{t+1}^* - \hat{x}_t^*\right) - \left(\hat{x}_{*t+1} - \hat{x}_{*t}\right) = \frac{d}{v}\left[\left(\hat{d}_t^* + \hat{x}_t^*\right) - \left(\hat{d}_t + \hat{x}_{*t}\right)\right] + 2\left(\frac{d}{v}\hat{d}_t + \frac{w}{v}\hat{w}_t - \frac{C}{v}\hat{C}_t\right). \qquad (22)$$

The first term on the right-hand side is the dividend income flow from net foreign assets accumulated in the previous period, while the second term is the trade balance.[7] Thus, the portfolio rebalancing term in equation (21) is the current account balance.

As a corollary of the equations above, it is evident that valuation changes can play a role in the adjustment of net foreign assets in response to shocks in our model only if cross-border equity holdings differ from zero. When there is no cross-border share holding, both components of net foreign assets in (19) are zero (since $x_{t+1}^* = x_{*t+1} = 0$ in this case), and there is no role for valuation changes.

Note that, in general, because of equity cross-ownership, corporate policies on dividend payouts affect the dynamics of external adjustment. The underlying assumption of our model is that all profits are distributed as dividends. However, if companies choose to retain profits internally, this can reduce the magnitude of current account variation in (22) and enhance the relative role of valuation changes in external adjustment (Obstfeld, 2005).

[6] Tille (2005) analyzes the valuation effects arising from this limited flexibility of bond prices. Our model examines the valuation channel when asset prices themselves are fully flexible. Furthermore, in our model, changes in real equity prices are the only source of valuation effects, since the real exchange rate is constant owing to purchasing power parity.

[7] The "2" that normalizes the trade balance originates from the fact that, with equal country size, asset market equilibrium requires $x_{t+1} + x_{*t+1} = 1$. In the symmetric steady state of this example, this implies $x = x_* = 1/2$. Division of both sides by vx in the log-linearization of the budget constraint results in the presence of the 2.

The analog to (22) in the foreign economy is:

$$-\left(\hat{x}^*_{t+1}-\hat{x}^*_t\right)+\left(\hat{x}_{*t+1}-\hat{x}_{*t}\right)=\frac{d}{v}\left[-\left(\hat{d}^*_t+\hat{x}^*_t\right)+\left(\hat{d}_t+\hat{x}_{*t}\right)\right]+2\left(\frac{d}{v}\hat{d}^*_t+\frac{w}{v}\hat{w}^*_t-\frac{C}{v}\hat{C}^*_t\right), \quad (23)$$

where we used the fact that $x = x^* = 1/2$ implies $x_* = x^*_* = 1/2$ via market clearing.

Subtracting (23) from (22) and using a superscript D to denote cross-country differences (home minus foreign) yields:

$$\hat{x}^D_{t+1}=\left(1+\frac{d}{v}\right)\hat{x}^D_t+\frac{w}{v}\hat{w}^D_t-\frac{C}{v}\hat{C}^D_t, \quad (24)$$

where $\hat{x}^D_{t+1}=\hat{x}^*_{t+1}-\hat{x}_{*t+1}$ measures home's net cross-border share holdings. Notice the resemblance between (24) and standard, log-linear laws of motion for net foreign bond holdings in the more familiar framework. In our model, the steady-state gross return on share holdings replacing the steady-state gross interest rate.

3.2 Valuation and Transmission around a Symmetric Steady State

We now complete the solution of the log-linear model for the case of a fully symmetric steady state in which everything is identical across two equal-sized countries (so that, in particular, $x = x^* = x_* = x^*_* = 1/2$).

Exploiting $\widehat{RP}^D_t = -(1/\omega)\hat{Z}^D_t$ and the definitions of home and foreign GDP's in units of consumption ($y_t = RP_t Z_t$ and $y^*_t = RP^*_t Z^*_t$, respectively) it is immediate to verify that the log-linear GDP differential is proportional to relative productivity:

$$\hat{y}^D_t=\left(\frac{\omega-1}{\omega}\right)\hat{Z}^D_t. \quad (25)$$

As expected, there is no GDP differential if $\omega = 1$.

Since dividends and wage income are constant fractions of GDP, it follows immediately that

$$\hat{w}^D_t=\hat{d}^D_t=\left(\frac{\omega-1}{\omega}\right)\hat{Z}^D_t. \quad (26)$$

Using the steady-state properties of the model, we may then rewrite the law of motion (24) as:

$$\hat{x}^D_{t+1}=\frac{(1+\gamma)}{\beta}\hat{x}^D_t+\frac{(\theta-1)(1-\beta+\gamma)}{\beta}\left(\frac{\omega-1}{\omega}\right)\hat{Z}^D_t-\frac{\theta(1-\beta+\gamma)}{\beta}\hat{C}^D_t, \quad (27)$$

where γ is the scaling parameter of financial frictions, common across equities and countries, and β is the common household discount factor.

We show in an appendix that no-arbitrage across different equities implies that expected relative consumption growth is tied to net cross-border share holdings, and relative share valuation reflects expected future share prices and dividends:

$$\hat{C}_t^D = E_t \hat{C}_{t+1}^D + \frac{\sigma\gamma/2}{1+\gamma/2} \hat{x}_{t+1}^D. \tag{28}$$

$$\hat{v}_t^D = \frac{\beta}{1+\gamma} E_t \hat{v}_{t+1}^D + \frac{1-\beta+\gamma}{1+\gamma} E_t \hat{d}_{t+1}^D. \tag{29}$$

Note that, absent financial frictions ($\gamma = 0$), the consumption differential follows a random walk: Any differential at time t is expected to persist at $t+1$. As we show below, consistent with models with bond trading only, the link between expected relative consumption growth and relative cross-border share holdings introduced when $\gamma > 0$ is crucial to deliver stationary responses to temporary shocks.

Equations (26) and (29) allow us to solve for the determinants of relative share prices (and thus the valuation effect). Assuming that home and foreign productivities $\hat{Z}_t$ and $\hat{Z}_t^*$ follow $AR(1)$ processes with common persistence $\phi_Z \in [0, 1)$, we have:

$$\hat{v}_t^D = \eta_{v^D Z^D} \hat{Z}_t^D = \left(\frac{1-\beta+\gamma}{1+\gamma-\beta\phi_Z} \right) \left(\frac{\omega-1}{\omega} \right) \phi_Z \hat{Z}_t^D. \tag{30}$$

The effect of relative productivity shocks on relative share prices depends on the persistence of the shock (ϕ_Z), the elasticity of substitution between home and foreign goods (ω), the size of financial frictions (γ), and the patience of households (β). We assume $0 \leq \gamma < 1$ and $\omega \geq 1$. Combining these assumptions with the restrictions $0 < \beta < 1$ and $0 \leq \phi_Z < 1$, we can conclude that:

$$\begin{aligned} \frac{\partial \eta_{v^D Z^D}}{\partial \phi_Z} &= \left(\frac{\omega-1}{\omega} \right) \frac{(1-\beta+\gamma)(1+\gamma)}{(1+\gamma-\beta\phi_Z)^2} \geq 0, \quad \frac{\partial \eta_{v^D Z^D}}{\partial \omega} = \frac{(1-\beta+\gamma)\phi_Z}{(1+\gamma-\beta\phi_Z)\,\omega^2} \geq 0, \\ \frac{\partial \eta_{v^D Z^D}}{\partial \gamma} &= \left(\frac{\omega-1}{\omega} \right) \frac{\beta\phi_Z (1-\phi_Z)}{(1+\gamma-\beta\phi_Z)^2} \geq 0, \quad \frac{\partial \eta_{v^D Z^D}}{\partial \beta} = -\left(\frac{\omega-1}{\omega} \right) \frac{\phi_Z (1-\phi_Z)(1+\gamma)}{(1+\gamma-\beta\phi_Z)^2} \leq 0. \end{aligned}$$

Relative productivity shocks induce larger changes in relative share valuation the more persistent the shocks, the more substitutable home and foreign goods, the larger financial frictions, and the more impatient households. Notice that purely temporary productivity shocks ($\phi_Z = 0$) have no effect on relative share valuation, because the differential in share prices is determined by its expected future level and expected relative dividends, which are not affected by the shock if this has no persistence.

No arbitrage around the fully symmetric steady state implies that we can solve for the dynamics of relative consumption and cross-border share holdings independently of the path of $\hat{v}_t^D$, by solving the system of equations (27) and (28). The solution for $\hat{x}_{t+1}^D$ and $\hat{C}_t^D$ takes the form:

$$\hat{x}_{t+1}^D = \eta_{x^D x^D} \hat{x}_t^D + \eta_{x^D Z^D} \hat{Z}_t^D, \tag{31}$$

$$\hat{C}_t^D = \eta_{C^D x^D} \hat{x}_t^D + \eta_{C^D Z^D} \hat{Z}_t^D. \tag{32}$$

Applying the method of undetermined coefficients, the elasticity $\eta_{x^D x^D}$ solves the quadratic equation:

$$\eta^2_{x^D x^D} - \left[1 + \frac{1+\gamma}{\beta} + \frac{\theta(1-\beta+\gamma)\gamma/2}{\beta(1+\gamma/2)}\right]\eta_{x^D x^D} + \frac{1+\gamma}{\beta} = 0. \tag{33}$$

If $\gamma = 0$, this equation has solutions 1 and $1/\beta$, and – discarding the explosive solution $1/\beta$ – we are left with the familiar unit root for net cross-border share holdings as in models with bond trading only and no stationarity inducing device. When $\gamma > 0$, there is still an explosive solution larger than 1, and the unit root is "pulled" inside the unit circle, between 0 and 1, ensuring stationary net foreign equity dynamics in response to temporary shocks.

Given the stable root $\eta_{x^D x^D}$, the solutions for the other elasticities are:

$$\begin{aligned}
\eta_{C^D x^D} &= \frac{\sigma\gamma/2}{(1+\gamma/2)(1-\eta_{x^D x^D})}\eta_{x^D x^D} > 0, \\
\eta_{x^D Z^D} &= \frac{(\theta-1)(1-\beta+\gamma)}{\beta}\left(\frac{\omega-1}{\omega}\right)\left[1 + \frac{\theta(1-\beta+\gamma)}{\beta(1-\phi_Z)}\left(\eta_{C^D x^D} + \frac{\sigma\gamma/2}{1+\gamma/2}\right)\right]^{-1} \geq 0, \\
\eta_{C^D Z^D} &= \frac{1}{1-\phi_Z}\left(\eta_{C^D x^D} + \frac{\sigma\gamma/2}{1+\gamma/2}\right)\eta_{x^D Z^D} \geq 0.
\end{aligned} \tag{34}$$

Note that our model replicates the result of Cole and Obstfeld (1991) and Corsetti and Pesenti (2001) that the economy mimics complete markets, and there is no movement in net cross-border share holdings nor consumption differential if $\omega = 1$. In that case, the terms of trade move in directly proportional fashion with relative productivity, there is no GDP differential, and $\eta_{x^D Z^D} = \eta_{C^D Z^D} = 0$, ensuring that $\hat{C}^D_t = \hat{x}^D_{t+1} = 0$ in all periods given the initial condition $\hat{x}^D_t = 0$ in the period of a shock.

We are thus in a position to draw conclusions on the determinants of net foreign asset changes. Using the results above yields:

$$\widehat{nfa}_{t+1} - \widehat{nfa}_t = -\left(\frac{1-\beta+\gamma}{1+\gamma-\beta\phi_Z}\right)\left(\frac{\omega-1}{\omega}\right)\phi_Z\left(\hat{Z}^D_t - \hat{Z}^D_{t-1}\right) - (1-\eta_{x^D x^D})\hat{x}^D_t + \eta_{x^D Z^D}\hat{Z}^D_t. \tag{35}$$

Of course, given the initial condition $\hat{x}^D_t = \hat{Z}^D_{t-1} = 0$, there is no change in net foreign assets if $\omega = 1$, since there is no valuation change and $\eta_{x^D Z^D} = 0$. The relative contributions of valuation and current account to the change in net foreign assets induced by a relative productivity shocks are thus given by:

$$\begin{aligned}
VALShare_t &\equiv \frac{-\left(\hat{v}^D_t - \hat{v}^D_{t-1}\right)}{\widehat{nfa}_{t+1} - \widehat{nfa}_t} = \left(1 - \frac{\hat{x}^D_{t+1} - \hat{x}^D_t}{\hat{v}^D_t - \hat{v}^D_{t-1}}\right)^{-1}, \\
CAShare_t &\equiv \frac{\hat{x}^D_{t+1} - \hat{x}^D_t}{\widehat{nfa}_{t+1} - \widehat{nfa}_t} = \left[1 - \left(\frac{\hat{x}^D_{t+1} - \hat{x}^D_t}{\hat{v}^D_t - \hat{v}^D_{t-1}}\right)^{-1}\right]^{-1},
\end{aligned} \tag{36}$$

where the minus sign at the numerator of $VALShare_t$ follows from the fact that an increase in the relative price of home equity contributes negatively to home's net foreign assets. Note that $VALShare_t + CAShare_t = 1$, but $VALShare_t$ and $CAShare_t$ are not individually constrained to being between 0 and 1. For instance, a more than proportional contribution of valuation can offset a negative share of the current account in a given increase in net foreign assets.

The ratio $\left(\hat{x}_{t+1}^D - \hat{x}_t^D\right) / \left(\hat{v}_t^D - \hat{v}_{t-1}^D\right)$ has solution:

$$\frac{\hat{x}_{t+1}^D - \hat{x}_t^D}{\hat{v}_t^D - \hat{v}_{t-1}^D} = \frac{-\left(1-\eta_{x^D x^D}\right)\hat{x}_t^D + \eta_{x^D Z^D}\hat{Z}_t^D}{\left(\frac{1-\beta+\gamma}{1+\gamma-\beta\phi_Z}\right)\left(\frac{\omega-1}{\omega}\right)\phi_Z\left(\hat{Z}_t^D - \hat{Z}_{t-1}^D\right)}. \tag{37}$$

The elasticity $\eta_{x^D x^D}$ from (33) does not depend on substitutability between home and foreign goods (ω). Thus, when evaluating the effect of ω on the relative share of valuation in net foreign asset changes, we may restrict attention to the ratio

$$\frac{\eta_{x^D Z^D}\hat{Z}_t^D}{\left(\frac{1-\beta+\gamma}{1+\gamma-\beta\phi_Z}\right)\left(\frac{\omega-1}{\omega}\right)\phi_Z\left(\hat{Z}_t^D - \hat{Z}_{t-1}^D\right)}.$$

Inspection of the solution for $\eta_{x^D Z^D}$ in (34) shows that this ratio is independent of ω (because $(\omega-1)/\omega$ appears at both numerator and denominator). Therefore, the degree of substitutability between home and foreign goods has no effect on the relative shares of valuation and the current account in net foreign asset changes. The effect of other parameters – specifically, of the size of financial frictions, γ – on the relative share of valuation versus the current account in net foreign asset changes cannot be disentangled analytically in such simple fashion. Thus, we evaluate it by means of numerical examples in the next section. However, before turning to a different special case that can be tackled analytically, we address the consequences of completely removing financial frictions.

Trade in Risky Assets Revisited The issue of what happens with $\gamma = 0$ is of interest because the textbook intuition is that frictionless trade in two equities in an environment with only two shocks – such as the one we are exploring – should reproduce the full insurance allocation of complete asset markets. So the question we address here is whether our model delivers the complete markets equilibrium if $\gamma = 0$ (and $\omega \neq 1$) owing to the ability to trade equity at no cost in the presence of productivity shocks only.

With $\gamma = 0$, it is $\eta_{x^D x^D} = 1$ and the solution of the model takes the form:

$$\hat{x}_{t+1}^D = \hat{x}_t^D + \eta_{x^D Z^D}\hat{Z}_t^D, \tag{38}$$

$$\hat{C}_t^D = \eta_{C^D x^D}\hat{x}_t^D + \eta_{C^D Z^D}\hat{Z}_t^D. \tag{39}$$

For the solution to replicate complete markets, it must be $\hat{C}_t^D = 0$. In other words, (given the initial condition $\hat{x}_t^D = 0$ at the time of a shock) it must be $\eta_{C^D Z^D} = \eta_{x^D Z^D} = 0$. The conjecture (38)-(39) must now be substituted in the system:

$$\begin{aligned}
\hat{x}_{t+1}^D &= \frac{1}{\beta}\hat{x}_t^D + \frac{(\theta-1)(1-\beta)}{\beta}\left(\frac{\omega-1}{\omega}\right)\hat{Z}_t^D - \frac{\theta(1-\beta)}{\beta}\hat{C}_t^D, \\
\hat{C}_t^D &= E_t\hat{C}_{t+1}^D.
\end{aligned}$$

Doing this and applying the method of undetermined coefficients yields:

$$\eta_{C^D x^D} = \frac{1}{\theta}, \quad \eta_{x^D Z^D} = \frac{(\theta-1)(1-\beta)}{1-\beta\phi_Z}\left(\frac{\omega-1}{\omega}\right), \quad \eta_{C^D Z^D} = \frac{(\theta-1)(1-\beta)}{\theta(1-\phi_Z)(1-\beta\phi_Z)}\left(\frac{\omega-1}{\omega}\right).$$

Therefore, the solution does not coincide with the full insurance outcome in which $\hat{C}_t^D = 0$. Relative productivity shocks case a consumption differential on impact, and the consumption differential persists as a consequence of the unit root in net cross-border share holding dynamics.

This result highlights an important property of our model with equity trading. It is well known that if the world economy consists of two countries consuming the same good, with country-specific stochastic endowments of the good, CRRA preferences, and the ability to trade equity in the form of shares in the endowments of the good, frictionless trade in these equities will lead to the complete markets equilibrium. (For instance, see the discussion of this case in Obstfeld and Rogoff's, 1996, textbook.) The same mechanism carries through to the case of two goods and a CES aggregator. But the crucial difference is that our model does not allow trade in equity claims on endowments. Our equity provides claims to profits, with the rest of a country's income going to wages. To put it differently, even with symmetric equity holdings, only part of GDP gets to be shared between home and foreign residents. The wage portion is kept wholly by the residents of each country. As the result, even with $\gamma \to 0$ (and thus frictionless trade in two equities in a world with only two shocks), the equilibrium does not converge to complete risk sharing.

This reasoning is confirmed by the results above. For equity trading to result in full insurance, all of a country's GDP should be distributed as profit, leaving nothing for wages. The share of dividends in GDP is $1/\theta$, implying that all of GDP goes to shareholders in the limiting case in which $\theta \to 1$ (the maximum possible degree of monopoly power). As one can see from the expressions above, $\eta_{C^D Z^D} \to 0$ in this case, and so does $\eta_{x^D Z^D}$. There is full risk sharing under the initial, symmetric equity allocation, and (given the initial condition $\hat{x}_t^D = 0$ at the time of a shock) the equilibrium is such that $\hat{C}_t^D = \hat{x}_{t+1}^D = 0$ in all periods.

Under this interpretation, we can conclude that a proper definition of equity in a production economy (claims to profit rather than whole output) is sufficient to disturb completeness of the market in the "conventional" case. The deviation from full consumption risk sharing is smaller the higher the degree of monopoly power along the two dimensions that are commonly explored in international macroeconomics: the higher monopoly power of individual producers within a country (the closer θ to 1) and the higher monopoly power of a country over its sub-basket of goods (the closer ω to 1). This result points to a difference between economies with bond trading only and our model with equity trading. In the economy with bond trading, $\omega = 1$ is the only scenario in which incomplete markets reproduce the full consumption insurance of complete markets. Once we allow for international trade in shares issued by firms with monopoly power, full consumption insurance across countries arises also with $\omega \neq 1$ if firms' monopoly power is extreme.[8]

3.3 Full Equity Cross-Ownership

Consider now a steady state in which equities issued by each country are wholly owned by residents of the other country (we call this full cross-shareholding). In terms of our notation: $x = 0$, $x_* = 1$, $x_*^* = 0$, and $x^* = 1$. This portfolio allocation arises endogenously by assuming that investing abroad is costless in both the home and the foreign economy (with common friction of size γ for domestic investment). Under this steady-state configuration, equity prices are $v = v^* = \beta / [\theta (1 - \beta)]$, but steady-state levels of wages, dividends, consumption, and relative prices are the same as in the previous case.

We show in an appendix that the following system now determines the dynamics of relative equity and the consumption differential:

$$\hat{x}_{t+1}^D = \frac{1}{\beta}\hat{x}_t^D + \frac{(1-\beta)(\theta-2)}{2\beta}\left(\frac{\omega-1}{\omega}\right)\hat{Z}_t^D - \frac{(1-\beta)\theta}{2\beta}\hat{C}_t^D, \tag{40}$$

$$\hat{C}_t^D = E_t\hat{C}_{t+1}^D + \sigma\gamma\hat{x}_{t+1}^D, \tag{41}$$

where we have conveniently redefined $\hat{x}_t^D \equiv -2\hat{x}_{*t}$.[9]

The solution of this system has the same form as (31)-(32). The elasticity $\eta_{x^D x^D}$ now satisfies:

$$\beta\eta_{x^D x^D}^2 - \left[1 + \beta + \frac{(1-\beta)\sigma\gamma\theta}{2}\right]\eta_{x^D x^D} + 1 = 0. \tag{42}$$

As before, we select the stable root between 0 and 1 when $\gamma > 0$. The other elasticities are

[8] See Cass and Pavlova (2004) for additional findings on the fragility of the welfare properties of the Lucas Trees model. We explore the normative implications of this result and its consequences for optimal monetary policy in a sticky-price version of our model in Ghironi, Lee, and Rebucci (2006).

[9] In this scenario, for analytical tractability, we allow countries to go short in their aggregate equity positions.

determined by:

$$\begin{aligned}
\eta_{C^D x^D} &= \frac{\sigma\gamma\eta_{x^D x^D}}{1-\eta_{x^D x^D}}, \\
\eta_{x^D Z^D} &= \frac{(1-\beta)(\theta-2)}{2\beta}\left(\frac{\omega-1}{\omega}\right)\left[1+\frac{\theta(1-\beta)\sigma\gamma}{2\beta(1-\eta_{x^D x^D})(1-\phi_Z)}\right]^{-1}, \\
\eta_{C^D Z^D} &= \frac{\sigma\gamma\eta_{x^D Z^D}}{(1-\eta_{x^D x^D})(1-\phi_Z)}.
\end{aligned} \tag{43}$$

The equity price differential now obeys:

$$\hat{v}_t^D = \beta E_t \hat{v}_{t+1}^D + (1-\beta) E_t \hat{d}_{t+1}^D - \gamma \hat{x}_{t+1}^D, \tag{44}$$

where the difference from the symmetric case is due to the non-symmetric steady-state equity holdings. Notice that the dynamics of share holdings now affect relative share valuation. This has the consequence of making relative valuation sensitive to zero-persistence productivity shocks via their effect on share holdings entering the following period.

We show in an appendix that the relative contribution of the current account and valuation changes to net foreign asset changes following shocks with no persistence is now:

$$\frac{\hat{x}_{t+1}^D - \hat{x}_t^D}{\hat{v}_t^D - \hat{v}_{t-1}^D} = \frac{1-\beta\eta_{x^D x^D}}{2\gamma}. \tag{45}$$

The relative contribution of the valuation change in (45) is higher the higher γ (the common financial intermediation cost on domestic shares).[10] When domestic financial intermediation is more costly (larger γ), valuation changes play a bigger role, as portfolio rebalancing entails larger costs. The relative contribution of valuation changes also increases with $\eta_{x^D x^D}$, which is larger when σ and/or θ become smaller. Lower values of these parameters lead to lower intertemporal substitution (more consumption smoothing) and weaker competition (higher profits and equity prices). As in the symmetric case, the elasticity of substitution between home and foreign goods, ω, does not affect the relative contribution of valuation change and current account, but it plays a critical role in determining the extent of adjustment via terms of trade movements.

Trade in Risky Assets Revisited (II) Does the asymmetry of the steady state affect the conclusion we reached above on the inability of trade in equity to mimic complete markets? The answer is no, but with an interesting difference. In this case, it is possible to verify that $\gamma = 0$

[10] A larger γ also causes $\eta_{x^D x^D}$ to decrease, but the net effect on the relative share of valuation in net foreign asset changes is positive.

yields the solution:

$$\begin{aligned}\hat{x}_{t+1}^{D} &= \hat{x}_{t}^{D}+\frac{(1-\beta)(\theta-2)}{2}\left(\frac{\omega-1}{\omega}\right)\hat{Z}_{t}^{D}, \\ \hat{C}_{t}^{D} &= \frac{2}{\theta}\hat{x}_{t}^{D}+\frac{(1-\beta)(\theta-2)}{\theta(1-\phi_{Z})}\left(\frac{\omega-1}{\omega}\right)\hat{Z}_{t}^{D}.\end{aligned}$$

As before, the equilibrium does not mimic complete markets, and the intuition is the same – sharing is limited only to a portion of GDP. However, assuming $\omega \neq 1$, it is no longer the case that $\theta = 1$ (and thus complete distribution of GDP to profits) is required for full consumption insurance to arise. This now happens when $\theta = 2$, i.e., with a share of dividends in GDP equal to $1/2$. With full cross-border shareholding, complete consumption insurance arises when half of GDP is allocated to profits, and the remainder goes to wages. The wage income portion is now necessary to compensate for the effect of full initial cross-border equity ownership on income sharing.

4 Quantitative Analysis

In this section we investigate the quantitative properties of the model by comparing data-based and model-based moments under alternative model specifications and parameter values. As in section (3), countries have equal size ($a = 1/2$) and bonds are not traded internationally. We consider two different configurations of international financial integration: (i) zero steady-state net foreign assets with symmetric equity cross-shareholding as in section 3 and (ii) non zero steady-state net foreign assets. In the first case, the benchmark economy, all scale parameters have the same value, $\gamma_{x^*}^* = \gamma_x = \gamma_{x^*} = \gamma_x^* = 0.01$, set so as to obtain realistic gross foreign asset and liability positions, both of about 100 percent of annual GDP. In the second case, the cost to foreign agents of holding home equity is lower than the cost of holding foreign equity (i.e., $\gamma_{x^*}^* = 0.01$ and $\gamma_x^* = 0.006$), while the cost to home agents of holding foreign shares is higher than the cost of holding home equity (i.e., $\gamma_x = 0.006$ and $\gamma_{x^*} = 0.01$). Thus, both home and foreign agents have a preference for the home economy's shares. As a result, the steady state price of home equity is bid higher than the price of foreign shares, while the distribution of equity share-holding remains symmetric as in the benchmark case.[11] This result in a net foreign liability position of the home economy of about 25 percent of annual GDP.

As for the choice of parameter values, we consider a standard parametrization, and explore some alternatives. We set relative risk aversion to 2 ($\sigma = 0.5$) and the elasticity of substitution across individual goods produced in each country to imply a 20 percent markup of prices over marginal cost (θ =6, as in Rotemberg and Woodford, 1992). We set a low elasticity of substitution between home and foreign sub-baskets of goods (ω=1.5), increasing it to 3 in the sensitivity

[11] The configuration of scale parameters that generates a gven net foreign asset position is not unique.

analysis.[12] We set $\beta = \beta^* = .99$, implying an annual real interest rate of about 4 percent in steady state.

We assume that the exogenous (log) productivities in the two countries follow $AR(1)$ processes with no cross-border spillover, an autoregressive parameter of 0.95, and innovations with one percent standard deviation.

4.1 Moments

Data-based business cycle moments for the U.S. economy as well as values from our benchmark economy and some of the alternatives we consider are reported in Table 1.[13] Looking at the data for the U.S. economy first (column 1), three features of the change in net foreign assets stands out. First, this measure of external balance is much more volatile than the trade balance or the current account balance. Second, while the trade balance and the current account are countercyclical, the change in net foreign assets is a-cyclical. Third, the change in net foreign assets is slightly less persistent than the trade balance and current account.[14] From Table 1, we also can see that home equity prices are highly volatile, highly correlated across countries, procyclical, as well as relatively persistent.

Looking next at theoretical moments (columns 2-4),[15] we can see that our model matches qualitatively the volatility, comovement with output, and persistence of changes in the U.S. net foreign asset position, albeit not perfectly. The model can generate changes in net foreign assets that are more volatile than the current account and the trade balance, are much less correlated with output and are less persistent than the trade balance and the current account. The model, however, underpredics equity price volatility and overpredicts equity price comovement across countries. As a result, the matching of the moments of the changes in U.S. net foreign assets is less than fully satisfactory from a quantitative standpoint. The absence of investment in the model also generates a pro-cyclical trade balance and current account.[16]

If persistence of the productivity process is lower, e.g., 0.9, we obtain a better match of the output and consumption volatility, but the performance of the model in terms of net foreign asset dynamics worsens (results not reported). So high persistence is a key ingredient to match the moments of the data we are focusing on. Similarly, if we increase the degree of substitutability

[12] Estimates of the elasticity of substitution between domestic and foreign goods range from values close to 1 in the macro literature to as high as 12 in the micro, trade literature.

[13] Data-based moments are computed as we describe in appendix.

[14] The persistence of the change in net foreign assets is much smaller than that of the current account or the trade balance at annual frequency (see Kollmann, 2005, for instance.)

[15] Theoretical moments are exact and computed with DYNARE.

[16] Making the scale parameter in the financial intermediation technology stochastic may permit us to do better on equity prices volatility and persistence, and hence help to match moments of the U.S. net foreign asset position in a quantitatively more satisfactory manner.

between home and foreign goods—say $\omega = 3, 6$ and 12, respectively—and thus decrease risk sharing through terms of trade movements, we obtain progressively more realistic correlations between home and foreign output and consumption,[17] but the model performance in terms of net foreign asset dynamics would worsen as the ratio of valuation change to current account is constant in this case, but the current account dynamics is taken away from the data by higher values of ω (again results not reported).

Tightening the degree of financial friction, by increasing financial intermediation costs parametrized by γ, affects both the overall amount of risk sharing allowed for in the model through asset markets as well as its composition. Table 1 suggests that increasing γ reduces the overall amount of risk sharing that takes place through asset markets and skews its composition toward valuation effects. All measures of external balance become less volatile and persistent with higher gamma, but net foreign asset changes does it more than the trade balance and the current account and, as the impulse responses below show, the ratio of valuation change to current account increases. A higher degree of financial friction makes risk sharing through portfolio rebalancing more costly. Agents therefore are less willing to engage in international trade in equity to smooth their consumption, and asset prices play a larger role in the transmission of productivity shocks. However, despite the large change in γ, the overall impact on either consumption volatility or the comovement between home and foreign consumption is limited. This is because with a low elasticity of substitution between home and foreign goods, plenty of risk sharing is already taking place through terms of trade.

Interestingly, introducing a net foreign asset position different from zero in the home economy increases the volatility net foreign asset changes by generating higher equity price volatility for a comparable comovement between home and foreign equity prices. The persistence of net foreign asset changes, however, falls close to zero in this case, while comovements with output are not affected significantly.

4.2 Impulse Responses

To further illustrate the working of the model, we also report some impulse responses to a productivity shock originating in the home economy. Consider a one-percent productivity shock in the home economy shock (i.e., a one-standard-deviation innovation) with 0.9 persistence and $\omega = 1.2$.[18] Figure 1 reports the response of the net foreign assets (nfa) and its two components, the valuation change (vD) and the net cross-share holding (xD), in the benchmark economy and the case in

[17] As most international real business cycle models, our model predicts consumption correlations across countries always higher than output correlations.

[18] The slightly different parameter values do not affect the conclusions we draw from these impulse responses. All other parameters are like in the benchmark economy in Table 1.

which $\omega = 3$ and $\gamma = 0.1$, respectively. Figure 1.a reports changes in net foreign assets and its two components. Figure 2 reports valuation and current account shares in the same cases (with 1 denoting the case in which $\omega = 3$ and 2 denoting the case in which $\gamma = 0.1$ for $\omega = 1.2$) and consumption differentials across countries. Finally, Figure 3 reports world consumption together with country-specific consumption responses, again, in the same two cases.

These impulse responses bring out the following points:

- Figure 1: A favorable relative productivity shock to the home economy causes the relative price of shares in home equity to increase and home households to increase their holdings of foreign equity (relative to foreign holdings of home equity) to smooth consumption. Thus, the relative increase in the value of home equity initially contributes negatively to home net foreign assets. So adjustment through asset prices offset in part adjustment through portfolio rebalancing. Over time, however, the two components switch sign.

- Figure 1.a:

  - Since vD returns to steady state monotonically after the initial increase, vD-vD(-1) is negative in all periods after the initial one.
  - xD-xD(-1) is positive, though decreasing, and eventually negative (consistent with the hump-shaped response of xD).
  - The combination of these two effects results in a rate of change in nfa that is larger than the rate of change in xD, as the rate of change in vD contributes positively after the initial period.

- Figure 2:

  - ω determines the share of adjustment that takes place through terms of trade changes, leaving the relative share of current account and valuation change unaffected.
  - Higher γ, for given ω, determines how much risk sharing through asset market takes place and affects the split between portfolio rebalancing and valuation change. The higher γ, the higher the valuation share, but of a smaller pie.

- Figure 3: the benchmark economy seems already close to market completeness to begin with, because of a low ω value.

5 Conclusions

[TO BE ADDED: See introduction and abstract for main results]

A Appendix

A.1 Aggregation and Equilibrium Household Behavior

We present here aggregate equilibrium conditions for household behavior, focusing on the home economy. Before doing that, we first define the following notation for equity holdings:

$\int_0^a x_{t+1}^{z,j} dz = a x_{t+1}^{z,j} \equiv x_{t+1}$: share of home equity held by the representative home household.

$\int_a^1 x_{t+1}^{z^*,j} dz^* = (1-a)\, x_{t+1}^{z^*,j} \equiv x_{t+1}^*$: share of foreign equity held by the representative home household.

$\int_0^a x_{t+1}^{z,j^*} dz = a x_{t+1}^{z,j^*} = x_{*,t+1}$ = share of home equity held by the representative foreign household.

$\int_a^1 x_{t+1}^{z^*,j^*} dz^* = (1-a)\, x_{t+1}^{z^*,j^*} = x_{*,t+1}^*$ = share of foreign equity held by the representative foreign household.

Households Equilibrium in bond markets implies that aggregate per capita bond holdings are zero in each country, since bonds are not traded internationally. Given the notation above, equilibrium in the international market for equities requires:

$$
\begin{aligned}
a x_{t+1} + (1-a) x_{*,t+1} &= a, \\
a x_{t+1}^* + (1-a) x_{*,t+1}^* &= 1-a.
\end{aligned}
\tag{46}
$$

Equilibrium versions of household budget constraint and Euler equations in aggregate per capita terms are thus given by:

$$
v_t x_{t+1} + v_t^* x_{t+1}^* + C_t = (v_t + d_t)\, x_t + (v_t^* + d_t^*)\, x_t^* + w_t, \tag{47}
$$

$$
C_t^{-\frac{1}{\sigma}} = \beta E_t \left[(C_{t+1})^{-\frac{1}{\sigma}} \frac{1+i_{t+1}}{1+\pi_{t+1}^{CPI}} \right], \tag{48}
$$

$$
C_t^{-\frac{1}{\sigma}} v_t \left(a + \gamma_x x_{t+1}\right) = \beta E_t \left[(C_{t+1})^{-\frac{1}{\sigma}} a \left(v_{t+1} + d_{t+1}\right) \right], \tag{49}
$$

$$
C_t^{-\frac{1}{\sigma}} v_t^* \left(1 - a + \gamma_{x^*} x_{t+1}^*\right) = \beta E_t \left[(C_{t+1})^{-\frac{1}{\sigma}} (1-a) \left(v_{t+1}^* + d_{t+1}^*\right) \right], \tag{50}
$$

where $v_t \equiv V_t/P_t$, $v_t^* \equiv V_t^*/P_t^*$, $d_t = D_t/P_t$, $d_t^* = D_t^*/P_t^*$, $1 + \pi_{t+1}^{CPI} \equiv P_{t+1}/P_t$, and we used PPP. Similar budget constraint and Euler equations hold abroad.

A.2 Steady State Solution

Steady-State Model Denoting a product with "·" where necessary for clarity, steady state equilibrium conditions are as follows:

Markups

$$\Psi = \frac{\theta}{(\theta - 1)}, \tag{51}$$

$$\Psi^* = \frac{\theta}{(\theta - 1)}, \tag{52}$$

Relative Prices

$$RP^{\omega} Z = aRPZ + (1-a)\, RP^* Z^*, \tag{53}$$

$$(RP^*)^{\omega} Z^* = aRPZ + (1-a)\, RP^* Z^*, \tag{54}$$

GDPs

$$y = RPZ, \tag{55}$$

$$y^* = RP^* Z^*, \tag{56}$$

Real wages

$$w\theta = (\theta - 1) RPZ, \tag{57}$$

$$w^*\theta = (\theta - 1) RP^* Z^*. \tag{58}$$

Real dividends

$$d = y - w, \tag{59}$$

$$d^* = y^* - w^*. \tag{60}$$

Budget constraints

$$\begin{aligned} & vx + v^* x^* \\ = \;& (v + d)\, x + (v^* + d^*)\, x^* + w - C. \end{aligned} \tag{61}$$

$$\begin{aligned} & vx_* + v^* x_*^* \\ = \;& (v + d)\, x_* + (v^* + d^*)\, x_*^* + w^* - C^*, \end{aligned} \tag{62}$$

Equity market equilibrium conditions are:

$$ax + (1-a) x_* = a, \tag{63}$$

$$ax^* + (1-a) x_*^* = 1 - a. \tag{64}$$

Households' F.O.C.s for portfolio choice (with r and r^* denoting the steady-state home and foreign real interest rate:

$$1 = \beta(1+r), \tag{65}$$

$$v(a+\gamma_x x) = \beta a (v+d),$$

$$v^*(1-a+\gamma_{x^*} x^*) = \beta(1-a)(v^*+d^*). \tag{66}$$

$$1 = \beta^*(1+r^*), \tag{67}$$

$$v(a+\gamma_x^* x_*) = \beta^* a (v+d), \tag{68}$$

$$v^*(1-a+\gamma_{x^*}^* x_*^*) = \beta^*(1-a)(v^*+d^*). \tag{69}$$

Solving for the Steady State Consider the case in which $Z = Z^* = 1$. Then:

$$RP^{\omega} = aRP + (1-a)RP^* = (RP^*)^{\omega}, \tag{70}$$

implying

$$RP = RP^* = 1. \tag{71}$$

It follows that

$$w = w^* = \frac{\theta-1}{\theta} \tag{72}$$

$$d = d^* = \frac{1}{\theta}.$$

From the budget constraints,

$$C = \frac{1}{\theta}(x+x^*) + \frac{\theta-1}{\theta} \tag{73}$$

$$C^* = \frac{1}{\theta}(x_*+x_*^*) + \frac{\theta-1}{\theta}. \tag{74}$$

In steady states with $x + x^* = 1$ ($x_* + x_*^* = 1$), requiring complete home bias or symmetric equity holdings, this simplifies to $C = 1$ (C^*).

From (**??**)-(**??**), it is straightforward to recover the steady-state portfolio shares and equity prices. Home and foreign equity holdings are:

$$x = \frac{\gamma_x^* \frac{a}{1-a}}{\gamma_x + \gamma_x^* \frac{a}{1-a}}, \quad \text{with } x_* = \frac{a}{1-a}(1-x) \tag{75}$$

$$x^* = \frac{\gamma_{x^*}^*}{\gamma_{x^*} + \gamma_{x^*}^* \frac{a}{1-a}}, \quad \text{with } x_*^* = 1 - \frac{a}{1-a}x^*. \tag{76}$$

Equity prices are:

$$v = \frac{1}{\theta}\frac{\beta a}{a(1-\beta)+\gamma_x x}, \quad v^* = \frac{1}{\theta}\frac{\beta(1-a)}{(1-a)(1-\beta)+\gamma_{x^*}x^*}. \tag{77}$$

Gross returns on equity holdings:

$$1+\frac{d}{v} = \frac{1}{\beta a}\left(a+\gamma_x x\right), \quad 1+\frac{d^*}{v^*} = \frac{1}{\beta(1-a)}\left(1-a+\gamma_{x^*}x^*\right). \tag{78}$$

A.3 No-Arbitrage in the Symmetric Case

The symmetric steady state we consider here is the following:

$$\begin{array}{ccc} \bar{Z} = \bar{Z}^* = 1 & \overline{RP} = \overline{RP^*} = 1 & \bar{w} = \bar{w}^* = \dfrac{\theta-1}{\theta} \\ \bar{d} = \bar{d}^* = \dfrac{1}{\theta} & \bar{r} = \bar{r}^* = \frac{1-\beta}{\beta} & \bar{C} = \bar{C}^* = 1 \\ \bar{v} = \bar{v}^* = \dfrac{\beta}{1-\beta}\dfrac{1}{\theta} & \bar{x} = 0 \quad \bar{x}_* = 1 & \bar{x}^*_* = 0 \quad \bar{x}^* = 1 \end{array}$$

Consider the equilibrium Euler equation for home holdings of foreign equity. In log-linear terms:

$$\frac{1}{\sigma}E_t\left(\hat{C}_{t+1}-\hat{C}_t\right)+\frac{\gamma/2}{1+\gamma/2}\hat{x}^*_{t+1} = -\hat{v}^*_t+\frac{\beta}{1+\gamma}E_t\hat{v}^*_{t+1}+\frac{1-\beta+\gamma}{1+\gamma}E_t\hat{d}^*_{t+1}.$$

Similarly, the equilibrium, log-linear Euler equation for foreign holdings of home equity is

$$\frac{1}{\sigma}E_t\left(\hat{C}^*_{t+1}-\hat{C}^*_t\right)+\frac{\gamma/2}{1+\gamma/2}\hat{x}_{*t+1} = -\hat{v}_t+\frac{\beta}{1+\gamma}E_t\hat{v}_{t+1}+\frac{1-\beta+\gamma}{1+\gamma}E_t\hat{d}_{t+1},$$

and the difference between these equations yields:

$$\frac{1}{\sigma}E_t\left(\hat{C}^D_{t+1}-\hat{C}^D_t\right)+\frac{\gamma/2}{1+\gamma/2}\hat{x}^D_{t+1} = \hat{v}^D_t-\frac{\beta}{1+\gamma}E_t\hat{v}^D_{t+1}-\frac{1-\beta+\gamma}{1+\gamma}E_t\hat{d}^D_{t+1}. \tag{79}$$

Similarly, the log-linear Euler equations for home holdings of home equity and foreign holdings of foreign equity may be written:

$$\begin{aligned} \frac{1}{\sigma}E_t\left(\hat{C}_{t+1}-\hat{C}_t\right)-\frac{\gamma/2}{1+\gamma/2}\hat{x}_{*t+1} &= -\hat{v}_t+\frac{\beta}{1+\gamma}E_t\hat{v}_{t+1}+\frac{1-\beta+\gamma}{1+\gamma}E_t\hat{d}_{t+1}, \\ \frac{1}{\sigma}E_t\left(\hat{C}^*_{t+1}-\hat{C}^*_t\right)-\frac{\gamma/2}{1+\gamma/2}\hat{x}^*_{t+1} &= -\hat{v}^*_t+\frac{\beta}{1+\gamma}E_t\hat{v}^*_{t+1}+\frac{1-\beta+\gamma}{1+\gamma}E_t\hat{d}^*_{t+1}, \end{aligned}$$

and their difference implies:

$$\frac{1}{\sigma}E_t\left(\hat{C}^D_{t+1}-\hat{C}^D_t\right)+\frac{\gamma/2}{1+\gamma/2}\hat{x}^D_{t+1} = -\hat{v}^D_t+\frac{\beta}{1+\gamma}E_t\hat{v}^D_{t+1}+\frac{1-\beta+\gamma}{1+\gamma}E_t\hat{d}^D_{t+1}. \tag{80}$$

Inspection of equations (79) and (80) makes it possible to conclude that, for both equations to hold at the same time, it must be:

$$\frac{1}{\sigma}E_t\left(\hat{C}^D_{t+1}-\hat{C}^D_t\right)+\frac{\gamma/2}{1+\gamma/2}\hat{x}^D_{t+1} = 0, \tag{81}$$

$$-\hat{v}^D_t+\frac{\beta}{1+\gamma}E_t\hat{v}^D_{t+1}+\frac{1-\beta+\gamma}{1+\gamma}E_t\hat{d}^D_{t+1} = 0. \tag{82}$$

A.4 Data

The U.S. variables used in the quantitative analysis are defined and constructed as follows.[19]

CPI: Consumer Price Index, IMF IFS, series code 62064...ZF.

PPI: Producer Price Index, IMF IFS, series code 62063...ZF.

NEER: Nominal Broad Trade-Weighted Exchange Value of the U.S. dollar, Jan 1997=100, Haver Analytics, series FXTWB@USECON.

REER: Real Broad Trade-Weighted Exchange Value of the U.S. dollar, Jan 1997=100, Haver Analytics, series FXTWBC@USECON.

VUS: MSCI US Equity Price Index (in U.S. dollar), Bloomberg, series MXUS.

VEXUS: MSCI World Index through 1987Q4 and MCI All Country World Index from 1988Q1 to 2004Q4 (in U.S. dollar), Bloomberg, series MXWDU and MXWOU.

GDPB\$: Gross Domestic Product, seasonally adjusted quoted at annual rates (SAAR), Billion of Dollar, Haver Analytics, series code GDP@USECON.

CAB\$: Balance on current account, SAAR, Billion of Dollar, Haver Analytics, series CAB@USECON.

NXB\$: Net Exports of Goods and Services, SAAR, Billion of Dollar, Haver Analytics, series XNET@USECON.

NFAB\$: Net Foreign Assets, Interpolated linearly from annual data, Billion of Dollar, Lane and Milesi-Ferretti (2006).

Output (GDPH): Real GDP, SAAR, Chained 2000 dollar, Haver Analytics, series GDPH@USECON.

Consumption: (CH): Real Personal Consumption Expenditures, SAAR, Chained 2000\$, Haver Analytics, series CH@USECON.

Trabe balance/Output (NX/GDP): NXB\$/ GDPB\$.

Current account/Output (CA/GDP): CAB\$/GDPB\$.

NFA change/Output (DNFA/GDP): First difference of NFAB\$/GDPB\$.

Current transfer/Output (CT/GDP): Current transfer/GDP\$

Income Balance/Output (IB/GDP): Income balance /GDP\$

Valuation Change/Output (VC/GDP): (CAB\$-DNFA)/GDP\$.

[19] SAAR means Seasonally adjusted, quoted at annual rates.

Foreign Equity Price (VF): (VEXUS*REER)/CPI.

Home Equity Prices (VH): VUS/CPI.

Foreign Equity Prices (Return):

Home Equity Prices (Return):

All variables are percent deviations from HP-filtered trend (with smoothing parameter equal 1600). Variables are transformed in natural logarithm whenever possible. All indices are rebased so that 2000 is 100. All series except NFA, which is interpolated, are quarterly.

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Table 1. Unconditional Moments: Data and Benchmark Model

	Data 1/	Alternative Economies		
Colum No.	1	2	3	4
	1973Q1-2004Q4	Benchmark Rho=0.95, Omega=1.5, Theta=6, Sigma=0.5, Gamma=0.01.	Benchmark Rho=0.95, Omega=1.5, Theta=6, Sigma=0.5, Gamma=0.1.	Non-zero NFA, Rho=0.95, Omega=1.5, Theta=6, Sigma=0.5, Gamma=0.01.
Volatility (Standard Deviation, in percent)				
Output	1.90	2.39	2.39	2.39
Consumption	1.50	2.34	2.36	2.33
Trade balance/Output	0.50	0.46	0.13	0.50
Current account/Output	0.50	0.32	0.06	0.35
NFA change/Output	1.70	0.56	0.21	1.51
Home equity price	10.10	3.92	0.56	4.01
Comovement (Contemporaneous correlation with Output)				
Consumption	0.85	0.98	1.00	0.98
Trade balance	-0.50	0.20	0.22	0.21
Current account	-0.45	0.28	0.17	0.28
NFA change/Output	-0.08	0.11	-0.01	-0.09
Home equity price	0.41	0.96	0.99	0.93
Comovement (Contemporaneous cross-correlation)				
Home and Foreign output	0.28 2/	0.80	0.88	0.80
Home and Foreign consumption	0.15 2/	0.88	0.84	0.88
Home and Foreign equity price	0.69 3/	0.99	0.95	1.00
Persistance (First autocorrelation)				
Output	0.88	0.95	0.95	0.95
Consumption	0.84	0.95	0.95	0.95
Trade balance	0.77	0.94	0.84	0.94
Current account	0.76	0.93	0.84	0.93
NFA change	0.68	0.24	-0.06	0.02
Home equity price	0.82	0.95	0.95	0.95

1/ See Appendix for details.
2/ Ambler, Cardia, and Zimmermann (2004, Table 1). Sample period 1973Q1-2000Q4.
3/ Heathcote and Perri (2004, Table IX), Sample period 1986-2000. Value is 0.57 during 1972--1986 period).

Figure 1.

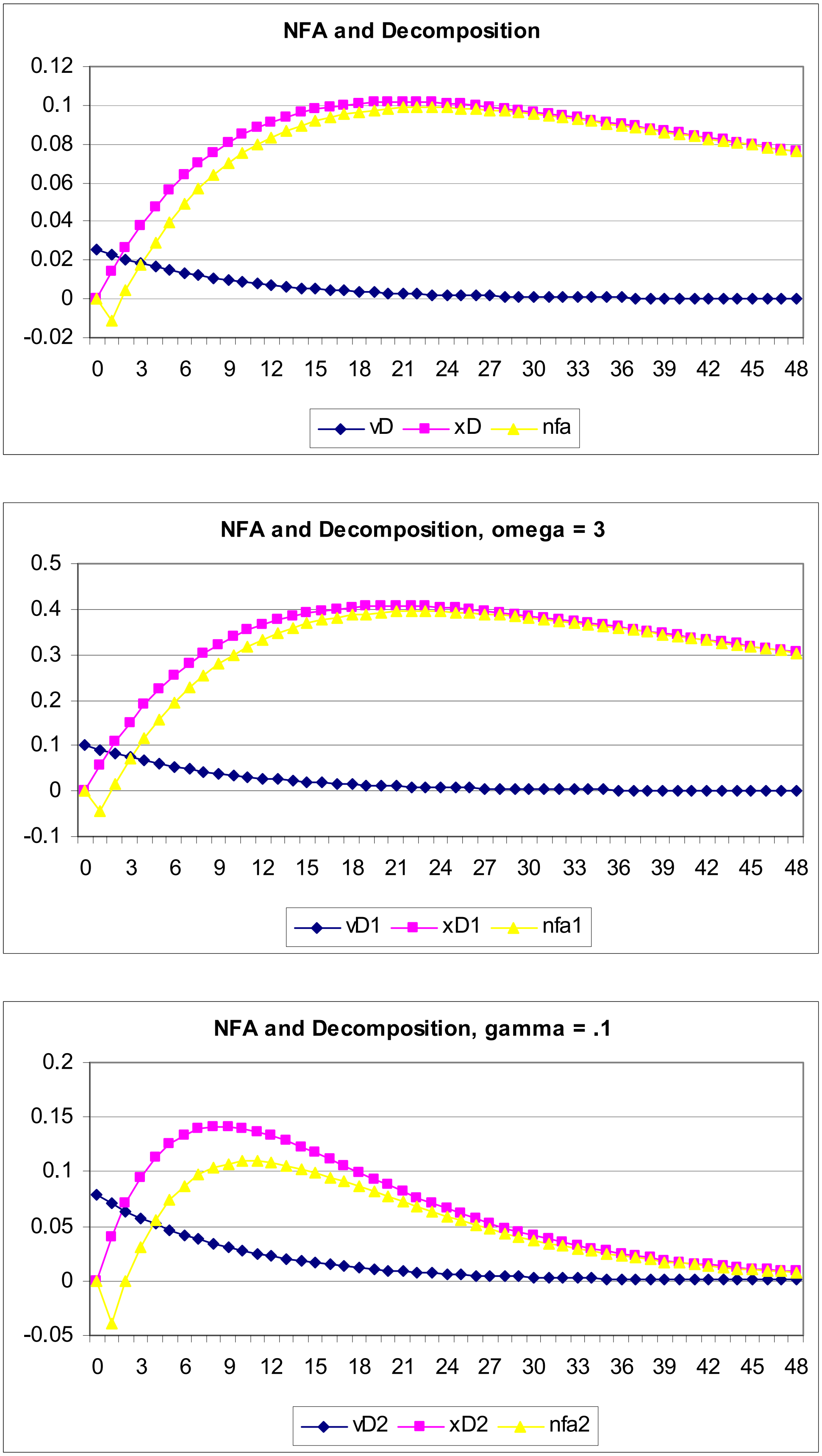
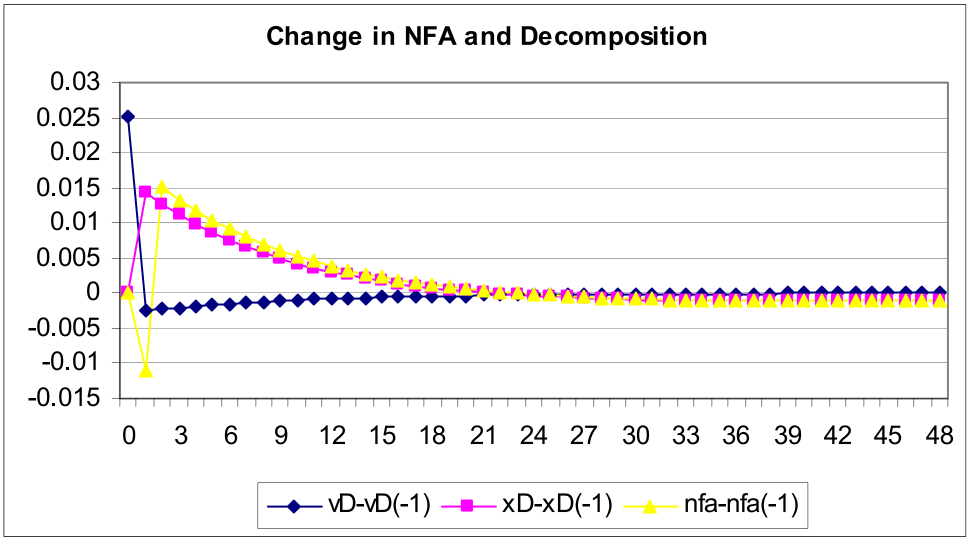
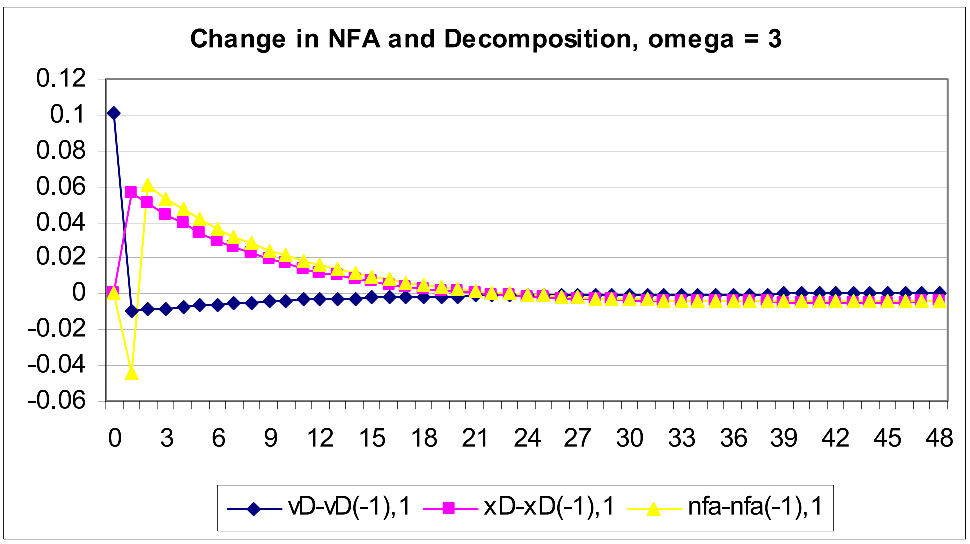

NFA and Decomposition
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
vD xD nfa
NFA and Decomposition, omega = 3
0.5
0.4
0.3
0.2
0.1
0
-0.1
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
vD1 xD1 nfa1
NFA and Decomposition, gamma = .1
0.2
0.15
0.1
0.05
0
-0.05
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
vD2 xD2 nfa2

Figure 1a.


Change in NFA and Decomposition
0.03
0.025
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
vD-vD(-1)
xD-xD(-1)
nfa-nfa(-1)


Change in NFA and Decomposition, omega = 3
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
vD-vD(-1),1
xD-xD(-1),1
nfa-nfa(-1),1

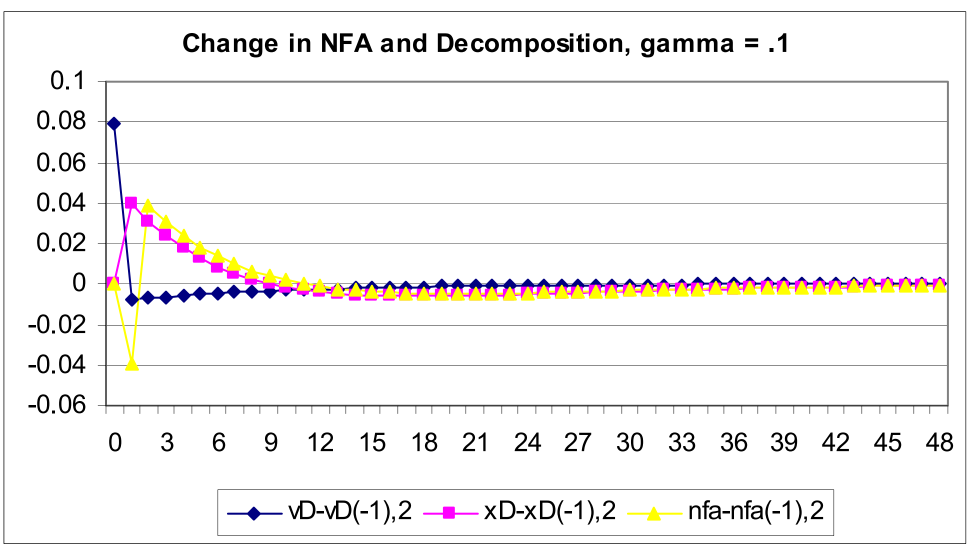
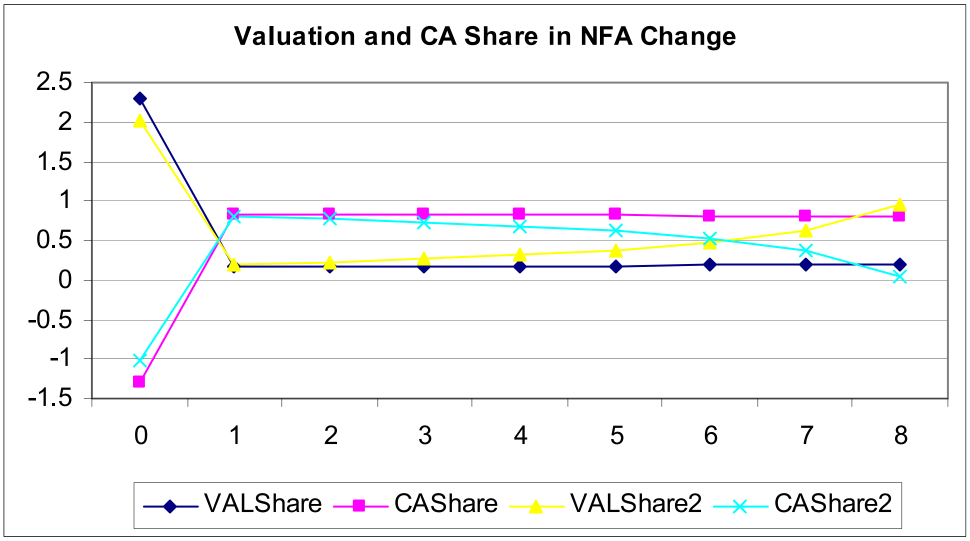
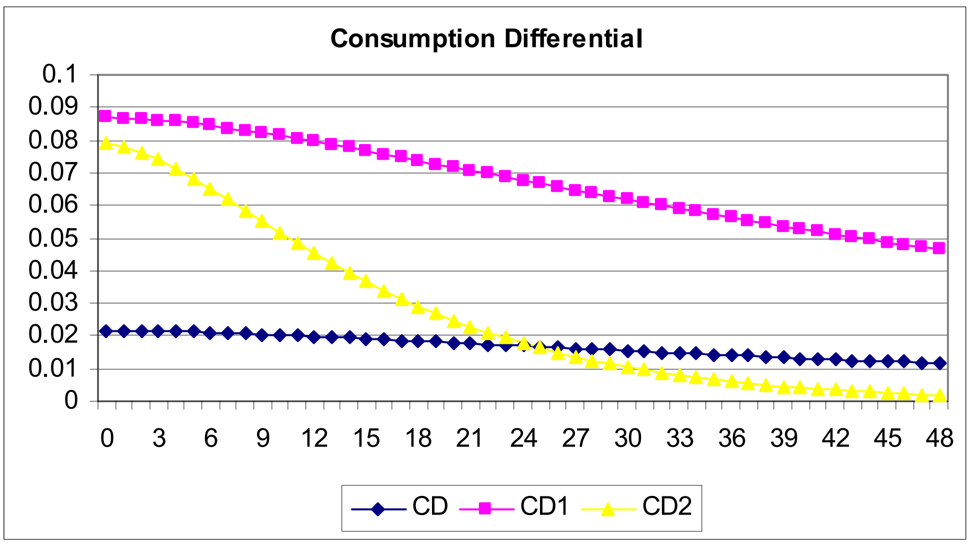

Change in NFA and Decomposition, gamma = .1
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
vD-vD(-1),2
xD-xD(-1),2
nfa-nfa(-1),2

Figure 2.

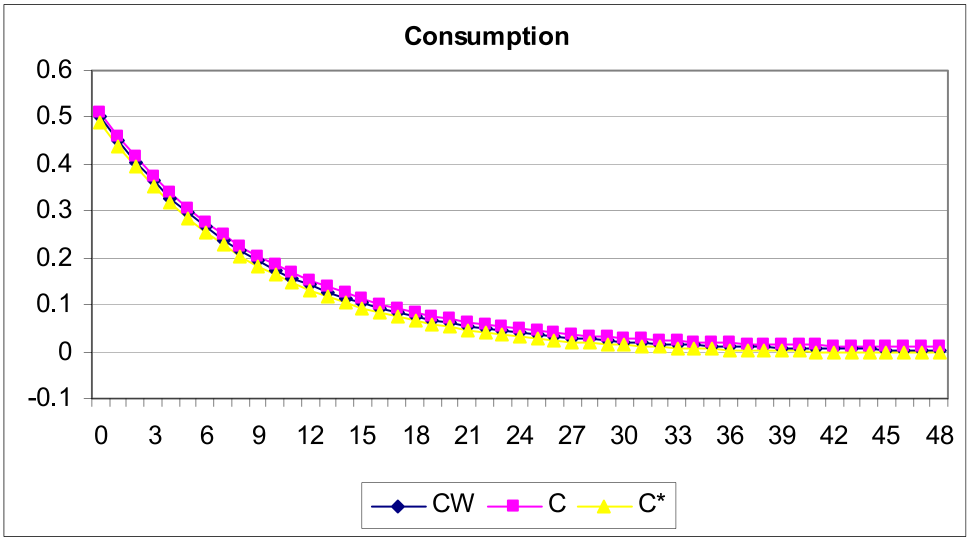


Valuation and CA Share in NFA Change
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
1
2
3
4
5
6
7
8
VALShare
CAShare
VALShare2
CAShare2

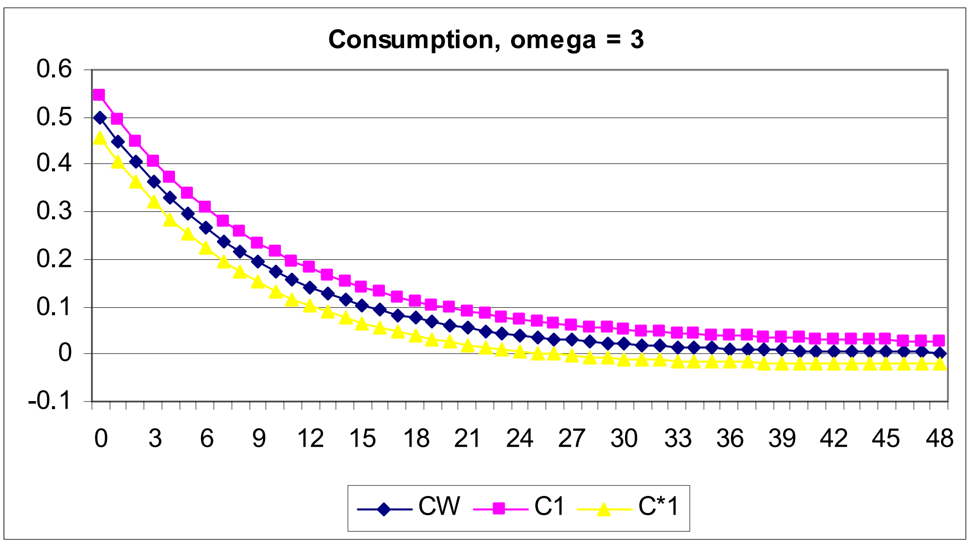


Consumption Differential
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
48
CD
CD1
CD2

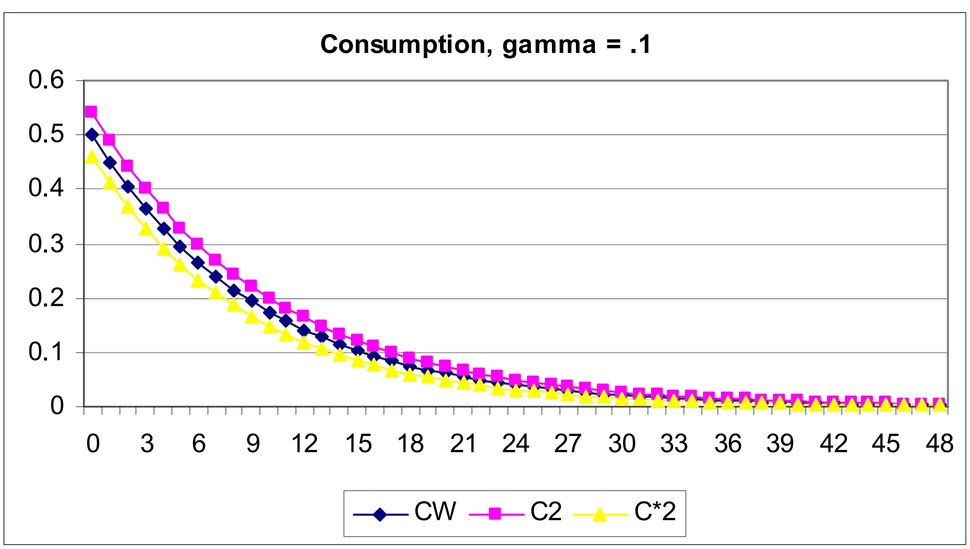
Figure 3



Consumption
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
CW
C
C*



Consumption, omega = 3
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
CW
C1
C*1



Consumption, gamma = .1
0.6
0.5
0.4
0.3
0.2
0.1
0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
CW
C2
C*2