An Equilibrium Model of "Global Imbalances" and Low Interest Rates

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PRELIMINARY

Abstract

Three of the most important recent facts in global macroeconomics — the sustained rise in the US current account deficit, the stubborn decline in long run real rates, and the rise in the share of US assets in global portfolio — appear as anomalies from the perspective of conventional wisdom and models. Instead, in this paper we provide a model that rationalizes these facts as an equilibrium outcome of two observed forces: a) potential growth differentials among different regions of the world and, b) heterogeneity in these regions' capacity to generate financial assets from real investments. In extensions of the basic model, we also generate exchange rate and gross flows patterns which are broadly consistent with the recent trends observed in these variables. Unlike the conventional wisdom, in the absence of a large change in (a) or (b), our model does not augur any catastrophic event. More generally, the framework is flexible enough to shed light on a range of scenarios in a global equilibrium environment.

JEL Codes: E0, F3, F4, G1

Keywords: Current account deficits, capital flows, interest rates, global portfolios and equilibrium, growth and financial development asymmetries, exchange rates, gross flows, Metzler diagram.

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1 Introduction

There are three facts that have dominated the discussion in global macroeconomics in recent times:

Fact 1: The US has run a persistent current account deficit since the early 1990s, which has accelerated dramatically since the late 1990s. Today, it exceeds US$600 billions a year. The solid dark line in Figure 1(a) illustrates this path, as a ratio of World's GDP (this line also includes the deficits of the U.K. and Australia, for reasons that will be apparent below, but it is overwhelmingly dominated by the U.S. pattern). The counterpart of these deficits have been driven by the surpluses in Japan and Continental Europe throughout the period and, starting at the end of the 1990s, by the large surpluses in Asia ex-Japan, commodity producers, and the turnaround of the current account deficits in most non-European emerging market economies.

Fact 2: The long run real interest rate has been steadily declining over the last decade, despite recent efforts from central banks to raise interest rates (the "Greenspan's Conundrum"). See Figure 1(b).

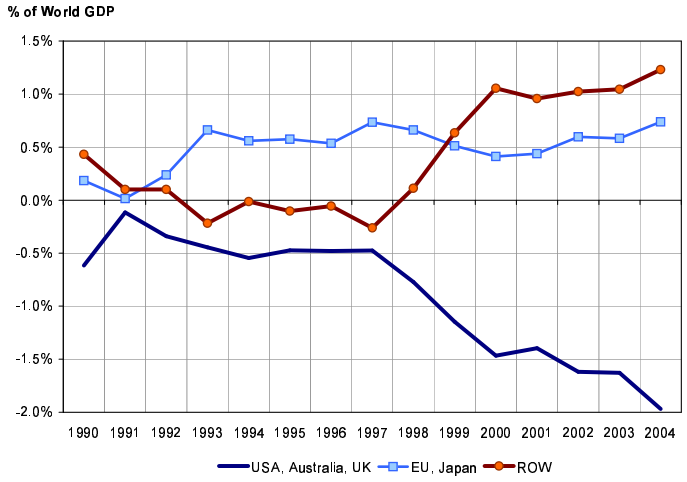
Fact 3: The importance of US assets in global portfolios has increased throughout the period and now constitute over half of the global holdings of financial assets. See Figure 1(c).

Despite extensive debates on the factors behind and sustainability of this environment, there are very few formal structures to analyze these joint phenomena. The conventional view and their recent formalizations, attempt mostly to explain (the first half of) fact 1, largely ignore fact 2, and take 3 as an exogenous anomaly. The analysis about the future then consists of telling the story that follows once this "anomaly" goes away. However, capital flows are primarily an asset market phenomenon and hence the paths of interest rates and portfolios must be made an integral part of the analysis if we are to conjecture on what got the world into the current situation and how it is likely to get out of it.[1]

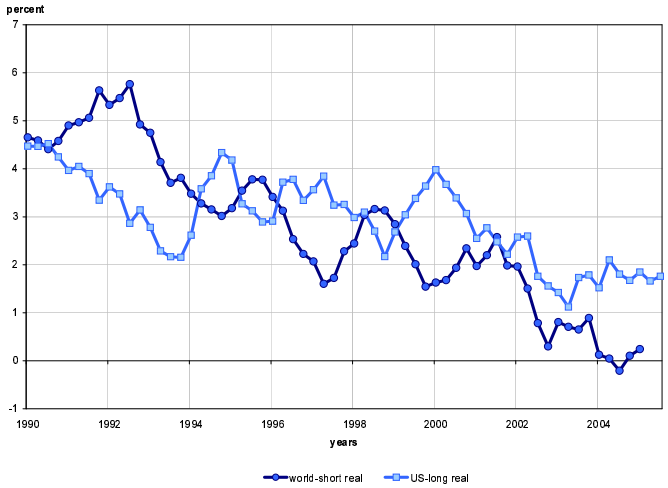
The main purpose of this paper is to provide a framework to analyze global equilibrium and, as an important side product, shed some light on the above facts. The model is fairly standard in its ingredients and provides a simple asset-demand and (most importantly) -supply framework to characterize the impact of different shocks on global capital flows, interest rates and portfolios. We use this model to show that the patterns in Figure 1 (together with observed exchange rate and gross flows patterns) can arise naturally from observed growth and financial market shocks, which interact with heterogeneous degrees of financial market development in different regions of the world.

We divide the world into three groups: The US (and "similar" economies such as Australia and the U.K.) (U); the EuroZone/Japan (E); and the rest (R). The latter include emerging markets, oil producing countries, and high saving newly industrialized economies, such as Hong-Kong, Singapore and Korea. Both U and E produce good quality financial instruments. R, on the other hand, has high growth potential but

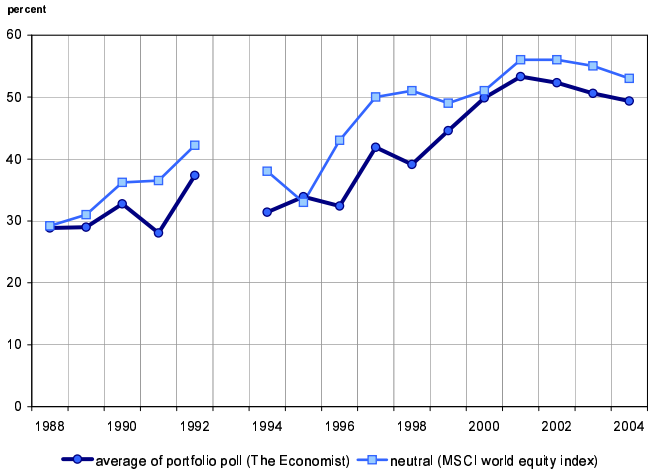
[1] Recently the policy sphere has also began to discuss views not entirely dissimilar to ours, highlighting the role of equilibrium in global capital markets. See especially Bernanke (2005) and IMF (2005).



(a) Current Account by Region (percent of world output)



(b) World and US Real Interest Rates



(c) Share of US in World Equity Portfolio

Figure 1: Three Stylized Facts. Sources: (a) WDI and Deutsche Bank. (b) IFS. (c) The Economist

has episodes when it cannot generate "enough" reliable savings instruments.[2]

In this world, we investigate the implication of a growth slowdown in E and, primarily, a collapse in asset markets in R. We show that both shocks point in the same direction, in terms of generating a rise in capital flows toward U, a decline in real interest rates, and an increase in the importance of U's assets in global portfolios. Importantly, while there are natural forces that undo some of the initial trade deficits in U, these are tenuous, as U's current account never needs to turn into surplus and capital flows indefinitely toward U.

The key feature of the model is that it focuses on the regions' ability to *supply* financial assets to savers. Regions U and E compete on asset production. Region R demands financial assets. Thus, fast growth in R coupled with their inability to generate local store of value instruments increases their demand for saving instruments from U and E. More growth potential in U than in E means that a larger share of global saving flows to U.

The basic model has a single good and focus on the saving side of capital flows. It is sufficiently simple to serve as a workhorse for a number of extensions. For instance, we consider the case of heterogeneous goods and also add an investment margin in R. We use the former to discuss (real) exchange rate determination and the latter to model gross capital flows. The exchange rate patterns generated by the expanded model in response to the shocks highlighted above are broadly consistent with those observed in the data, and anticipate a very limited and slow depreciation of U's exchange rate in the absence of further shocks. Gross flows steadily rise as R's saving continues to flow to U, which in turn sends foreign direct investment flows back to R to implement, *and generate financial assets from*, R's investment opportunities.

There are several recent articles related to the $U - E$ analysis in our paper. For instance, Blanchard, Giavazzi and Sa (2005) analyzes US external imbalances from the point of view of portfolio balance theory a la Kouri (1982). Their approach takes world interest rates as given and focuses on the dual role of the exchange rate in allocating portfolios between imperfectly substitutable domestic and foreign assets and relative demand through the terms of trade. According to their model, the large recent US current account imbalances result from exogenous increases in U.S. demand for foreign goods and in foreign demand for U.S. assets. Their model predicts a substantial future depreciation of the US dollar since the exchange rate is the only equilibrating variable in their model and current account deficits must be reversed. Obstfeld and Rogoff (2004) and (2005) consider an adjustment process through the global reallocation of demand for traded versus non traded goods. Their analysis takes as given that a current account reversal needs to occur in the US, as well as the levels of relative supply of traded and non-traded goods in each country. Because the

[2]See Caballero and Krishnamurthy (forthcoming 2005) for a model of bubbles in emerging markets as a result of their inability to generate reliable financial assets. When local bubbles crash, countries need to seek store of value abroad.

current account deficits represents a large share of traded output, they too, predict a large real depreciation of the dollar. These papers differ from ours in terms of the shocks leading to the current "imbalances", our emphasis on equilibrium in global financial markets and, most importantly, on the connection between this equilibrium and the countries' ability to produce sound financial assets.

For the $U - E$ part, the closest paper in terms of themes and some of the implications is Caballero, Farhi and Hammour (forthcoming 2005), who present several models of speculative investments booms in U and low global interest rates. One of the mechanisms they discuss is triggered by a slowdown in investment opportunities in E. However the emphasis in that paper is on the investment side of the problem and ignores the role of R and asset supply, which are central to our analysis in this paper. Kraay and Ventura (forthcoming 2005) analyze an environment similar to that in Caballero et al.. Their emphasis is on the allocation of excess global savings to a US bubble but it does not connect capital flows to growth and domestic financial markets fundamentals as we do here.

For the $U - R$ part, Dooley, Folkerts-Landau and Garber (2003) and Dooley and Garber (forthcoming 2005) have argued that the current pattern of US external imbalances does not represent a threat to the global macroeconomic environment. Their "Bretton Woods II" analysis argues instead that the structure of capital flows is optimal from the point of view of developing countries trying to maintain a competitive exchange rate, to develop a productive traded good sector, or to absorb large amounts of rural workers in the industrial sector. Unlike theirs, our analysis emphasizes the role of private sector capital flows.[3]

Section 2 is the core of the paper and presents the main model and mechanisms. Section 3 analyzes exchange rate determination, while Section 4 introduces an investment margin in R to capture gross flows and the excess return in U's foreign direct investment. Section 5 presents our procedure to "calibrate" some of the key parameters we use to generate the figures and scenarios throughout the paper. Section 6 concludes and is followed by an appendix.

2 A Model with Explicit Asset Supply Constraints

In this section we develop a stylized model that endogenizes and captures the broad patterns of capital flows, interest rates and global portfolios shown in Figure 1. The model highlights the supply side of the

[3]We do not deny the existence of large reserves accumulation by China and others. Nonetheless, we make three observations. First, most of these reserves are indirectly held by their local private sectors through (quasi-collateralized) low-return sterilization bonds in a context with only limited capital account openness. Second, gross flows are an order of magnitude larger than official flows – rather than imputing Chinese reserves accumulation to financing the US current account deficit, one could equally well (or poorly) argue that they are financing FDI flows to emerging markets, including China. Third, the role of official interventions was most important at a time when the US was experiencing a temporary slowdown, while our analysis refers to more persistent trends.

market for global saving instruments. We slice the world into three groups: U-countries have deep financial markets and good growth conditions; E-countries have deep financial markets but (perhaps temporarily) bad growth conditions; finally, R-countries (perhaps temporarily) do not have deep financial markets but have exceptional growth conditions.

In this context we show that both the depressed growth conditions in E and the depressed financial markets in R compound to generate large and persistent capital flows to U. Moreover, the exceptional growth conditions in R exacerbate rather than offset this pattern.[4]

After a series of preliminaries explaining the essence of our framework, we split the argument into two parts. In the first one, we study global equilibrium in a world with U and E countries only. This is the closest to the conventional analysis and has the dual role of showing the workings of our model and studying the equilibrium impact of a persistent decline in E's growth conditions, as experienced by Japan from the early 1990s and Continental Europe more recently. This decline raises capital flows from E to U and lowers global interest rates almost indefinitely. That is, the automatic rebalancing forces, regardless of the extent of home-bias, are tenuous in the absence of a reversal in the factors that led to the original imbalances, namely depressed growth conditions in E.

In the second part we study global equilibrium in a world with U and R countries only. This is the core of our model. We first show that if R's capacity to generate reliable financial assets crashes, global interest rates drop and capital flows from R to U permanently. Moreover, if growth potential in R is above that of the rest of the world, both effects are exacerbated. In particular, long run rates decline by more than short rates, and U can finance very significant current account deficits indefinitely. That is, if the initial asymmetry in financial development is not undone, the automatic rebalancing forces are even more tenuous than in the $U - E$ world. This part primarily captures the events following the Asian and Russian crises, as well as the fast growth and (favorably) high commodity prices experienced by much of the R region shortly afterwards. It also captures some of the elements following the crash of the Japanese bubble in the early 1990s.

2.1 Preliminaries

2.1.1 A closed economy

Time evolves continuously. Infinitesimal agents (traders) are born at a rate θ per unit time and die at the same rate; population mass is constant and equal to one. At birth, agents receive a perishable endowment

[4]Thus, the view that growth of US trading partners is on average similar to that of the US, so that differential growth cannot be a factor in explaining the large capital flows to the US, is misguided from our perspective. It matters a great deal who is growing faster and who is growing slower than the US. If those that compete with the US in asset production grow slower and those that demand assets grow faster, then both factors play in the same direction.

of $(1-\delta)X_t$ which they save in its entirety until they die (exit). Agents consume all their accumulated resources at the time of death. The term $(1-\delta)X_t$ should be interpreted as the share of national output that is not capitalizable.

The only saving vehicles are identical "trees" producing in aggregate a dividend of δX_t per unit time. Agents can save only in local trees.

By arbitrage, the instantaneous return from hoarding a unit of a tree, r_t, satisfies:

$$r_t V_t = \delta X_t + \dot{V}_t \tag{1}$$

where V_t is the value of the trees at time t. As is standard, the return on the tree equals the dividend price ratio $\delta X_t/V_t$ plus the capital gain $\dot{V}_t/V_t$.

Let W_t denote the savings accumulated by active agents at date t. Savings decrease with withdrawals (deaths), and increase with the endowment allocated to new generations and the return on accumulated savings:

$$\dot{W}_t^i = -\theta W_t^i + (1-\delta)X_t^i + r_t W_t^i. \tag{2}$$

In equilibrium, savings must be equal to the value of the trees:

$$W_t = V_t. \tag{3}$$

Replacing (3) into (1), and the result into (2), yields a relation between savings and production:

$$W_t = \frac{X_t}{\theta}. \tag{4}$$

Alternatively, noticing that θW_t corresponds to consumption, we can re-write this relation as a goods-market equilibrium condition:

$$\theta W_t = X_t. \tag{5}$$

Replacing this expression back into (1), using (3), we obtain an expression for the instantaneous equilibrium interest rate:

$$r_t = \frac{\dot{X}_t}{X_t} + \delta\theta, \tag{6}$$

The interest rate rises with growth because the latter lifts the expected capital gain; it rises with δ because this increases the dividend rate; and it rises with θ because this increases the dividend yield as reduced saving demand lowers asset prices.

Let us pause at this time to highlight our model's simple mechanism to enrich the supply side of assets markets, which will play a key role in $U-R$ analysis. Note that (6) differs from the usual equation that would prevail if we were to adopt the standard frictionless infinite horizon consumption theory. There, the interest would be determined entirely by the (asset) demand side: it would depend only on consumption growth, the

rate of time preference and the elasticity of intertemporal substitution. Hence, δ, which parameterizes the supply of financial assets (it is the share of income that is capitalized), would play no role. The reason is that in the standard frictionless infinite horizon model, an increase in δ changes the relative importance of financial to human wealth, without changing total wealth and hence consumption. That is, as we increase δ, the increase in financial savings — the demand for financial assets— exactly offsets the increase in financial asset supply, leaving the interest rate unaffected. Thus, in order to introduce an equivalent role for supply of financial assets in that model, we would have to introduce collateral constraints and link collateral to capitalizable income. Our preferences and demographic assumptions achieve the same more efficiently, by making consumption proportional to *financial* wealth. Thus an increase in δ does not raise the demand for financial savings, and hence the increased supply of assets requires the interest rate to rise (i.e., the price of a unit of dividend perpetuity to fall).

Returning to the model description, we now assume that the total endowment in the economy, X_t, grows at rate g. Hence r_t is given by r_{aut} where

$$r_{aut} = g + \delta\theta.$$

2.1.2 A Small Open Economy

Let us now open the (small) economy, which faces a given world interest rate, r, such that:

Assumption 1 $g < r < g + \theta$

Definition 1 *(Trade Balance and Current Account): Let us denote the trade balance and current account at time t as TB_t and CA_t, respectively, with:*

$$\begin{aligned} TB_t &\equiv X_t - \theta W_t \\ CA_t &\equiv \dot{W}_t - \dot{V}_t \end{aligned}$$

The definition of the trade balance is standard. The current account is also standard. It is the dual of the financial account and is defined as the increase in the small economy's net asset demand.

To find the steady state of this economy, we integrate (1) forward and (2) backward:

$$\begin{aligned} V_t &= \int_t^\infty \delta X_s e^{-r(s-t)} ds \\ W_t &= W_0 e^{(r-\theta)t} + \int_0^t (1-\delta) X_s e^{(r-\theta)(t-s)} \end{aligned}$$

Assumption 1 implies that asymptotically

$$\frac{V_t}{X_t} \underset{t\to\infty}{\to} \frac{\delta}{r-g} \tag{7}$$

$$\frac{W_t}{X_t} \underset{t\to\infty}{\to} \frac{1-\delta}{g+\theta-r} \tag{8}$$

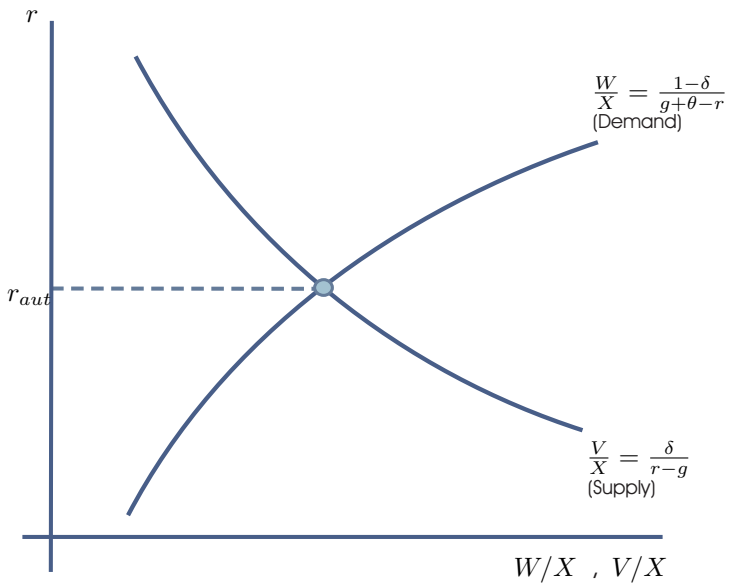


Figure 2: The Metzler diagram.

Equation (7) is just Gordon's formula. It shows that the asymptotic supply of assets, normalized by the size of the economy, is a decreasing function of r. Equation (8) describes the asymptotic demand for assets which, normalized by the size of the economy, is an increasing function of r. Figure 2 represents the equilibrium in a supply and demand diagram, a version of the famous Metzler diagram. The supply curve and demand curve cross at $r = r_{aut}$.

If $r < r_{aut}$

$$\frac{\delta}{r-g} > \frac{1-\delta}{g+\theta-r}$$

and domestic asset supply exceeds demand. Since in balanced growth $\dot{W}_t = gW_t$ and $\dot{V}_t = gV_t$, the above inequality implies that the small country runs an asymptotic current account deficit (financed by an asymptotic financial account surplus):

$$\frac{CA_t}{X_t} \underset{t\to\infty}{\to} g\left(\frac{1-\delta}{g+\theta-r} - \frac{\delta}{r-g}\right) = -g\frac{(r_{aut}-r)}{(g+\theta-r)(r-g)}. \tag{9}$$

Note also that, asymptotically, the trade balance is in surplus: The lower rate of return on savings depresses wealth accumulation and, eventually, consumption

$$\frac{TB_t}{X_t} \underset{t\to\infty}{\to} \frac{r_{aut}-r}{g+\theta-r} \tag{10}$$

Importantly, however, this asymptotic trade surplus is *not* enough to service the accumulated net external liabilities of the country, which is why the current account remains in deficit forever.

Conversely, note that when $r > r_{aut}$, (9) and (10) still hold, but now the economy runs an asymptotic trade deficit and current account surplus.

We can prove a stronger result that will be useful later on.

Lemma 1 *Consider an exogenous path for the interest rate* $\{r_t\}_{t\geq 0}$ *such that* $\lim_{t\to\infty} r_t = r$ *with* $g < r < g + \theta$. *Then*

$$\frac{V_t}{X_t} \underset{t\to\infty}{\to} \frac{\delta}{r-g}, \qquad \frac{W_t}{X_t} \underset{t\to\infty}{\to} \frac{1-\delta}{g+\theta-r}$$
$$\frac{CA_t}{X_t} \underset{t\to\infty}{\to} \frac{g(r-g-\delta\theta)}{(g+\theta-r)(r-g)}, \qquad \frac{TB_t}{X_t} \underset{t\to\infty}{\to} \frac{g+\delta\theta-r}{g+\theta-r}$$

Proof. We now have

$$\begin{aligned} V_t &= \int_t^\infty \delta X_s e^{-\int_t^s r_u du} ds = \delta X_t \int_t^\infty e^{-\int_t^s (r_u - g)du} ds \\ W_t &= W_0 e^{\int_0^t (r_s-\theta)ds} + \int_0^t (1-\delta) X_s e^{\int_s^t (r_u-\theta)du} ds \\ &= (1-\delta)X_t \left[\frac{W_0}{(1-\delta)X_t} e^{\int_0^t (r_s-\theta)ds} + \int_0^t e^{\int_s^t (r_u-\theta-g)du} ds \right] \end{aligned}$$

The Lemma follows from the fact that

$$\begin{aligned} \lim_{t\to\infty} \int_t^\infty e^{-\int_t^s (r_u-g)du} ds &= \frac{1}{r-g} \\ \lim_{t\to\infty} \int_0^t e^{\int_s^t (r_u-\theta-g)du} ds &= \frac{1}{g+\theta-r} \end{aligned}$$

and

$$\lim_{t\to\infty} \frac{W_0}{(1-\delta)X_t} e^{\int_0^t (r_s-\theta)ds} = 0$$

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2.2 A World with Symmetric (and Developed) Financial Markets (A $U-E$ World)

Let us now study global equilibrium with two large regions, $i = \{U, E\}$. Each of them is described by the same setup as in the closed economy, with an instantaneous return from hoarding a unit of either tree, r_t, which is common across both regions and satisfies:

$$r_t V_t^i = \delta X_t^i + \dot{V}_t^i \tag{11}$$

where V_t^i is the value of country i's tree at time t.

Let W_t^i denote the savings accumulated by active agents in country i at date t. These savings decrease with withdrawals (deaths), and increase with the endowment allocated to new generations and the return on accumulated savings:

$$\dot{W}_t^i = -\theta W_t^i + (1-\delta)X_t^i + r_t W_t^i. \tag{12}$$

Adding (11) and (12) across both countries, yields:

$$r_t V_t = \delta X_t + \dot{V}_t \tag{13}$$

$$\dot{W}_t = -\theta W_t + (1-\delta)X_t + r_t W_t \tag{14}$$

with

$$W_t = W_t^U + W_t^E, \qquad V_t = V_t^U + V_t^E, \qquad X_t = X_t^U + X_t^E.$$

From now on, the solution for global equilibrium proceeds exactly as in the closed economy above, with

$$\theta W_t = X_t. \tag{15}$$

and

$$r_t = \frac{\dot{X}_t}{X_t} + \delta\theta. \tag{16}$$

Let us now specify the initial conditions and follow with our first shock.

Assumption 2 *(Initial Conditions): The world is initially symmetric, with equal levels of X_t^i and a constant rate of growth, common to both countries, g. There are no (net) capital flows across the economies and $W_t^U = V_t^U = V_t^E = W_t^E$.*

Suppose now that, unexpectedly, at $t = 0$, the rate of growth of E drops permanently to

$$g^E = g - \Delta_{g^E}, \qquad \Delta_{g^E} > 0.$$

Lemma 2 *(Continuity): At impact, r absorbs the shock while V and W remain unchanged.*

Proof. At any point in time, it must be true that

$$W_t = \frac{X_t}{\theta}$$

It follows that W_t does not jump at $t = 0 : W_{0-} = W_{0+} = X_0/\theta$. Since $W_t = V_t$ must hold at all times, we conclude that V_t does not jump either: $V_{0-} = V_{0+} = X_0/\theta$. But for this absence of a decline in V at impact to be consistent with the asset pricing equation, the growth slowdown in E must be offset by a drop in r:

$$r_{0+} \quad = \quad g - \frac{\Delta_{g^E}}{2} + \delta\theta < r_{0-} = g + \delta\theta$$

■

While global wealth and capitalization values do not change at impact, the allocation of these across economies does. On one hand, it stands to reason that the lower growth in X_t^E implies that V_0^U/V_0^E must rise since both dividend streams are discounted at the common global interest rate. On the other, whether W_0^U/W_0^E rises or not depends on the agents' initial portfolio allocations. However, as long as there is some home bias in these portfolios, W_0^U/W_0^E rises as well. Because the conventional view has taken the well established fact of home bias as a key force bringing about rebalancing of portfolios, we shall assume it as well, as this isolates the contribution of our mechanisms more starkly. Moreover, for clarity, in the main propositions we assume an extreme form of home bias, but then extend the simulations and figures to other cases.

Assumption 3 *(Home Bias). Agents first satisfy their saving needs with local assets and only hold foreign assets once they run out of local assets.*

This assumption implies that, at impact, local wealths' changes match the changes in the value of local trees one-for-one:

$$\begin{aligned} W_{0+}^E - \frac{W_0}{2} &= V_{0+}^E - \frac{V_0}{2} \\ W_{0+}^U - \frac{W_0}{2} &= V_{0+}^U - \frac{V_0}{2} \end{aligned}$$

These changes in wealth have a direct impact on consumption, which are reflected immediately in the trade balance and current account. Before describing these effects, let us digress momentarily.

At times, it will be convenient for exposition to note that the current account can also be written as the sum of trade balance and net income from global holdings:

Lemma 3 *(Alternative Formulation of the Current Account)*

$$\begin{aligned} CA_t^i &= X_t^i - \theta W_t^i + r_t(\alpha_t^{i,j} V_t^j - \alpha_t^{j,i} V_t^i) \\ &= TB_t^i + r_t(\alpha_t^{i,j} V_t^j - \alpha_t^{j,i} V_t^i) \end{aligned}$$

where $i \neq j$, $\alpha_t^{i,j}$ is the share of country j's trees held by agents in country i, $\alpha_t^{j,i}$ is the share of country i's trees held by agents in country j.

Proof. By definition, we can write:

$$W_t^j = \alpha_t^{j,i} V_t^i + (1 - \alpha_t^{i,j}) V_t^j$$

and the net asset demand as:

$$W_t^j - V_t^j = \alpha_t^{j,i} V_t^i - \alpha_t^{i,j} V_t^j$$

so that:

$$\begin{aligned} CA_t^i &= \dot{W}_t^i - \dot{V}_t^i \\ &= (1-\delta)X_t^i - \theta W_t^i + r_t W_t^i - \dot{V}_t^i \\ &= (1-\delta)X_t^i - \theta W_t^i + r_t(W_t^i - V_t^i) + \delta X_t^i \\ &= X_t^i - \theta W_t^i + r_t(\alpha_t^{i,j} V_t^j - \alpha_t^{j,i} V_t^i) \end{aligned}$$

■

Note that our current account definition excludes, as does national accounts, unexpected valuation effects (unexpected capital gains and losses from international positions). This is not a relevant issue for now since the only surprise takes place at date 0, when agents are not holding international assets. We shall return to this issue when relevant.

Also note that since $CA_t^E + CA_t^U = 0$, we only need to describe one of the current accounts to characterize both. Henceforth, we shall describe the behavior of CA_t^U, with the understanding that this concept describes features of the global equilibrium rather than U-specific features.

Finally, without any substantive implication (see the Appendix for the general case), we make an assumption to narrow the asymptotic cases we need to analyze:

Assumption 4 *(Bounded Growth Decline):* $\Delta_{g^E} < (1-\delta)\theta$.

Proposition 1 *(Persistent Current Account Deficits in U): Under assumptions 1 to 4, an unexpected and persistent decline in E's rate of growth from g to* $g^E = g - \Delta_{g^E}$*, with* $\Delta_{g^E} > 0$*, turns* CA_t^U *into a deficit at impact and remains in deficit in the long run (although vanishing asymptotically relative to* X_t^U*).*

Proof. At impact, we have

$$W_{0+}^U = V_{0+}^U$$

$$CA_0^U = TB_0^U = X_0^U - \theta V_{0+}^U < 0$$

For $t > 0$, using $\theta W_t = X_t$ and $\theta V_t = X_t$ we have

$$CA_t^U = \dot{W}_t^U - \dot{V}_t^U = \dot{V}_t^E - \dot{W}_t^E$$

From equation (16) and $g > g^E$, $\lim_{t\to\infty} r_t = r_{aut}^U$. Lemma 1 shows that

$$\frac{V_t^E}{X_t^E} \underset{t\to\infty}{\to} \frac{\delta}{r_{aut}^U - g^E}$$

$$\frac{W_t^E}{X_t^E} \underset{t\to\infty}{\to} \frac{(1-\delta)}{g^E + \theta - r_{aut}^U}$$

and

$$\frac{CA_t^U}{X_t^E} = -\frac{CA_t^E}{X_t^E} \underset{t\to\infty}{\to} -\frac{g^E(r_{aut}^U - g^E - \delta\theta)}{(g^E + \theta - r_{aut}^U)(r_{aut}^U - g^E)} < 0.$$

Finally, it follows immediately from $\Delta_{g^E} > 0$ that CA_t^U / X_t^U vanishes asymptotically. ■

The impact effect of a decline in E's rate of growth is a decline in the value of E's assets which drags down E's wealth one for one given the extreme home bias assumption. This leads to an immediate drop in E's consumption which is not matched by a drop in E's current income. Thus E's trade balance, which is equal to the current account in the symmetric initial equilibrium, goes into surplus. In equilibrium, U has to absorb this surplus by running a trade deficit. The latter is achieved by an increase in U's consumption, which results from an increase in U's wealth following the appreciation of U's assets. This appreciation does not stem from any increase in U's growth prospects, but from the fall in interest rates brought about by E's slowdown.

Suddenly U's assets look relatively more attractive, and hence a share of E's saving begins to flow to these assets. Over time, the return on these assets raises E's wealth and consumption (relative to output), eventually overturning the initial trade surplus, and hence U' s trade deficit.

However, U's eventual trade surpluses are never enough to service the accumulated net-foreign liabilities in full, and hence U's current account remains in deficit forever. The counterpart of this persistent deficit is a sustained accumulation of U's assets by E. This accumulation is very fast early on, as the relative importance of U assets in E's portfolio rises until it converges (asymptotically) to:

$$\frac{\Delta_{g^E}}{\left((1-\delta)\theta - \Delta_{g^E}\right)\left(\Delta_{g^E} + \delta\theta\right)} > 0.$$

Thus, in the limit, E continuously accumulates U's assets at a rate g^E.

Of course, this does not mean that our model violates the intertemporal approach to the current account. Integrating forward the equation:

$$\dot{W}_t^U - \dot{V}_t^U = X_t^U - \theta W_t^U + r_t(W_t^U - V_t^U)$$

we find the usual expression:

$$\begin{aligned} W_t^U - V_t^U &= -\int_t^\infty \left(X_s^U - \theta W_s^U\right) e^{-\int_t^s r_u du} ds \\ &= -\int_t^\infty TB_s^U e^{-\int_t^s r_u du} ds. \end{aligned}$$

In particular

$$0 = W_{0^+}^U - V_{0^+}^U = -\int_0^\infty TB_t^U e^{-\int_0^t r_s ds} dt.$$

Since the initial net asset position is balanced in our basic scenario, the net present value of trade balance surpluses is zero. The trade balance TB_t^U is initially in deficit and eventually turns into surplus since:

$$\frac{TB_t^U}{X_t^E} = -\frac{TB_t^E}{X_t^E} \underset{t\to\infty}{\to} \frac{\Delta_{g^E}}{g^E + \theta - r_{aut}^U} > 0.$$

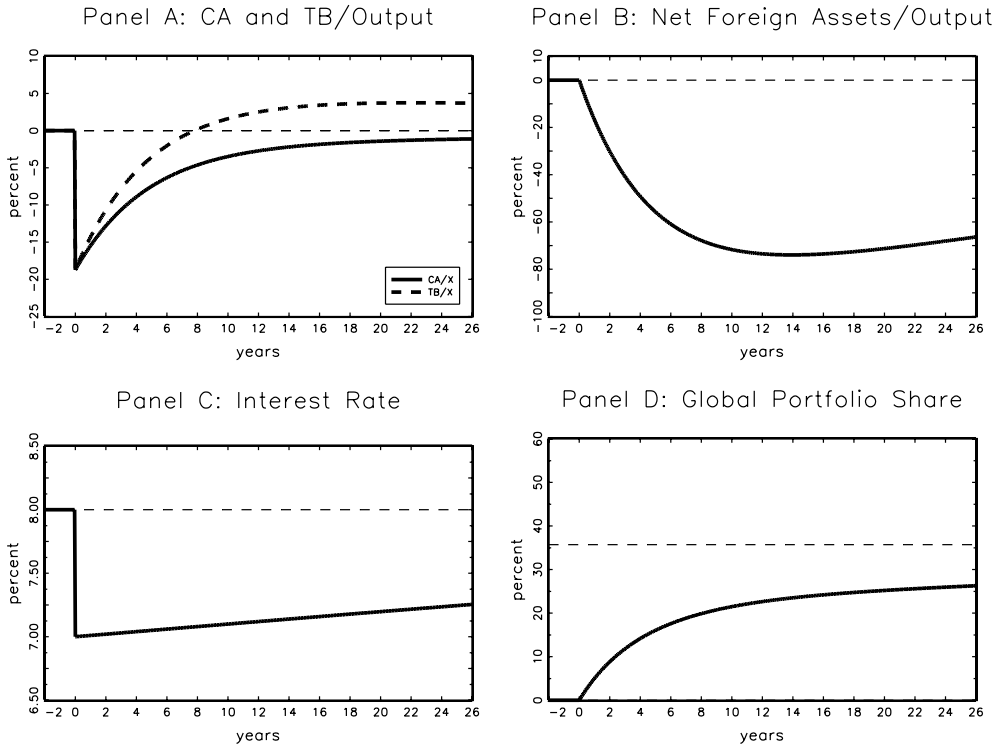


Figure 3: A Collapse in g^E

Importantly, however, increased net interest payments to E due to U's accumulation of net foreign liabilities exceed the trade balance surpluses and generate a chronic current account deficit in U.

We can understand the asymptotic result in the proposition with reference to the simple small open economy in Section 2.1, and its Figure 2. First, since in the long run U dominates the global economy, the equilibrium interest rate converges to the Autarky interest rate for U:

$$r_\infty = r^U_{aut} = g + \delta\theta.$$

Thus the gap between W^U_t/X^U_t and V^U_t/X^U_t is asymptotically vanishing. However, note that the limit interest rate exceeds the new Autarky rate in E:

$$r_\infty = g + \delta\theta > g^E + \delta\theta = r^E_{aut}.$$

Thus the asymptotic gap between W^E_t/X^E_t and V^E_t/X^E_t is strictly positive. Moreover, by global equilibrium this means that the asymptotic gap between W^U_t/X^E_t and V^U_t/X^E_t is strictly *negative*.

Let us now turn to a characterization of the entire path. Figure 3 portrays an example of the impact of a growth slowdown for parameters calibrated to match some key aspects of the data (see Section 5), except for the fact that we assume a history with extreme home bias. Our only goal here is to consolidate the insights from the proposition and to argue that the effects we describe are quantitatively significant. We do

not attempt to match the exact paths in the data, as that would require additional smoothing mechanisms, such as gradual globalization, and other adjustment costs. Absent these, adjustments are too large at impact and too fast. Note, however, that despite the absence of frictions adjustments are gradual and capital flows remain large many years after the shock.

Panel A of figure 3 shows that U's current account and the trade balance (both relative to domestic output) exhibit large initial deficits (at 19 percent of output). The trade balance turns into surplus after eight years, while the current account converges very slowly toward zero. The large initial current account deficits worsen rapidly U's net foreign asset position from zero to -74 percent in 14 years. Eventually, the net foreign asset position converges to zero (relative to domestic output), but panel B illustrates that this convergence is very slow, and in fact it comes entirely from the denominator (output growth) as in levels U never runs a current account surplus after the initial shock. Given the parameter values we assume (see Section 5), the initial real interest rate equals 8 percent. Panel C shows that it drops to 7 percent when growth in E slows down, then converges back to 8 percent very gradually: after 26 years the real interest rate is still only 7.25 percent. Finally, the last panel shows the share of U's assets in E's portfolio, under the assumption, for now, that U never diversifies its holdings. This portfolio share increases rapidly from zero (our assumption of extreme bias) to 20 percent and asymptotes to 36 percent.

The model is thus able to generate simultaneously long lasting current account deficits in U (Fact 1); a decline in real interest rates (Fact 2) and an increase in U's share in the global portfolio (Fact 3).

Figure 4 repeats the above simulation but it now allows for a more realistic portfolio allocation at the time of the growth shock (there are cross-holdings of assets consistent with the data reported in Section 5). It is apparent that the main message from the previous figure is not modified. Initial portfolio diversification only attenuates the impact of the growth surprise on both W_0^U and W_0^E, and hence the overall impact of the shock on current accounts.[5] On the other hand, the share of U's assets in E's portfolio increases from 30 percent to 55 percent asympotically, roughly matching figure 1(c).

Finally, Figure 5 shows the same paths as Figure 4, but now g^E unexpectedly rises back to g ten years after the initial shock. Such reversal raises interest rates and lowers asset values in U while it raises them in E. As a result, consumption drops in U and CA^U turns into a surplus. The purpose of this figure is twofold: First, note that the reversal in U's current account (+9.2 percent) is less dramatic than the initial deficit in the current account (11 percent). The reason for this is that E suffers an important negative valuation effect as a significant share of its savings is composed of U assets at the time of the reversal. Second, and more importantly, the point of the figure is that the reversal in the current account stems from a fundamental shock, and not from the exogenous and spontaneous correction of an "anomaly," as the conventional view

[5]Note that the attenuation of the current account impact comes from consumption, not from valuation effects, which we exclude in our definition of the current account in order to track more closely the concept used in national accounts.

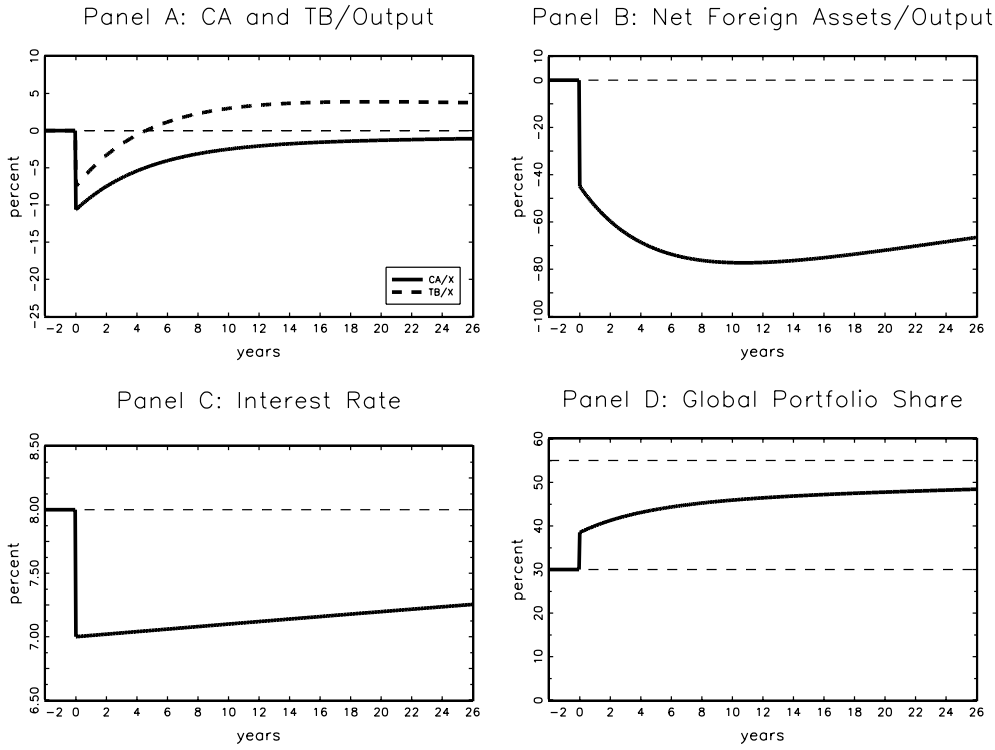


Figure 4: A Collapse in g^E with $\alpha_0^{EU} V_0^U / W_0^E = 0.3$

would have it. That is, current account "imbalances" are rapidly undone only if the growth-differential that justifies them disappears.

The importance of taking into consideration the countries' relative ability to create assets is central when there are important institutional differences across these countries. We turn to this analysis next, which is at the core of our explanation for recent global imbalances.

2.3 A World with Asymmetric Financial Markets (a $U-R$ World)

Let us now turn to the interaction between U and R. For clarity, we shall remove E from the analysis. The key element of this part of the model is that R is able to grow and generate income for savers but is limited in its ability to generate sound financial assets for these savers.

In this section we develop our argument in two steps: First, at date 0 we let R's δ drop from δ to $\delta^R = \delta - \Delta_\delta$, in an environment where R and U are growing at the same rate g. Second, we repeat the experiment but now in an environment where R is growing faster than U, $g^R > g$.

The formulae are very similar to that in the $U - E$ model, but there are some differences that need to be highlighted. Let quantities without superscript denote world aggregates (now made of U and R, rather

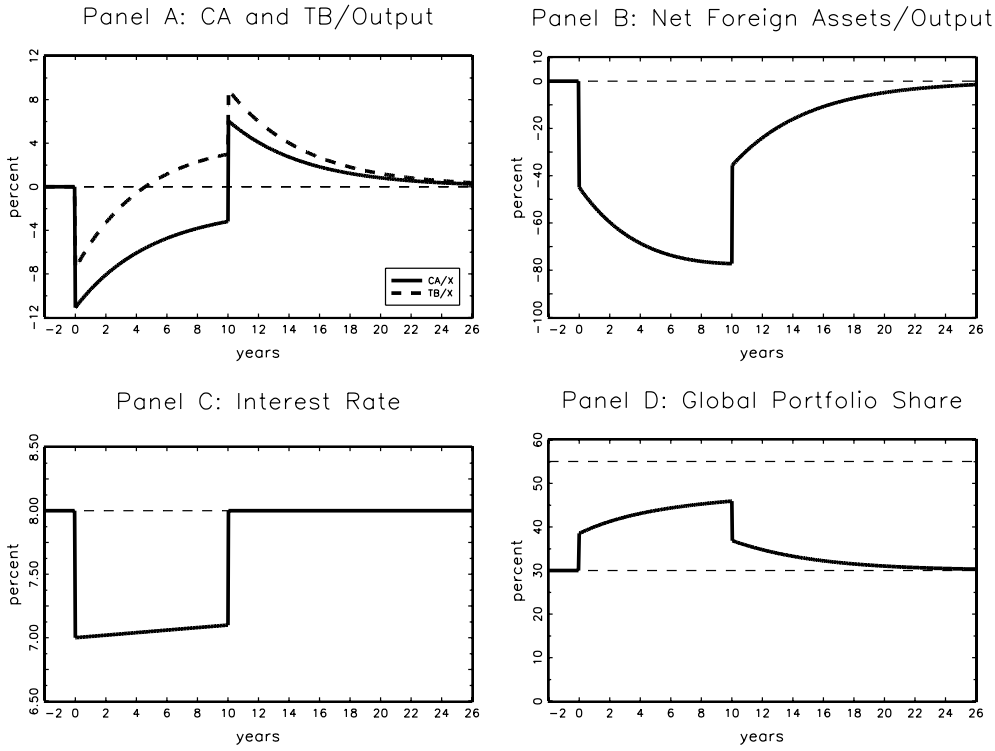


Figure 5: A Collapse in g^E at $t = 0$ followed by a recovery at $t = 10$

than U and E), then:

$$r_t V_t^R = \dot{V}_t^R + \delta^R X_t^R$$

and

$$r_t V_t = \dot{V}_t + \delta^R X_t + x_t^U \Delta_\delta X_t$$

with $x_t^U \equiv X_t^U / X_t$. Similarly, we have that:

$$\dot{W}_t^R = (1 - \delta^R) X_t^R + (r_t - \theta) W_t^R$$

and

$$\dot{W}_t = \left[1 - \delta + \Delta_\delta (1 - x_t^U)\right] X_t + (r_t - \theta) W_t$$

Finally, using the equilibrium conditions $W = V = X/\theta$, and the arbitrage equation for V, we can solve for the equilibrium interest rate as before:

$$\begin{aligned} r_t &= x_t^U (g + \delta\theta) + (1 - x_t^U)(g + \delta^R \theta) && (17) \\ &= g + \delta\theta - (1 - x_t^U)\Delta_\delta \theta. && (18) \end{aligned}$$

Let us rule out corner solutions:

Assumption 5 *(Non-negligible regions)* $1 > x_0^U > 0$,

and turn to the main results:

Proposition 2 *(Crash in R's Financial Markets with Symmetric Growth): Assume R and U grow at the same rate g. Under assumption 3 and 5, if at date 0 δ drops to $\delta^R = \delta - \Delta_\delta$ in R, with $\Delta_\delta > 0$, then the current account of U turns into a deficit at impact and remains in deficit thereafter, with CA_t^U/X_t^U converging to a strictly negative constant. The interest rate falls permanently below r_{aut}^U.*

Proof. Note first that since both regions are growing at the same rate, $x_t^U = x_0^U$ for all $t > 0$, and the interest rate remains constant after dropping at date 0:

$$r_t = r^+ = r_{aut}^U - (1 - x_0^U)\Delta_\delta\theta < r_{aut}^U. \tag{19}$$

Next, because the interest rate is constant, the values of the trees change immediately to their new balanced growth path:

$$V_t^R = \frac{\delta^R X_t^R}{r^+ - g}, \qquad V_t^U = \frac{\delta X_t^U}{r^+ - g}.$$

Let us now describe the balanced growth path and then return to describe transitory dynamics. In the balanced growth path, we know from Lemma 1 that

$$W_t^R = \frac{(1-\delta^R)X_t^R}{\theta + g - r^+} \qquad W_t^U = \frac{(1-\delta)X_t^U}{\theta + g - r^+}$$

and

$$\frac{CA_t^U}{X_t^U} = -g\frac{g + \delta\theta - r^+}{(g + \theta - r^+)(r^+ - g)} < 0.$$

For transitory dynamics define $w_t^R = W_t^R/X_t^R$ so that

$$\dot{w}_t^R = (r^+ - g - \theta)w_t^R + (1 - \delta^R).$$

with a balanced growth equilibrium value of $(1-\delta^R)/(\theta + g - r^+)$.

From home-bias Assumption 3 we have that

$$w_{0+}^R = \frac{V_{0+}^R}{X_0^R} < \frac{1-\delta^R}{\theta + g - r^+}$$

since $r^+ < r_{aut}^U$. That is, w_t^R is below its balanced growth path at $t = 0^+$.

Since $r^+ < r_{aut}^U < g + \theta$, we must have $\dot{w}_t^R > 0$ when w_t^R is below its steady state, or equivalently:

$$\dot{W}_t^R > gW_t^R$$

Thus we also have that U's current account $CA_t^U = \dot{V}_t^R - \dot{W}_t^R$ is in deficit – in fact, a larger deficit– before converging to its new balanced growth path. ■

That is, now even if both regions have similar rates of growth, U runs a permanent current account deficit. The latter is the counterpart of the increasing flow of resources from R-savers, who have few reliable local assets to store value and hence must resort to U-assets. In balanced growth, R-savings needs grow at the rate of growth of income. If R-savings are below (output-detrended) steady state, then the rate of accumulation exceeds the rate of growth of the economy and capital flows toward U grow at a fast rate (faster than g).

The collapse in δ^R decreases the global supply of assets, by reducing the share of R's income that can be capitalized. As before, the shock is entirely absorbed via a decline in world interest rates, reflecting a decline in the global dividend rate from δ to $\delta - (1 - x_0)\,\Delta_\delta$. While global wealth and capitalization do not change at impact, the allocation of wealth and assets across countries does. The collapse in δ^R implies that V_0^U/V_0^R must rise as an unchanged stream of U's dividends is now discounted at a lower interest rate. Correspondingly, under our home bias assumption, the ratio W_0^U/W_0^R must also rise.[6]

Again, we can resort to the analysis of a small open economy in Section 2.1, and its Figure 2, to understand the asymptotic result. For this, note that the equilibrium interest rate falls to a level in between the two ex-post Autarky rates:

$$r_{aut}^U = g + \delta\theta > r^+ = g + \delta\theta - (1 - x_0^U)\Delta_\delta\theta > g + (\delta - \Delta_\delta)\theta = r_{aut}^R$$

Thus the gap between W_t^U/X_t^U and V_t^U/X_t^U is negative and *non*-vanishing (see Lemma 1). Or, from the other side, the gap between W_t^R/X_t^R and V_t^R/X_t^R is positive and non-vanishing. Figure 6 presents the asymptotic result. Starting from a symmetric equilibrium at A and A^* with a world interest rate r_{aut}^U, the decline in δ^R shifts the V^R/X^R curve to the left (decline in asset supply) and the W^R/X^R curve to the right (increase in asset demand). The world interest rate declines asymptotically to r such that the net foreign assets in U ($NA^U \equiv W^U - V^U < 0$) and the net foreign assets in R ($NA^R \equiv W^R - V^R > 0$) sum to zero.

Figure 7 characterizes the entire path following a collapse of δ^R calibrated so that R's asset prices collapse by 50% on impact (see Section 5 for a discussion – also, the figure relaxes the extreme home bias assumption of the proposition to match observed cross-holdings). Again, our objective is not to match the precise trajectory of the US and developing countries current accounts following the Asian crisis, but to argue that the effects we describe are quantitatively significant. Panel A of figure 7 shows that U's current and trade accounts (relative to domestic output) exhibit large initial deficits (-14.8 and -12.2 percent respectively). The trade balance turns into surplus after 6.5 years and asymptotes at 4 percent of output while the current account remains negative at -3 percent of output. As in the $U - E$ case, the large initial current account

[6]It is easy to show that if δ^R crashes to zero, then a bubble must arise in U-trees. While that drop in δ^R is extreme, it captures the flavor of the behavior of U's asset markets in recent years. In the less extreme version we have highlighted, we still capture this flavor through the rise in the value of fundamentals following the decline in equilibrium interest rates.

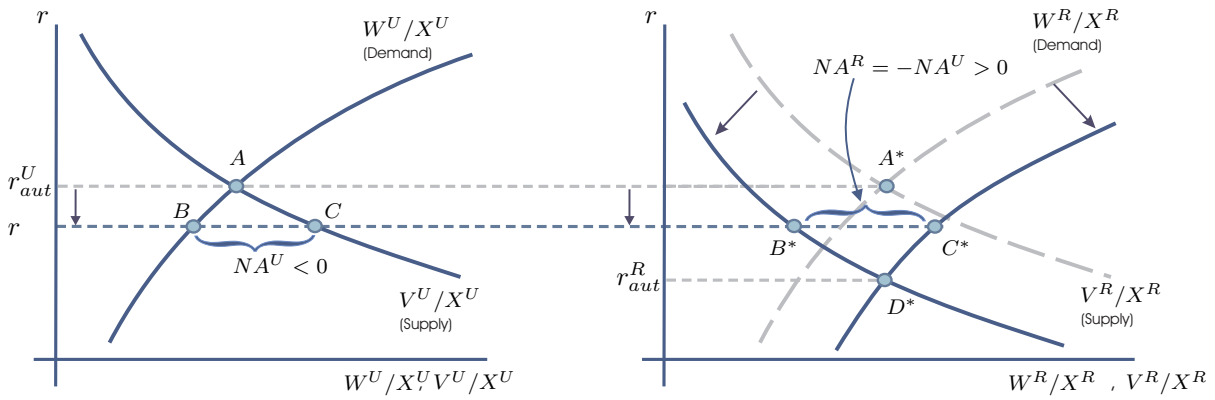


Figure 6: The Metzler diagram for a permanent drop in δ^R.

deficits worsen rapidly the net foreign asset position from -36 percent to -102 percent (panel B).[7] The real interest rate drops from 8 percent to 7.11 percent, and remains permanently lower. Finally, U's share in R's portfolio increases gradually from 51 to 68 percent.[8]

Once again, the model is able to generate, simultaneously, long lasting current account deficits in U (Fact 1); a decline in real interest rates (Fact 2) and an increase of U's assets in global portfolios (Fact 3).

Importantly, now CA^U_t/X^U_t does not vanish asymptotically as it converges to:

$$\frac{CA^U_t}{X^U_t} = -g\frac{\Delta_\delta(1-x^U_0)\theta}{(\theta+g-r^+)(r^+-g)} < 0.$$

The reason is that excess savings needs in R grow with R's output, which grows in tandem with U's output.

Note also that the size of the permanent current account deficit in U (relative to output) is increasing in the relative size of R (equal to $(1-x^U_0)$). This observation hints at an important additional source of large and persistent deficits in U. In practice, R's rate of growth exceeds that of U, and hence the relative importance of this source of funding of U-deficits rises over time.

Let us now turn to our second experiment and explore the effect of a crash in δ^R that takes place in an environment where:

$$g^R > g$$

The instantaneous interest rate in this case is:

$$r_t = x^U_t\,(g+\delta\theta) + (1-x^U_t)(g^R+\delta^R\theta) \tag{20}$$

and we make the following assumption:

[7]The initial jump at $t=0^+$ reflects the unexpected valuation effect from U's holdings of R's asset. Recall that our convention, similar to NIPA or BoP accounting, excludes these valuation effects from the current account.

[8]The initial jump from 30 to 51 percent reflects the drop in R's wealth at $t=0^+$.

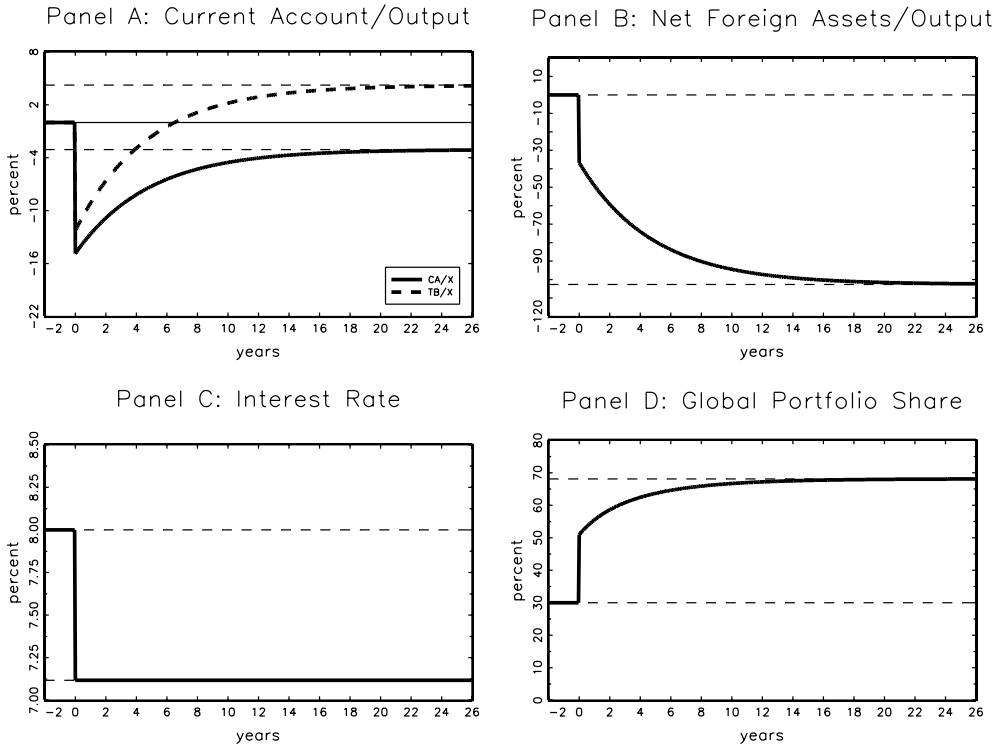


Figure 7: A Collapse in δ^R with $\alpha_0^{RU} V_0^U / W_0^R = 0.3$

Assumption 6 *(Lower ex-post autarky rate in R)* $\quad r_{aut}^R = g^R + \theta\delta^R < r_{aut}^U - \theta(1 - x_0^U)\Delta_\delta < r_{aut}^U$

Proposition 3 *(Crash in R's Financial Markets with High Growth in R) Suppose that assumptions* 3, *5, and 6 hold, but that* $g^R > g$. *If* δ^R *drops from* δ *to* $\delta^R = \delta - \Delta_\delta$ *in R, with* $\Delta_\delta > 0$, *at date 0, then:*

$$r_{0^-} > r_{0^+} > r_\infty = r_{aut}^R$$

and the asymptotic current account deficit in U relative to its output is larger when $g^R > g$ *than when* $g^R = g$*:*

$$\lim_{\substack{t\to\infty \\ g^R > g}} \frac{CA_t^U}{X_t^U} < \lim_{\substack{t\to\infty \\ g^R = g}} \frac{CA_t^U}{X_t^U} < 0$$

Proof. The first inequality of the first statement follows directly from $\Delta_\delta > 0$, as in Proposition 2. The second inequality follows from assumption 5 and the fact that x_t^U declines over time. Asymptotically, r_t converges to r_{aut}^R.

From Lemma 1, we know that

$$\frac{CA_t^U}{X_t^U} \underset{\substack{t\to\infty \\ g^R > g}}{\to} -g\frac{g + \delta\theta - r_{aut}^R}{\left(g + \theta - r_{aut}^R\right)\left(r_{aut}^R - g\right)} < 0$$

On the other hand, from Proposition 2 we have that

$$\frac{CA_t^U}{X_t^U} \underset{\substack{t\to\infty \\ g^R=g}}{\to} -g\frac{g+\delta\theta-r^+}{(g+\theta-r^+)(r^+-g)} < 0$$

where $r^+ = r_{aut}^U - \theta\left(1-x_0^U\right)\Delta_\delta$ (see (19)). From assumption 6, $r^+ > r_{aut}^R$ and the second statement in the proposition now follows since

$$\frac{r-g-\delta\theta}{(g+\theta-r)(r-g)} = \frac{1-\delta}{g+\theta-r} - \frac{\delta}{r-g}$$

is increasing with respect to r. ■

The result in this proposition is intuitive given the previous proposition: As R's growth rises, so does its demand for financial assets. Since this rise is not matched by an increase in R's ability to generate financial assets, these assets must be found in U and interest rates drop as the price of U-assets rise. The corresponding increase in capital flows finances the larger current account deficit in U. Long run interest rates fall more than the short term interest rates because the relative importance of the country with excess demand for assets, R, rises over time.

As before, let us now describe the asymptotic result in terms of Figure 2, from section 2.1. First, since in the long run R dominates the global economy when $g^R > g$, the equilibrium interest rate converges to the Autarky interest rate for R:

$$r_\infty = r_{aut}^R = g^R + \delta^R\theta.$$

Thus, relative to X_t^R, the gap between W_t^R and V_t^R is vanishing, and so is that between W_t^U and V_t^U.

However, note that this limit interest rate is below the Autarky rate in U:

$$r_\infty = g^R + \delta^R\theta < g + \delta\theta = r_{aut}^U.$$

Thus, relative to X_t^U, the gap between W_t^U and V_t^U is negative and *not* vanishing. Moreover, since

$$r_\infty < r^+ < r_{aut}^U,$$

that gap is larger when $g^R > g$ than when $g^R = g$.

Let us conclude this section with two comments: First, Figure 8 shows the same paths as Figure 7 (with $g^R = g$), but now δ^R unexpectedly rises back to δ ten years after the initial shock. As δ^R rises the global supply of assets increases, which in turn raises world real interest rates back to r_{aut}^U. Such reversal lowers asset values in U while it raises them in R. As a result, consumption drops in U and CA^U turns into a surplus. As in the $U-E$ case, the main point of this figure is to illustrate that a sharp reversal in U's current

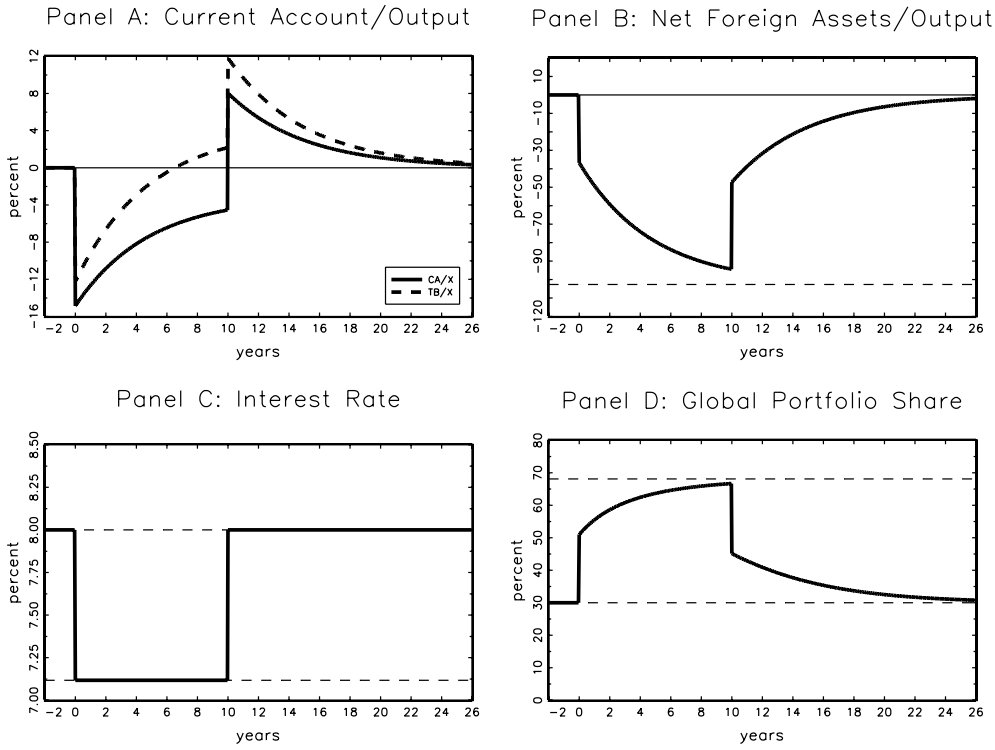


Figure 8: A Collapse in δ^R followed by a recovery when $t = 10$

account can take place. However, for this to happen there must be a *reversal* of the causes that triggered the initial shift, since the strength of automatic rebalancing forces is tenuous at best.

Second, if we were to integrate the $U - E$ and $U - R$ worlds, all our qualitative conclusions would go through. Perhaps the main point worth highlighting in this context is that the crash in asset markets in R reallocates their savings toward both U and E, but the differential growth among the latter means that, on net, a larger share is reallocated to U.

3 Multiple Goods and Exchange Rates

Up to now, our conclusions have abstracted from (real) exchange rate considerations. However, the main point of this section is to show that adding such dimension to the model does not alter the qualitative (and in some cases quantitative) features of the results in Section 2. While adding multiple goods allows us to generate exchange rate patterns from our shocks that resemble those observed in recent data, the behavior of capital flows and interest rates remain largely unchanged with the exception of some attenuation in the $U - E$ context.

3.1 Preliminaries

We maintain the general framework of Section 2 but extend it to consider differentiated goods. Each country i produces one type of good X^i, while its consumers have the following constant elasticity preferences (CES):

$$C^i = \left(\sum_j \gamma_{ij}^{\frac{1}{\sigma}} x^{j\,\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{21}$$

where σ represents the –constant– elasticity of substitution between the goods from any two countries. The coefficients γ_{ij} measure the strength of preferences for the various goods and satisfy $\sum_j \gamma_{ij} = 1$. Assumption 7 below imposes that agents have a preference for their home good. This assumption is well-established empirically. It also generates relative demand effects that will be important for exchange rate dynamics.

Assumption 7 *(Consumption Home Bias) Each agent has a preference for the home good:* $\gamma_{ii} \equiv \gamma > 0.5$.

Let X^U be the numeraire good and define q^j as the price of good j in terms of good U (with the convention $q^U = 1$). Given (21), the Fisher-ideal price indices are:

$$P^i = \left(\sum_j \gamma_{ij} q^{j(1-\sigma)} \right)^{1/(1-\sigma)}$$

and the real exchange rate between countries i and k is

$$\lambda^{ik} = \frac{P^k}{P^i} = \left(\frac{\sum_j \gamma_{kj} q^{j(1-\sigma)}}{\sum_j \gamma_{ij} q^{j(1-\sigma)}} \right)^{1/(1-\sigma)}$$

This expression highlights the importance of consumption home bias for exchange rate movements: if $\gamma_{ij} = \gamma_{kj}$ for all j, then purchasing power parity obtains and the real exchange rate is equal to 1.

Given CES preferences, the demand for good j by residents of country i satisfy:

$$x^{ij} = \gamma_{ij} C^i \left(\frac{q^j}{P^i} \right)^{-\sigma}, \ \forall i, j$$

and equilibrium in the goods market imposes

$$\sum_i x_{ij} = X_j, \ \forall j.$$

Substituting $P^i C^i = \theta W^i$ (where domestic wealth is now measured in terms of U's good), the equilibrium condition for good i can be rewritten as:

$$\theta \sum_i \gamma_{ij} \frac{W^i}{P^i} \left(\frac{q^j}{P^i} \right)^{-\sigma} = X^j, \ \forall j.$$

3.2 A $U - E$ World

We now specialize the model to a symmetric $U - E$ world, and denote by r_t the instantaneous return in terms of the numeraire. By arbitrage, r_t satisfies

$$r_t V_t^i = \delta q_t^i X_t^i + \dot{V}_t^i$$

while wealth dynamics follow

$$\dot{W}_t^i = (1-\delta)\, q_t^i X_t^i + (r_t - \theta)\, W_t^i.$$

As before, adding across countries and using the equality between global wealth and global asset values, one obtains:

$$W_t = V_t = \frac{X_t}{\theta}$$

where $X_t = X_t^U + q_t^E X_t^E$.

Following the same steps as before, the instantaneous interest rate satisfies:

$$r_t = \frac{\dot{X}_t}{X_t} + \delta\theta.$$

The only notable difference is that the (inverse of the) terms of trade q_t^E –and hence the real exchange rate– enters into the determination of global wealth and of the equilibrium interest rate via X_t.

In turn, the terms of trade are determined by the equilibrium on the market for X^U (by Walras' Law, the market for X^E is also in equilibrium):

$$\theta\gamma W_t^U P_t^{U(1-\sigma)} + \theta\,(1-\gamma)\, W_t^E P_t^{E(1-\sigma)} = X_t^U.$$

Let Assumptions 2 and 3 hold, so that the world is initially symmetric with a common rate of growth g, and there is extreme portfolio home bias. Given the symmetry assumption, it is immediate that $q^E = 1$, so that the interest rate satisfies:

$$r = g + \delta\theta$$

while asset values and wealth satisfy

$$V^i = W^i = \frac{X^i}{\theta}.$$

As before, suppose that at $t = 0$ the growth rate of E drops unexpectedly and permanently to:

$$g^E = g - \Delta_{g^E},\ \Delta_{g^E} > 0.$$

The main initial difference with Section 2 is that now both the interest rate *and* the real exchange rate absorb the shock at impact. To see this, observe that the decline in g^E decreases E's asset values. With Assumption 3 (extreme home portfolio bias), this impoverishes E's residents. Given the consumption-home-bias assumption (Assumption 7), the associated decline in E's consumption falls mostly on the demand for

E goods. Equilibrium in the goods markets then requires that q^E falls. This *relative demand effect* implies that U's real exchange rate *appreciates at impact*. It is a direct consequence of both home consumption and portfolio biases. Over time, however, the increase in the *relative supply* of U's good requires that its real exchange rate *depreciates*.

How large is the initial fall and eventual increase in q^E depends on the elasticity of substitution σ. To see this, observe that the relative demands satisfy

$$\frac{x^{iE}}{x^{iU}} \propto (q^E)^{-\sigma}$$

Asymptotically, the ratio of relative demands for at least one country must equal the ratio of relative supply, X^E/X^U. From this, we infer that:

$$\frac{\dot{q}_t^E}{q_t^E} \underset{t\to\infty}{=} \frac{1}{\sigma}\Delta_{g^E}$$

Let us rule out the region $\sigma < 1$ since it implies immiserizing growth. In the feasible region, consider first the $\sigma = 1$ case which yields the starkest departure from the previous section. One can show that now terms of trade satisfy

$$q_t^E = \frac{X_t^U}{X_t^E}$$

which implies

$$x_t^U = \frac{1}{2}.$$

In this extreme case, when growth slows down in E there is no change in the exchange rate at impact, and a gradual increase in q at rate Δ_{g^E} thereafter. Since the output share is constant, the instantaneous return in terms of X^U is also constant and equal to

$$r = \frac{1}{2}g + \frac{1}{2}\left(g^E + \frac{\dot{q}^E}{q^E}\right) + \delta\theta = g + \delta\theta.$$

Log preferences also eliminate the model's dynamics. One can check that

$$V_t^i = W_t^i = \frac{q^i X_t^i}{\theta}.$$

Hence neither country needs to run current account imbalances in response to the collapse in g^E. The reason is that the terms of trade offset perfectly the relative decline in output growth, leaving relative wealth and relative output unchanged (when measured in the same units).

Consider now the more realistic case where $\sigma > 1$. From the previous discussion, we infer that q^E increases at a smaller rate than the growth differential. For instance, with $\sigma = 4$ —not an unreasonable value[9]— and a growth differential of 2 percent per year, the model implies that U's terms of trade would worsen at 0.5

[9]See Blanchard et al. (2005), Broda and Weinstein (2004) and Obstfeld and Rogoff (2005) for a discussion of plausible values for $\sigma > 1$.

percent per year. This implies an even slower real exchange rate depreciation, which eventually converges to a steady state value of $\left((1-\gamma)/\gamma\right)^{1/(1-\sigma)}$.

We can prove a result similar to Proposition 1 and the associated Metzler diagram in presence of exchange rates. From $r_t = \dot{X}_t/X_t + \delta\theta$, we have

$$r_t = g x_t^U + \left(g^E + \dot{q}_t/q_t\right)\left(1 - x_t^U\right) + \delta\theta.$$

Since x_t^U tends to 1, we obtain:

$$\lim_{t\to\infty} r_t = g + \delta\theta = r_{aut}^U.$$

From

$$\begin{aligned} \dot{W}_t^E &= (r_t - \theta) W_t^E + (1-\delta) q_t^E X_t^E \\ r_t V_t^E &= \delta q_t X_t^E + \dot{V}_t^E \end{aligned}$$

it is apparent that

$$\begin{aligned} \frac{W_t^E}{q_t^E X_t^E} &\underset{t\to\infty}{\to} \frac{(1-\delta)}{\theta + \left(g^E + \frac{1}{\sigma}\Delta g^E\right) - r_{aut}^U} \\ \frac{V_t^E}{q_t X_t^E} &\underset{t\to\infty}{\to} \frac{\delta}{r_{aut}^U - \left(g^E + \frac{1}{\sigma}\Delta g^E\right)} \end{aligned}$$

Thus, the asymptotic wealth and asset values are similar to those of Proposition 1, the only difference being that g^E has to be replaced by $g^E + \frac{1}{\sigma}\Delta g^E < g^U$.

By a reasoning analogous to that in Lemma 1, we obtain:

$$\frac{CA_t^U}{q_t^E X_t^E} = -\frac{CA_t^E}{q_t^E X_t^E} \underset{t\to\infty}{\to} \left(g^E + \frac{1}{\sigma}\Delta g^E\right)\left[\frac{\delta}{r_{aut}^U - \left(g^E + \frac{1}{\sigma}\Delta g^E\right)} - \frac{(1-\delta)}{\theta + \left(g^E + \frac{1}{\sigma}\Delta g^E\right) - r_{aut}^U}\right] \leq 0$$

As we discussed above, when $\sigma = 1$ there is no current account deficit. At the other extreme, when σ tends to infinity we recover the deficits from Proposition 1 since there is no offsetting long-run exchange rate movement. While there can be non-monotonicities in the intermediate region, the general message is apparent: The possibility of *long-run* exchange rate movements attenuates rather than exacerbates the wealth effects associated with differential growth and hence attenuates asymptotic current account deficits. The main reason behind the latter is that the reduced wealth effects at impact when $\sigma < \infty$ leads to smaller initial trade deficits in U and hence smaller accumulated net external liabilities.

Figure 9 confirms the previous conclusion presenting the results of a simulation similar to that in Figure 3, now for the two-goods model when $\sigma = 4$ and $\gamma = 0.9$. Comparing panels A-D in both figures, we observe that relative price movements limit the size of the current account deficit (Panel A, 9.5 percent versus 19 percent in the single good model) and limit accordingly the build up in net foreign debt (Panel B, -61 percent

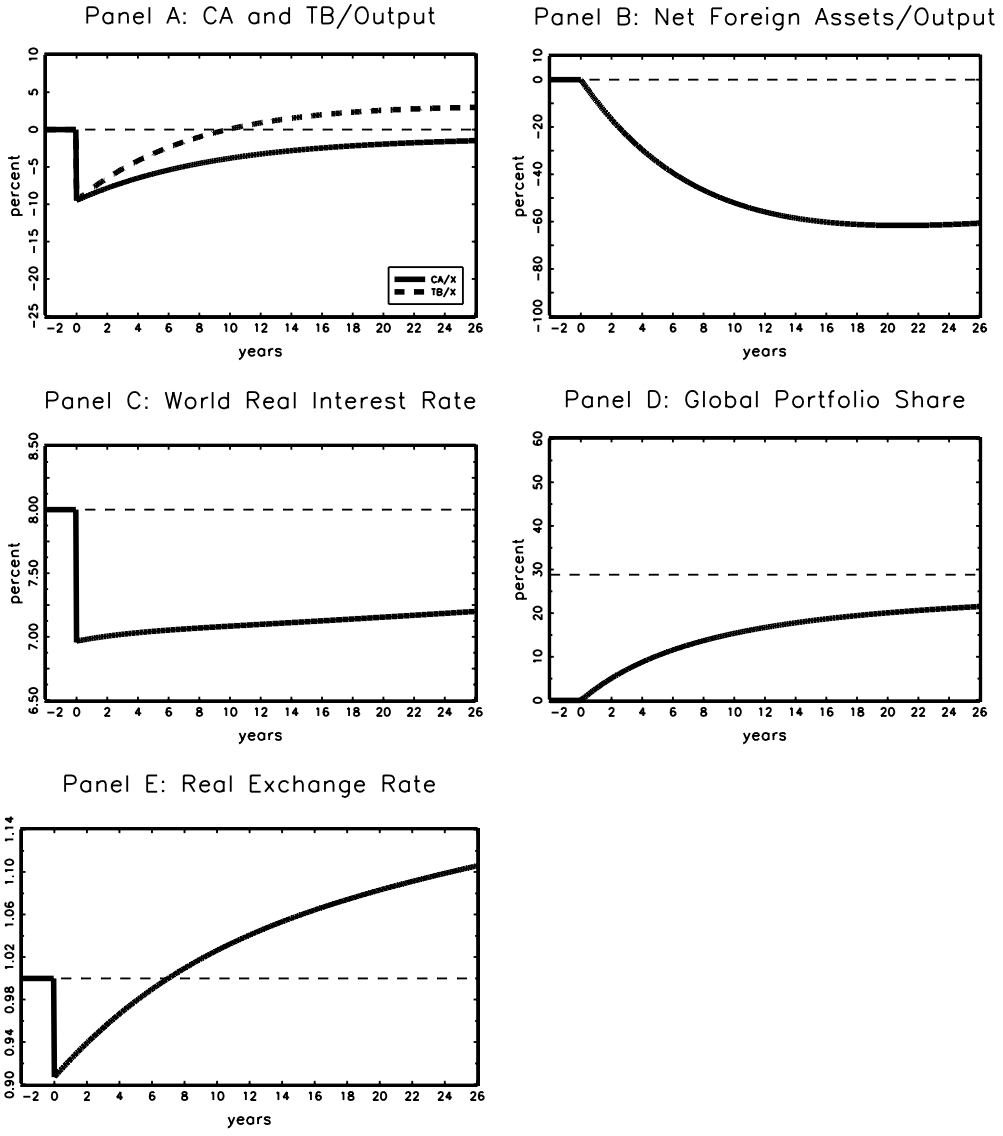


Figure 9: A Collapse in g^E in the two-good model

after 21 years versus -74 percent of output after 14 years in the single good model). Accordingly, the increase in the share of U in global portfolios is more muted (Panel D). Panel C reports the world's real instantaneous rates of return, defined as the output-weighted average of both countries real returns. The trajectory of the world real interest rates is very similar to the one obtained in panel C in figure 3: from 8 percent, the world interest rate drops to 6.96 percent on impact, then climbs very slowly back toward 8 percent. Finally, Panel E reports the real exchange rate $\lambda = P^E/P^U$. On impact λ appreciates by about 9.3 percent, to then gradually but persistently depreciate. Importantly, in our model it is the latter that dominates (dampens) wealth effects and hence limits the initial current account deficits in U. .

Finally, Figure 10 presents a figure similar to Figure 9, with an unexpected reversal in g^E after ten years.

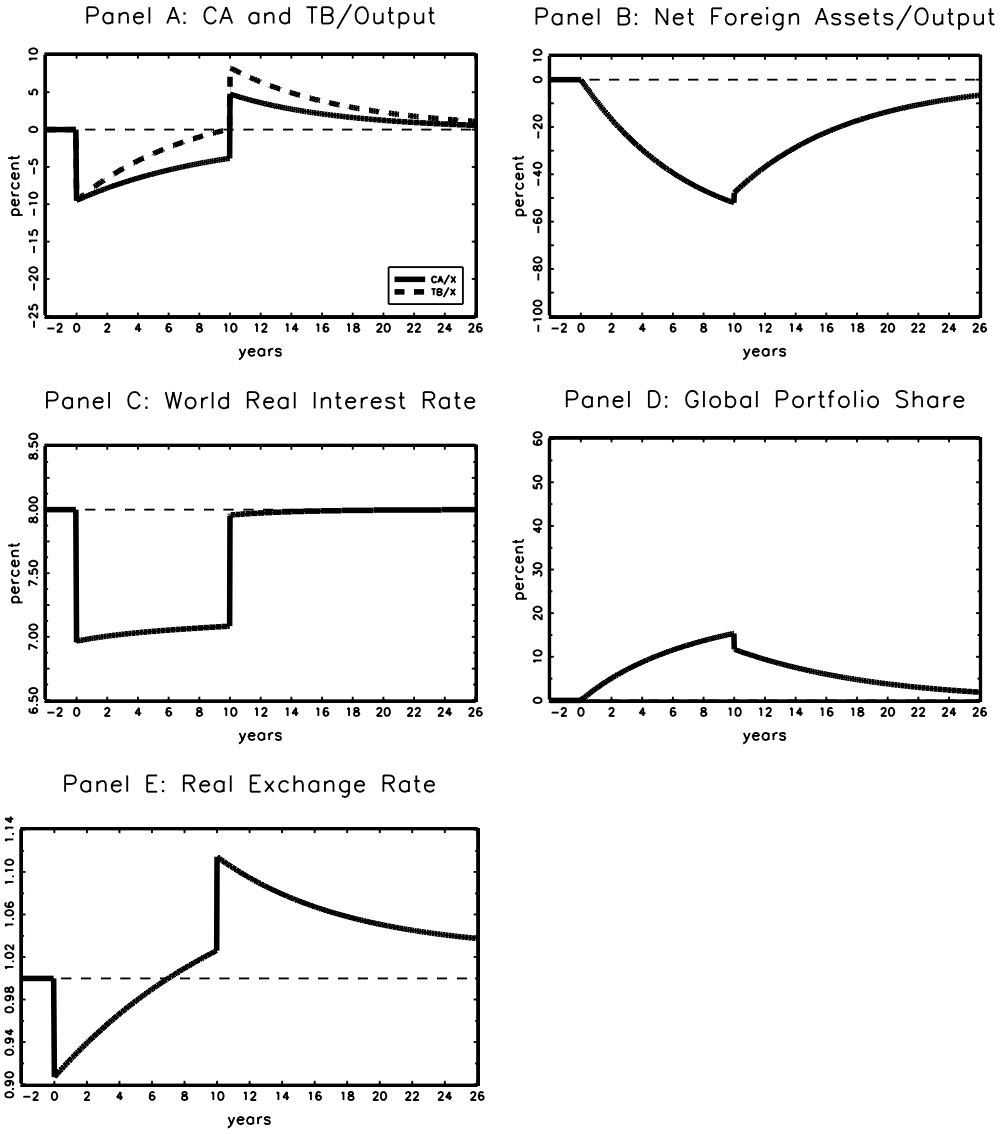


Figure 10: A Collapse in g^E in the two-good model, followed by a reversal at $t = 10$

Comparing both figures we see that the increase in g^E is now associated with a sharp depreciation of the dollar at $t = 10$, but followed by a gradual appreciation so that by year 25, U's exchange rate is at 1.04 rather than the 1.10 in figure 9.

3.3 A $U - R$ World

Consider now the interaction between U and R. As before, let's consider a scenario where R's ability to capitalize financial assets drops from δ to $\delta^R = \delta - \Delta_\delta < \delta$ while $g^R = g$.

Following the same steps as before, we obtain:

$$V_t = W_t = \frac{X_t}{\theta}$$

where $X_t = X_t^U + q_t^R X_t^R$, $V_t = V_t^U + V_t^R$ and $W_t = W_t^U + W_t^R$. The instantaneous rate of return now satisfies:

$$r_t = r_{aut}^U + \left(1 - x_t^U\right)\left(\frac{\dot{q}_t}{q_t} - \theta\Delta_\delta\right)$$

which is similar to equation (17), except for the rate of change of the terms of trade.

Since output growth is the same in both countries, a reasoning similar to the previous section implies that $\dot{q}_t^R/q_t^R = 0$ asymptotically. The absence of relative supply effect implies that the long run terms of trade are stable. On impact, however, the relative demand effect is still present: the decline in δ^R reduces the value of R's financial assets which, under portfolio home bias, reduces R's financial wealth. Finally, due to consumption home bias, the decline in financial wealth in R reduces disproportionately the relative demand for R's good and induces a decline in q^R.

Asymptotically, substituting $\dot{q}_t^R/q_t^R = 0$ into the expression for r_t, we see that the interest rate reaches the value:

$$\lim_{t\to\infty} r_t = r_\infty^+ = r_{aut}^U - \left(1 - x_\infty^U\right)\Delta_\delta\theta < r_{aut}^U$$

where x_∞^U represents the asymptotic share of U's output. Now Lemma 1 applies, so that

$$\frac{V_t^R}{q_t^R X_t^R} \underset{t\to\infty}{\to} \frac{\delta^R}{r_\infty^+ - g};\ \frac{V_t^U}{X_t^U} \underset{t\to\infty}{\to} \frac{\delta}{r_\infty^+ - g},$$

$$\frac{W_t^R}{q_t^R X_t^R} \underset{t\to\infty}{\to} \frac{1-\delta^R}{\theta + g - r_\infty^+};\ \frac{W_t^U}{X_t^U} \underset{t\to\infty}{\to} \frac{1-\delta}{\theta + g - r_\infty^+}$$

and the asymptotic current account satisfies

$$\frac{CA_t^U}{X_t^U} \underset{t\to\infty}{\to} g\left(\frac{1-\delta}{\theta + g - r_\infty^+} - \frac{\delta}{r_\infty^+ - g}\right) < 0.$$

Since $r_{aut}^U > r_\infty^+$, U runs a permanent current account deficit.

The results of Proposition 2 carry through with one exception: the asymptotic output share x_∞^U may differ from the initial output share x_0^U. It is immediate that the current account deficit will be larger if $r_\infty^+ < r^+$, or, from the formula for r_∞^+, if

$$x_\infty^U < x_0^U.$$

Since $x_t^U = X_0^U / \left(q_t^R X_0^R + X_0^U\right)$, this is equivalent to $q_\infty^R > q_0^R$ or $\lambda_\infty > \lambda_0$. If the real exchange rate depreciates asymptotically, the asymptotic current account worsens, compared to the single good case.

Figure 11 reports the asymptotic terms of trade q_∞^R as a function of Δ_δ/δ for our benchmark parameters. The dashed line reports the asymptotic values of the current account and world interest rate in the one-good model. The solid line reports the same variables in our two-goods model. Panel A indicates that the asymptotic terms of trade always worsen in these simulations, so that U's asymptotic current account deficit is always larger in the two-goods model than in the one-good model. The difference is not large, but it

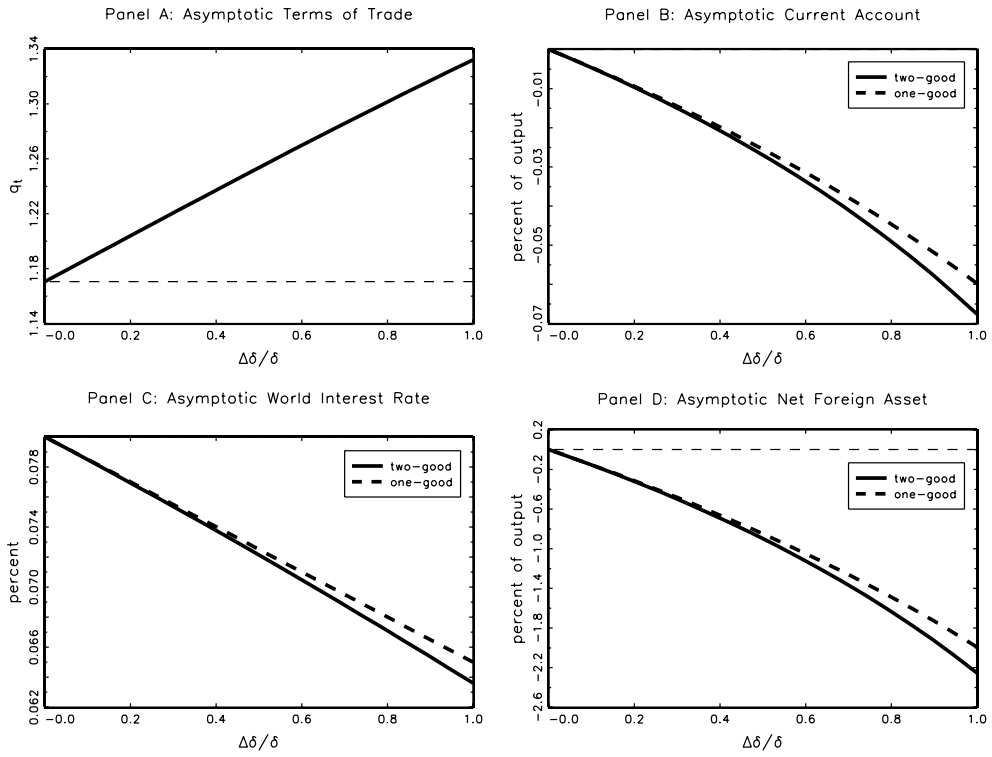


Figure 11: Asymptotic Terms of Trade, World Interest Rate, Trade and Current Account

makes the point that the conclusions from Section 2 are robust to alternative formulations yielding exchange rate fluctuations. The conventional rebalancing channel has implications for exchange rate movements but does not affect the core story for capital flows, which lies somewhere else in global asset markets.[10] In fact, although small for our calibrated parameters, adding the exchange rate dimension allows U to run larger asymptotic current account deficits and hold larger net foreign liabilities (Panel B and D). The reason is that the long run depreciation reduces U's share of output (x^U_∞). This is equivalent to a further reduction in the global supply of assets and pushes world interest rates lower (Panel C), reducing U's borrowing costs.

Figure 12 presents the results of a simulation similar to Figure 7. Panel E demonstrates that the real exchange rate appreciates on impact by 11 percent, then depreciates slowly, reaching λ_0 in eight years, then depreciating by another 6 percent. Given the previous discussion, the long run depreciation of the real exchange rate implies that the asymptotic current account deficits are (slightly) larger than in the single good model (-3.26 percent versus -3 percent in the single good model) with a correspondingly higher permanent accumulation of net foreign assets (108% of output versus 102%). Panel C shows that our conclusion with respect to the decline in interest rates from the single good model remains more or less unchanged.

Finally, figure 13 documents the paths when δ^R returns unexpectedly to δ at $t = 10$. Comparing figure

[10]The rebalancing channel refers to the mechanism whereby the rapid accumulation of claims on U by R residents, together with the consumption home bias assumption requires a future a depreciation of the real exchange rate.

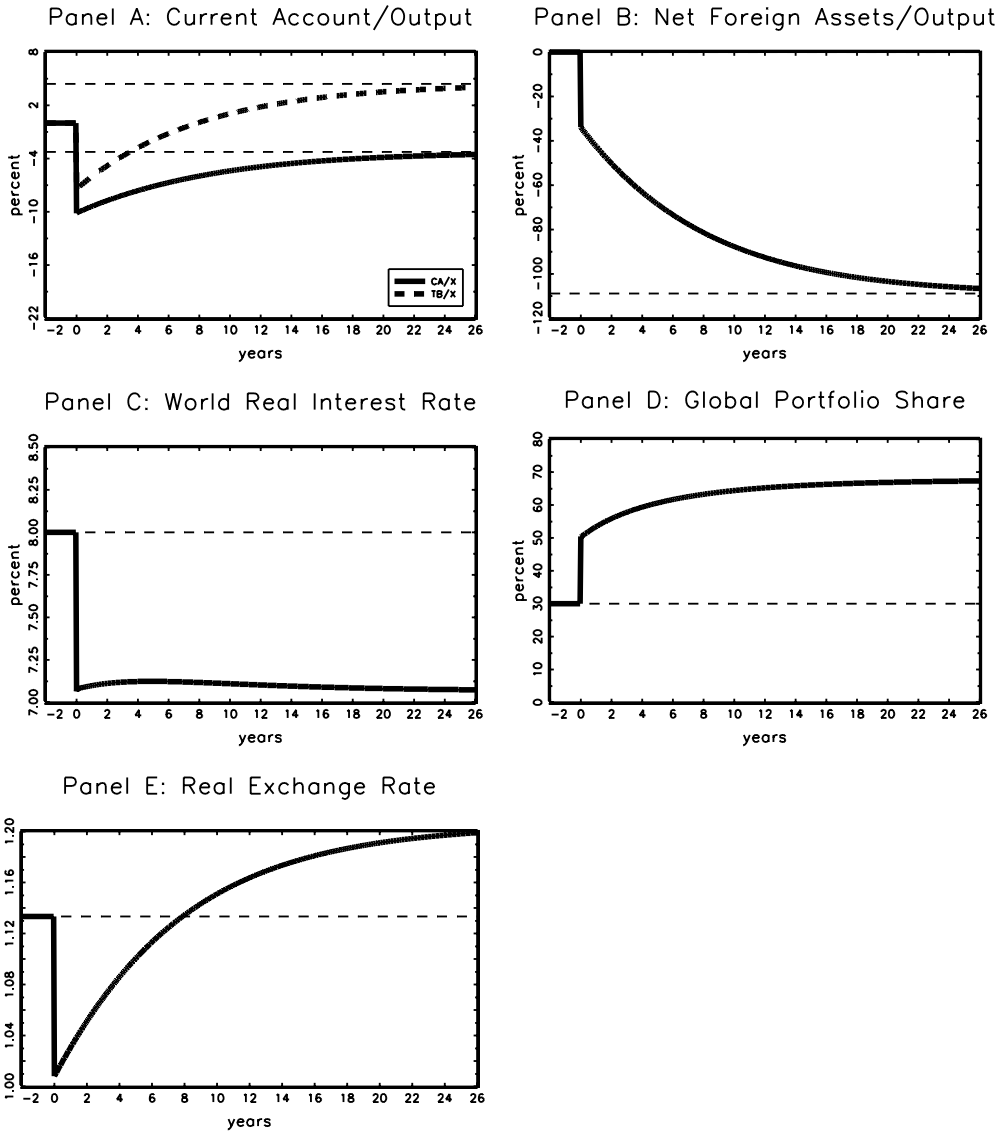


Figure 12: A Collapse in δ^R in the two-good model

12 and 13, we observe that as δ^R increases, the real exchange rate depreciates by 8 percent, then slowly appreciates. This appreciation reflects the rapid de-cumulation of claims on U by R residents (panel D). Again, however, the conclusions for quantities remain qualitatively similar to those in the one-good global economy.

4 Investment, Gross Flows, and Excess Returns

Consider the $U - R$ model, with the following modification: In each period, a limited number of high return investment opportunities appear in R. Importantly, since only U firms can generate financial assets from

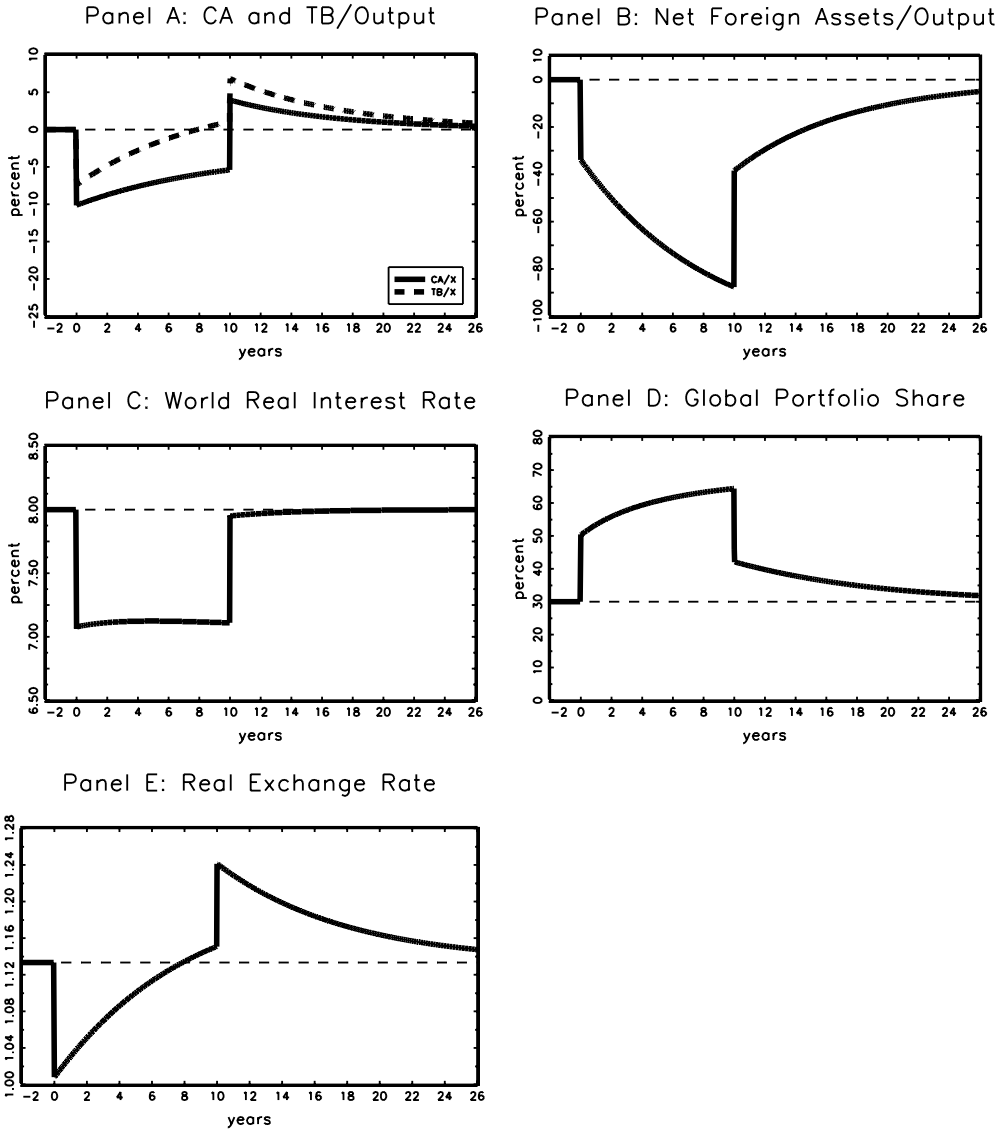


Figure 13: A Collapse in δ^R in the two-good model, followed by a reversal at $t = 10$

these investments, it is U that implements these projects and obtains a rent for its "intermediation" services. This simple extension adds four realistic implications to the model: (a) Capital flows into R to implement high marginal product projects; (b) However, this foreign direct investment into R is largely financed by R's saving which, as before, flows to U seeking high quality saving instruments. The result is gross flows that exceed net flows; (c) The excess return obtained by U implies that the effective cost of holding a large external liability position is low and; (d) Equivalently, U does not need to generate large asymptotic trade surpluses to service the large external liabilities accumulated during a sustained period of (larger) trade deficits.

The view here is not unrelated to that in Despres, Kindleberger and Salant (1966) and Kindleberger

(1965), who during the Bretton Woods era argued that the US had a unique role as a provider of international currency liquidity. More recently, Gourinchas and Rey (forthcoming 2005) have documented that the total return on US gross assets (mostly equity and FDI) consistently exceeded the total return on gross liabilities (mostly safe instruments) by an average of 3.32 percent per year since 1973.[11] Everything suggests that this "intermediation" role of the US has only grown in importance as total gross capital flows to/from the US have risen from $222 billion in 1990 to $2.3 trillion in 2004.[12]

In our framework, while financial intermediation increases global asset supply, it also increases global asset demand. This second effect dominates and results in lower world real interest rates. This, together with the rents from intermediation, allows the US to sustain permanently larger external imbalances, the so-called "exorbitant privilege of the U.S."[13]

Let us develop the minimal structure we need for this purpose: Suppose that trees in R appear in the form of growth options given to U residents at the rate of growth of the world economy, g (common to U and R). In order to plant these trees, U residents need to pay an up-front aggregate cost of X_t^I. The per-period output of each of these trees is equal to one and that of all the trees planted as of time t is Y_t^R. New trees come at the rate g, if the maximum number of trees is planted in each period, which we assume, so that (aggregate) Y_t^R grows at the rate g as well. In addition to recouping $(1-\delta)X_t^I$ of the initial investment, U residents receive a capitalizable dividend of δY_t^R. Thus R residents receive $(1-\delta)(Y_t^R - X_t^I)$ of (non-capitalizable) income. The growth options are not capitalized until the new trees are planted. Let us assume that $X_t^R = 0$ and denote by V_t^R the value of trees planted at date t by U residents. Then, we have that

$$\begin{aligned} r_t V_t^U &= \dot{V}_t^U + \delta X_t^U \\ r_t V_t^R &= \dot{V}_t^R - g V_t^R + \delta Y_t^R \end{aligned}$$

where $\dot{V}_t^R - g V_t^R$ represents capital gains on trees planted in R by U, and

$$r_t V_t = \dot{V}_t - g V_t^R + \delta X_t$$

with

$$X_t = Y_t^R + X_t^U; \qquad V_t = V_t^U + V_t^R.$$

[11] Of course part of this excess return is due to the risk-premium differential associated to the leveraged nature of US investments (see Gourinchas and Rey (forthcoming 2005)). Our analysis omits this risk dimension and focus on the "intermediation" rent obtained by the US.

[12] According to the BEA. US International Transactions Accounts, Table 1. See also Lane and Milesi-Ferretti (forthcoming 2005) for a systematic analysis of cross border flows and positions for a large sample of countries.

[13] Giscard d'Estaing (February 16, 1965)

Also,

$$\begin{aligned}\dot{W}_t^R &= (1-\delta)(Y_t^R - X_t^I) + (r_t - \theta)W_t^R \\ \dot{W}_t^U &= (1-\delta)X_t^U + (r_t - \theta)W_t^U + gV_t^R - \delta X_t^I.\end{aligned}$$

From the latter expression it is apparent that if $gV_t^R > \delta X_t^I$ country U receives rents which support higher consumption along the path for any given level of external liabilities. Thus, fixing X^I, U can finance larger trade deficits as Y^R rises.

To make the above statement precise, however, we need to solve for the interest rate as we vary Y^R (and hence V^R). Continuing with the above derivation, we have

$$\dot{W}_t = (1-\delta)X_t + (r_t - \theta)W_t + gV_t^R - X_t^I.$$

The equilibrium condition in goods (and assets) markets is:

$$X_t - X_t^I = \theta W_t$$

and the equilibrium interest rate is now

$$r_t = g + \delta\theta\frac{X_t - (g/\delta)V_t^R}{X_t - X_t^I}.$$

In the long run we have

$$\begin{aligned}\frac{V_t}{Y_t^R + X_t^U} &\underset{t\to\infty}{\to} \frac{\delta}{r} + \frac{\delta}{r-g} \\ \frac{W_t}{Y_t^R + X_t^U} &\underset{t\to\infty}{\to} \frac{1}{g+\theta-r}\left[(1-\delta) + \frac{\frac{g}{r}\delta Y_t^R - X_t^I}{Y_t^R + X_t^U}\right]\end{aligned}$$

We can therefore analyze the results in a modified version of the Metzler diagram in Section 2. The only difference comes from the extra term

$$\frac{\frac{g}{r}\delta Y_t^R - X_t^I}{Y_t^R + X_t^U}$$

in the asset demand equation. If $gV_t^R = \delta X_t^I$, which takes place if:

$$Y_t^R = \left(1 + \frac{\delta\theta}{g}\right)X_t^I$$

then the interest rate is equal to r_{aut}^U and, while there are gross capital flows, U does not run trade deficits. If

$$Y_t^R > \left(1 + \frac{\delta\theta}{g}\right)X_t^I$$

then we show in the appendix that in equilibrium, $\frac{g}{r}\delta Y_t^R - X_t^I > 0$. The extra rents accruing to U shift the asset demand curve to the right and results in a lower equilibrium interest rate. Not only gross capital flows take place, but also U now can finance trade deficits early on which do not need to be fully offset by future trade surpluses.[14]

[14] See the appendix for a more complete characterization of equilibrium.

5 "Calibration"

This section discusses the choice of parameters underlying Figures 3-13. The 'calibration' of the model requires parameter values for δ, θ, g, x_0, α_0^{iU}, α_0^{Ui}, Δ_{g^E} and Δ_δ. We chose to assign parameters approximately based on US aggregate data. Table 1 summarizes our parameter assumptions.

Parameter	θ	g	δ	x_0^E	x_0^R	μ_{0-}^{iU}	NA_{0-}^U/X_0^U	$\frac{\Delta V^R}{V^R}\|_{t=0}$	Δ_{g^E}	Δ_δ
Value	0.25	0.03	0.2	0.5	0.3	0.3	0	-0.5	0.02	0.12

Table 1: Main Parameters

According to (4), we should think of θ as the output to financial wealth ratio, X/W. We obtain an estimate of W as the net financial worth of the household sector. According to the US Flow of Funds, it is equal to \$48.52 trillion in 2004.[15] With a US GDP of \$11.73 trillion in 2004, this implies $\theta = \frac{11.73}{48.53} \sim 0.24$. In the simulations, we round this parameter to 0.25. Average output growth in the U.S. between 1950 and 2004 equals 3.33%. We round this number and set the growth rate g to 3 percent. Finally, observe that in steady state, the P/E ratio in the model is $V/\delta X = 1/\delta\theta$. The P/E ratio for the S&P 500 averages 18.2 for the period 1950-2005.[16] This yields $\delta = 0.22$, which we round to $\delta = 0.2$.[17]

Given our assumptions so far, the autarky interest rate is

$$r_{aut}^U = g + \delta\theta = 0.08.$$

This level is probably on the high end of reasonable values but it turns our that reducing it by lowering $\delta\theta$ does not change the results too much. It reduces somewhat the effect of δ^R shocks on interest rates but it exacerbates the impact of both $\delta^R$and g^E shocks on the persistence of current account and trade deficits.

We now turn to the output shares. We define U as the U.S., the U.K. and Australia. These countries are good asset suppliers, and experienced robust growth in the past decade. We identify E with developed non-oil producing countries with sound financial markets, but a lackluster growth performance. Accordingly, we define E as countries from the European Union (less the UK), Iceland, Japan, New Zealand, and Switzerland. Finally, we identify R with developing and oil producing countries with a good income growth potential, but limited asset production capacity.[18]

[15] See the Balance Sheet Table B100, line 42 of the September 2005 release.

[16] The P/E series is obtained from Robert Shiller's webpage (http://www.econ.yale.edu/~shiller/data.htm).

[17] An alternative calibration for δ is to associate it with the capital share in the economy. This would yield a larger δ, close to 1/3. However, since not all assets in the economy are capitalizable, we prefer our estimate of δ based on price-earning ratios.

[18] The list includes Argentina, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, Hong-Kong, India, Indonesia, Korea, Mexico, Malaysia, Nigeria, Panama, Peru, Philippines, Poland, Russia, Singapore, Thailand and Venezuela. Output data for Poland and Russia starts in 1990.

We measure the initial output share as the average output share between 1980 and 2003.[19] We find

$$\begin{aligned} x_0^E &= \frac{X_0^E}{X_0^E + X_0^U} \approx 0.50 \\ x_0^R &= \frac{X_0^R}{X_0^R + X_0^U} \approx 0.30. \end{aligned}$$

Lastly, we assume that the initial portfolio share for U-trees equals the share of US assets in global portfolios reported by The Economist portfolio, 0.3. That is, we set:

$$\mu_{0-}^{iU} = \frac{\alpha_0^{iU} V_{0-}^U}{W_{0-}^i} = 0.30 \tag{22}$$

where $i \in \{E, R\}$. Furthermore, we assume that the initial net foreign asset position is 0.[20] This implies that

$$V_{0-}^i = W_{0-}^i = \frac{X_0^i}{\theta}.$$

Substituting into (22), we obtain

$$\alpha_0^{iU} = \mu_{0-}^{iU} \frac{x_0^i}{1 - x_0^i}$$

which yields:

$$\begin{aligned} \alpha_0^{EU} &= 0.30 \\ \alpha_0^{RU} &= 0.13. \end{aligned}$$

Finally, since

$$W_{0-}^U - V_{0-}^U = \alpha_0^{Ui} V_{0-}^i - \alpha_0^{iU} V_{0-}^U = 0$$

we find

$$\alpha_0^{Ui} = \mu_{0-}^{iU} = 0.3.$$

We now describe the parameters for our shocks. We set the decline in E's growth rate, $\Delta_{g^E} = 0.02$. According to the WDI, the average growth rate between 1990 and 2003 (ppp-adjusted) was 2.71 percent for U and 1.85 percent for E. In recent years, however, the growth differential has increased: it was close to two percent in five years our out of seven between 1997 and 2003.[21]

We calibrate the decline in δ^R so that it matches the decline in asset values around the time of the Asian crisis. From Section 2.3, R's assets price drops from $V_{0-}^R = X_0^R/\theta$ before the shock to $V_{0+}^R = \delta^R/\theta\bar{\delta}X_0^R$ where $\bar{\delta} = \left(x_0^U \delta + \left(1 - x_0^U\right) \delta^R\right)$ is the world capitalization index. Hence the drop in asset values at $t = 0$ is

$$\frac{\Delta V^R}{V^R}|_{t=0} = \delta^R/\bar{\delta} - 1 < 0.$$

[19] We use GDP data in current dollars from the World Development Indicators.

[20] According to the Bureau of Economic Analysis, the US had a zero net foreign asset position in 1988.

[21] The two exceptions being 2000 and 2001 when the US entered a brief and shallow recession.

Solving this expression for δ^R, we obtain

$$\Delta_\delta = \delta \left(1 + \frac{x_0^U \left[1 + \frac{\Delta V^R}{V^R}|_{t=0} \right]}{\left[\frac{\Delta V^R}{V^R}|_{t=0} \left(1 - x_0^U \right) - x_0^U \right]} \right).$$

The decline in dollar asset values was 37 percent in Hong-Kong, 75 percent in Korea and 83 percent in Indonesia.[22] We conservatively consider a decline of 50 percent. This implies:

$$\Delta_\delta = 0.12;\ \delta^R = 0.08$$

6 Final Remarks

In this paper we have proposed a framework to analyze the effects of different structural shocks on global capital flows, portfolio shares and interest rates. The framework highlights the connection between a region's relative fundamentals – in particular, its growth potential and the quality (or acceptance) of its financial assets – and its ability to produce financial assets for global savers.

We used the framework to discuss two shocks that we view as particularly relevant in explaining recent "global imbalances" and the "interest rate conundrum." The first one is a sustained growth slowdown in E; The second one is a collapse in the capacity to generate assets in R. The former captures well the effect of a relative slowdown in the Euro area and Japan. The second captures aspects of the Japanese bubble crash in the early 1990s and the developments in much of emerging markets and newly industrialized economies of Asia in the aftermath of the Asian and Russian crises at the end of the 1990s. We also explored the global effects of the interaction between R's limited financial markets and its fast potential growth. All these effects point in the same direction: That is, toward a sustained reallocation of savings toward U and lower interest rates.

In extensions, we also modelled the behavior of gross flows and the rents obtained by U in its role of international financial intermediary, as well as the response of exchange rates to our basic shocks. The implications for both broadly conform with the data.

The framework is flexible enough to explore a variety of experiments and issues that have been postulated in the "global imbalances" debate. For example, a dimension we did not develop in the main text but is trivial to analyze is that of an increase in a regions saving propensity (for example, a decline in θ^R). The implications would be similar in terms of the path of capital flows, measured saving rates, interest rates and the interaction with fast growth in R, as those following a crash in δ^R. However the implications would be enirely different for V^R: While a drop in δ^R comes with an initial crash in R's asset prices, an increase in

[22] We calculated the decline between July 1997 and January 1998 of the Hang Sen Composite Index (Hong Kong), the KOSPI (Korea) and the Jakarta Stock Index (Indonesia). All price indices were converted into dollars using daily exchange rates.

the propensity to save does the opposite. This distinction is important since the dramatic acceleration in capital flows toward the US in the late 1990s from R came with a crash rather a rise in asset values in R. This is not to say that a drop in θ^R is not part of the story, as it is a convenient short-cut to represent the more recent increase in saving rates by commodity producing economies (which have come with high local asset prices). Moreover, such drop further strengthens the downward pressure on long rates when combined with fast growth in R. However, in terms of timing it is probably the crash in δ^R that started the massive flows from R to U.

One could also model some of the aspects of fiscal deficits in the US as an increase in θ^U. This would indeed lead to current account deficits in U but it would increase rather than reduce interest rates, and hence it is probably not the main factor behind current "global imbalances."

Finally, a word of caution. Our framework also highlights that the current configuration of global asymmetries is likely to continue building the already large net external liabilities of U. Leverage always comes with risks. We have already illustrated within our framework how a reversal in the relative growth advantage of U vis-a-vis E, or in R's financial underdevelopment, would lead to a sharp reversal in capital flows, interest rates and exchange rates. One could also go outside the model and add a credit-risk concern with U's liabilities and generate a more harmful reversal. Our model has little to say about the latter possibility, although it seems remote. Moreover, one of our main points has been that such risk does *not* follow as an unavoidable outcome of the current scenario, as the latter is consistent with current global asymmetries in growth potential and financial development. .

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A Appendix

A.1 The role of assumption 4

Suppose that assumption 4 does not hold. This appendix shows that the essence of our analysis is not affected by this change, although the expressions are less friendly, if we are willing to make the minimal assumption that $g^E > 0$, so that $g > (1-\delta)\theta$ if Assumption 4 does not hold.

Let $x_t^u \equiv \frac{X_t^U}{X_t^U + X_t^E}$ be the relative size of country U's endowment. Since $X_0^U = X_0^E$, we have

$$x_t^u = \frac{X_0^U e^{gt}}{X_0^U e^{gt} + X_0^E e^{g^E t}} = \frac{1}{1 + e^{-(g-g^E)t}}$$

It will prove useful to compute $\int_0^t x_s^u ds$ in closed form

$$\begin{aligned}
\int_0^t x_s^u ds &= \int_0^t \frac{1}{1+e^{-(g-g^E)x}} dx = \frac{1}{g-g^E} \int_{e^{-(g-g^E)t}}^1 \frac{1}{u(1+u)} du \\
&= \frac{1}{g-g^E} \left[\ln\left(\frac{u}{1+u}\right) \right]_{e^{-(g-g^E)t}}^1 = \frac{1}{g-g^E} \ln\left(\frac{1+e^{(g-g^E)t}}{2}\right)
\end{aligned}$$

Note that we can express $r_t = \frac{\dot{X}_t}{X_t} + \delta\theta$ as

$$r_t = \delta\theta + g^E + x_t^U \left(g - g^E\right)$$

Solving forward the differential equation for V_t^E, we get

$$\begin{aligned}
V_t^E &= \int_t^\infty \delta X_s^E e^{-\int_t^s r_u du} ds \\
&= \int_t^\infty e^{-\delta\theta(s-t) - g^E(s-t) - (g-g^E)\int_t^s x_h^u dh} \delta X_t^E e^{g^E(s-t)} ds \\
&= \delta X_t^E \int_t^\infty e^{-\delta\theta(s-t) - (g-g^E)\int_t^s x_h^u dh} ds \\
&= \delta X_t^E \int_t^\infty \frac{1+e^{-(g-g^E)t}}{1+e^{-(g-g^E)s}} e^{-(g-g^E+\delta\theta)(s-t)} ds
\end{aligned}$$

Similarly, we can solve forward the differential equation for V_t^U

$$\begin{aligned}
V_t^U &= \int_t^\infty \delta X_s^U e^{-\int_t^s r_u du} ds \\
&= \int_t^\infty e^{-\delta\theta(s-t) - g^E(s-t) - (g-g^E)\int_t^s x_h^u dh} \delta X_t^U e^{g(s-t)} ds \\
&= \delta X_t^U \int_t^\infty e^{-\delta\theta(s-t) + (g-g^E)(s-t) - (g-g^E)\int_t^s x_h^u dh} ds \\
&= \delta X_t^U \int_t^\infty \frac{1+e^{-(g-g^E)t}}{1+e^{-(g-g^E)s}} e^{-\delta\theta(s-t)} ds
\end{aligned}$$

We can also solve the differential equation for W_t^E and W_t^U, with initial conditions $W_{0^+}^E$ and $W_{0^+}^U$

$$\begin{aligned}
W_t^E &= W_{0^+}^E e^{\int_0^t (r_s-\theta)ds} + \int_0^t (1-\delta) X_s^E e^{\int_s^t (r_u-\theta)du} \\
&= W_{0^+}^E \exp\left[-(1-\delta)\theta t + g^E t + (g-g^E)\int_0^t x_s^u ds\right] \\
&\quad +(1-\delta)X_t^E \int_0^t \exp\left[-(1-\delta)\theta(t-s) + (g-g^E)\int_s^t x_h^u dh\right] ds \\
&= W_{0^+}^E \frac{e^{g^E t}+e^{gt}}{2} e^{-(1-\delta)\theta t} + (1-\delta)X_t^E \int_0^t \frac{1+e^{-(g-g^E)t}}{1+e^{-(g-g^E)s}} e^{(g-g^E-(1-\delta)\theta)(t-s)} ds \\
W_t^U &= W_{0^+}^U e^{\int_0^t (r_s-\theta)ds} + \int_0^t (1-\delta) X_s^U e^{\int_s^t (r_u-\theta)du} \\
&= W_{0^+}^U \exp\left[-(1-\delta)\theta t + g^E t + (g-g^E)\int_0^t x_s^u ds\right] \\
&\quad +(1-\delta)X_t^U \int_0^t \exp\left[-(1-\delta)\theta(t-s) - (g-g^E)(t-s) + (g-g^E)\int_s^t x_h^u dh\right] ds \\
&= W_{0^+}^U \frac{e^{g^E t}+e^{gt}}{2} e^{-(1-\delta)\theta t} + (1-\delta)X_t^U \int_0^t \frac{1+e^{-(g-g^E)t}}{1+e^{-(g-g^E)s}} e^{-(1-\delta)\theta(t-s)} ds
\end{aligned}$$

Hence

$$\begin{aligned}
V_t^E &= \delta X_t^E \int_t^\infty \frac{1+e^{-(g-g^E)t}}{1+e^{-(g-g^E)s}} e^{-(g-g^E+\delta\theta)(s-t)} ds \\
&\underset{t\to\infty}{\sim} \frac{\delta X_t^E}{g-g^E+\delta\theta} \\
W_t^E &= W_{0^+}^E \frac{e^{g^E t}+e^{gt}}{2} e^{-(1-\delta)\theta t} + (1-\delta)X_t^E \int_0^t \frac{1+e^{-(g-g^E)t}}{1+e^{-(g-g^E)s}} e^{(g-g^E-(1-\delta)\theta)(t-s)} ds \\
&\underset{t\to\infty}{\sim} W_{0^+}^E \frac{e^{(g-(1-\delta)\theta)t}}{2} + (1-\delta)X_0^E e^{(g-(1-\delta)\theta)t} \int_0^t \frac{1+e^{-(g-g^E)t}}{1+e^{-(g-g^E)s}} e^{-(g-g^E-(1-\delta)\theta)s} ds \\
&\underset{t\to\infty}{\sim} W_{0^+}^E \frac{e^{(g-(1-\delta)\theta)t}}{2} + (1-\delta)X_0^E e^{(g-(1-\delta)\theta)t} \int_0^\infty \frac{1}{1+e^{-(g-g^E)s}} e^{-(g-g^E-(1-\delta)\theta)s} ds
\end{aligned}$$

Therefore, it is easy to see that

$$\begin{aligned}
V_t^E &\underset{t\to\infty}{\sim} \frac{\delta X_t^E}{g-g^E+\delta\theta} \\
\dot{V}_t^E &\underset{t\to\infty}{\sim} \frac{\delta g^E X_t^E}{g-g^E+\delta\theta} \\
W_t^E &\underset{t\to\infty}{\sim} e^{(g-(1-\delta)\theta)t}\left(W_{0^+}^E + (1-\delta)X_0^E\right)\left(\frac{1}{2} + \int_0^\infty \frac{1}{1+e^{-(g-g^E)s}} e^{-(g-g^E-(1-\delta)\theta)s} ds\right) \\
\dot{W}_t^E &\underset{t\to\infty}{\sim} (g-(1-\delta)\theta) e^{(g-(1-\delta)\theta)t}\left(W_{0^+}^E + (1-\delta)X_0^E\right)\left(\frac{1}{2} + \int_0^\infty \frac{1}{1+e^{-(g-g^E)s}} e^{-(g-g^E-(1-\delta)\theta)s} ds\right)
\end{aligned}$$

Hence

$$CA_t^U \underset{t\to\infty}{\sim} -\dot{W}_t^E$$
$$CA_t^U \underset{t\to\infty}{\sim} -(g-(1-\delta)\theta)e^{(g-(1-\delta)\theta)t}\left(W_{0^+}^E+(1-\delta)X_0^E\right)\left(\frac{1}{2}+\int_0^\infty \frac{1}{1+e^{-(g-g^E)s}}e^{-(g-g^E-(1-\delta)\theta)s}ds\right)$$

Now the decomposition is:

$$\theta W_t^E - X_t^E \underset{t\to\infty}{\sim} \theta W_t^E$$
$$r_t(V_t^E - W_t^E) \underset{t\to\infty}{\sim} -(g+\delta\theta)W_t^E$$

Therefore, the trade balance is positive while income flows are negative (and larger in absolute value than the trade balance), as in the main text.

A.2 Investment and gross flows

We make the following assumption:

Assumption 8 $\frac{g}{g+\theta}Y_t^R > X_t^I$

This implies $Y_t^R > X_t^I$ and $(1-\delta)Y_t^R + \frac{g}{g+\theta}\delta Y_t^R - X_t^I + (1-\delta)X_t^U > 0$.

In steady state, we have

$$\begin{aligned} V_t &= \frac{\delta Y_t^R}{r} + \frac{\delta X_t^U}{r-g} \\ W_t &= \frac{1}{g+\theta-r}\left[(1-\delta)(Y_t^R - X_t^I) + \left(g\frac{\delta Y_t^R}{r} - \delta X_t^I + (1-\delta)X_t^U\right)\right] \text{ and } g\frac{\delta Y_t^R}{r} - \delta X_t^I > 0 \end{aligned}$$

i.e

$$\begin{aligned} V_t &= \frac{\delta Y_t^R}{r} + \frac{\delta X_t^U}{r-g} \\ W_t &= \frac{1}{g+\theta-r}\left[(1-\delta)Y_t^R + \frac{g}{r}\delta Y_t^R - X_t^I + (1-\delta)X_t^U\right]. \text{ and } g\frac{\delta Y_t^R}{r} - \delta X_t^I > 0 \end{aligned}$$

When r goes to g, V_t goes to ∞ while W_t has a finite limit. Similarly, when r goes to $g+\theta$, then W_t goes to ∞ and V_t has a finite limit. Hence we know there is at least one solution to $W_t = V_t$ on $(g, g+\theta)$. Moreover, we know that as we increase r from g, W_t crosses V_t the first time from below. Hence, since W_t is eventually above V_t when r is close enough to $g+\theta$, and since as we show below, the equation $V_t = W_t$ has at most two solutions, we conclude that W_t and V_t can cross only once for $r \in (g, g+\theta)$. This solution is stable. Our assumption ensures that $g\frac{\delta Y_t^R}{r} - \delta X_t^I > 0$ at the maximum feasible interest rate.

It is then easy to see that an increase in the level of Y_t increases W_t more than V_t on the balanced growth path

$$\frac{dW_t}{dY_t^R} = \frac{g + (1-\delta)\delta\theta}{(1-\delta)\theta(g+\delta\theta)} > \frac{dV_t}{dY_t^R} = \frac{(1-\delta)\delta\theta}{(1-\delta)\theta(g+\delta\theta)}$$

Hence an increase in Y_t^R lowers the equilibrium value of r.