Corporate Saving in Global Rebalancing

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The increase in global imbalances in the last decade posed a theoretical challenge for international macroeconomics. Why did some less developed countries with a higher need for capital, like China, lend to richer countries? The inconsistency of standard dynamic open-economy models with actual global capital flows had already been recognized, (for example, by Lucas, 1990), but the sensitivity to this issue became more acute with increasing global imbalances. This stimulated the development of several alternative theoretical frameworks.[1] However, global imbalances have declined since the global financial crisis. What light can the recent models shed on this global rebalancing?

In this paper, we focus on a specific dimension of global imbalances: corporate saving. Increased global imbalances were greatly associated with an increase in net saving in emerging Asia. Part of this increase can be explained by an increase in corporate saving.[2] This aspect has typically been ignored in the literature, but it is the focus of our previous work in Bacchetta and Benhima (2015), in which we propose a two-country model where firms need

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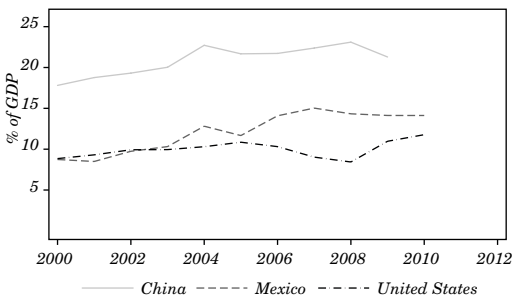
1. See Gourinchas and Rey (2014) for a survey.
2. See, for example, Jain-Chandra, Nabar and Porter (2009).

Global Liquidity, Spillovers to Emerging Markets and Policy Responses, edited by Claudio Raddatz, Diego Saravia, and Jaume Ventura, Santiago, Chile.

to save in liquid assets to finance their working capital. We show that a country with a less developed financial system and strong growth has a higher corporate saving rate and that saving exceeds investment. The model is consistent with the main features of global imbalances, but it also has interesting properties for international spillovers. The strategy of this paper is to adopt a modified version of the Bacchetta-Benhima model and focus on corporate saving in the context of global rebalancing.

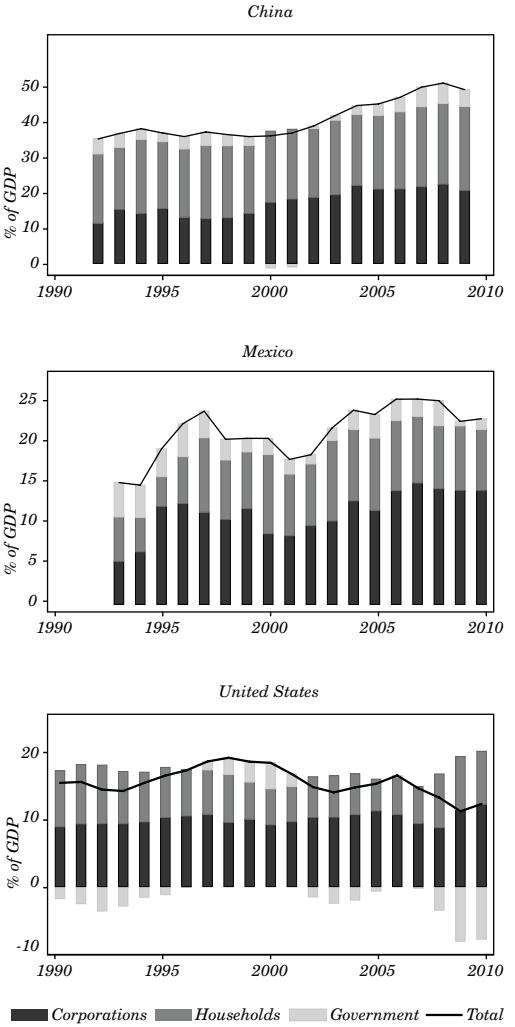
Global imbalances increased sharply from 2000 to 2007. This was associated with an increase in China's total saving, and part of the increase came from the growth of corporate saving. Figure 1 shows the evolution of the corporate saving rate for three countries: China, the United States and Mexico. Between 2000 and 2008, the corporate saving rate increased significantly in China, while there was little change in the United States. Mexico has not been a key player in global imbalances, but corporate saving increased from 2003 to 2007, which coincides with an increase in output growth and a slight improvement in the country's current account deficit. To put corporate saving in perspective, figure 2 shows the evolution of total saving and its components. While the literature typically focuses on household or government saving, corporate saving also contributed significantly to changes in total saving. It is too early to assess the evolution of corporate saving after the crisis (the data are published with a long delay), but the available data indicate that corporate saving has increased in the United States and declined slightly in China and Mexico.

Figure 1. Corporate Saving Rates



Sources: National Bureau of Statistics of China, United Nations Statistics Division.

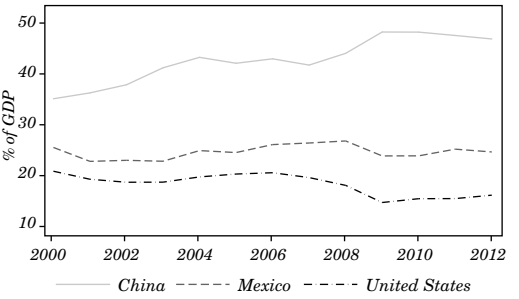
Figure 2. Saving and its Components



Sources: National Bureau of Statistics of China, United Nations Statistics Division.

With regard to the evolution of investment, figure 3 shows that it increased sharply in China and less strongly in Mexico, while it declined in the United States. There is thus a relationship between increases in corporate saving and increases in investment in the period under review. This positive link is a key aspect of our theoretical analysis.

Figure 3. Investment Rates



Source: IMF World Economic outlook.

The process of global rebalancing occurred after the global financial crisis in 2008 and the subsequent recession in developed countries. More recently, the global economy has been affected by a slowdown in emerging market economies. We examine the impact of these developments on global imbalances in a model where corporate saving and investment determine the current account. We consider an asymmetric world economy with an Emerging country and a Developed country and examine the impact of three shocks: a credit crunch and a growth slowdown in the Developed country and a growth slowdown in the Emerging country. We find that all three shocks lead to global rebalancing, but they have different impacts on the world interest rate. The two shocks originating in the Developed country have a negative impact on the interest rate, while the shock in the Emerging country has a positive impact. This implies that the initial phase of rebalancing was associated with downward pressure on real interest rates, whereas the recent period is more likely to be associated with an increase in world interest rates. We also notice that slower growth in the Emerging country improves the trade balance of the Developed country.

As mentioned, the model used in this paper is a simplified version of Bacchetta and Benhima (2015). Since we already conducted a systematic study of the model and its dynamic properties, in this paper we focus on some implications of the model, including international spillovers. In the Bacchetta-Benhima model, firms need liquid assets in the spirit of Holmstrom and Tirole (2001, 2011). To introduce this aspect in a dynamic macroeconomic model, we follow

Woodford (1990), where entrepreneurs have two-period projects.[3] In the first period, entrepreneurs invest in illiquid capital and decide on their liquid asset holdings. In the second period, they produce using a labor input. To pay for wages, firms can either borrow or use their liquid assets. When borrowing is limited, firms need more liquid assets. This is the reason why fast-growing countries with tight borrowing limits have higher liquid asset holdings and higher corporate saving. Moreover, higher growth leads to a joint increase in saving and investment. When we consider an asymmetric two-country model, we assume that the liquidity motive is strong in the Emerging country and weaker in the Developed country. Consequently, the Developed country behaves similarly to standard open-economy models, while the Emerging country has a different behavior.

The strong need for liquid assets in the Emerging country introduces a new channel of international transmission. A decrease in the world interest rate has a negative impact on surplus economies holding liquid assets. This negative liquidity channel is combined with two other, more standard channels. First, there is a substitution channel as firms substitute capital for labor. Second, there is a collateral channel as credit constraints are looser with a lower interest rate. We analyze theoretically and numerically the different factors determining the strength of these different channels. In addition to affecting the spillover mechanism of interest rate changes, the large liquidity holdings in the Emerging country affect the response of the world interest rate to fundamental shocks. An interesting aspect of the model is a positive output comovement in the presence of productivity shocks. This contrasts with standard intertemporal open-economy macroeconomic models, where productive shocks have negative spillovers (for example, Obstfeld and Rogoff, 1996). However, the mechanism leading to this positive comovement is different whether the shock originates in the Developed or in the Emerging country. Nevertheless, the liquidity needs of the Emerging country play a key role in these mechanisms, as they affect either the direct impact of the shock on the world interest rate or the spillover channel.

The rest of the paper is organized as follows. In the next section we present the model, from the individual entrepreneur to the global economy. Section 2 examines the impact of interest rate shocks, which

3.Woodford (1990) presents two models: one with credit-constrained consumers and endowments and one with credit-constrained entrepreneurs and production. Our approach is based on his second model.

represent the main spillover channel across the countries. Section 3 examines numerically the impact of the three shocks mentioned above. Section 4 concludes.

1. A Two-Country Model with Corporate Saving

We consider a two-country model with an Emerging country and a Developed country. The structure of both economies, based on Bacchetta and Benhima (2015). features a demand for liquidity (short-term bonds) from entrepreneurs, which they can trade domestically and internationally. Three ingredients in the model are necessary to generate a demand for liquidity. First, production takes time: capital needs one installation period before it can be used in the production process. Second, the wage bill has to be paid before output can be sold, which generates a need for funds. Third, entrepreneurs face credit constraints. This implies that entrepreneurs are not always able to borrow all the funds needed to hire labor for production, so they need to keep liquid assets when they invest in capital. This creates a liquidity channel of the interest rate through which a decrease in the world's interest rate on liquid assets has a negative effect on production.

To distinguish the Developed country from the Emerging one, we denote the Developed country variables with an asterisk. Since the two economies have the same structure and differ only in their parameter values, we first lay down the model for the Emerging economy. The model is then closed through the equilibrium on the bond market, which defines the world interest rate.

1.1 The Production Process

Entrepreneurs are infinitely lived and maximize the present value of their utility. They have two-period production projects, as it takes one period to install capital before producing. An entrepreneur starting a project at time t invests K_{t+1}. At $t + 1$, after capital is installed, he hires labor, l_{t+1}, to produce $Y_{t+1} = F(K_{t+1}, Z_{t+1}l_{t+1})$, where Z_t measures productivity and F is a constant-return-to-scale production function, and pays wages, $w_{t+1}l_{t+1}$. This production is available only at $t + 2$. At $t + 2$, the entrepreneur gets another investment opportunity. The entrepreneur consumes c_t each period and can borrow or lend short-term bonds with a gross interest rate r_t.

In this setup, working capital in the form of early payment of wages interacts with credit constraints to generate a demand for liquidity. Entrepreneurs can use part of the proceeds from previous production to invest K_{t+1}. At $t + 1$, however, they have no income to pay $w_{t+1}l_{t+1}$ for workers. Consequently, they have an incentive to borrow an amount L_{t+2}. When an entrepreneur is credit-constrained, he will not be able to borrow the desired amount to pay for the wage bill. He will therefore have a demand for liquidity at time t in the form of a positive demand for bonds, A_{t+1}.

1.2 Optimal Behavior

Entrepreneurs maximize

$$\sum_{s=0}^{\infty} \beta^s u(c_s). \tag{1}$$

Consider an entrepreneur who invests every other period, starting at time t. Denote by W_t his initial income at time t. It is made up of the output from production initiated at date $t - 2$, $Y_{t+1} = F(K_{t+1}, Z_{t+1}l_{t+1})$, minus debt repayments, r_tL_t. Hence, $W_t = Y_{t-1}\ r_tL_t$. His budget constraints at t and $t + 1$ are as follows:

$$W_t = c_t + K_{t+1} + A_{t+1}; \tag{2}$$

$$r_{t+1}A_{t+1} = c_{t+1} + w_{t+1}l_{t+1} - L_{t+2}. \tag{3}$$

The entrepreneur's income at date t is allocated to consumption, c_t, investment in a new project, K_{t+1}, and bond holdings, A_{t+1}. In the following period, at $t + 1$, the only income is the bond return, $r_{t+1}A_{t+1}$. This has to pay for consumption, c_{t+1}, and the wage bill, $w_{t+1}l_{t+1}$. Typically the entrepreneur will borrow, so that at the optimum $L_{t+2} \geq 0$.

The entrepreneur might face a credit constraint at date $t + 1$. Due to standard moral hazard arguments, a fraction $0 \geq \phi \geq 1$ of output can be used as collateral for bond repayments:[4]

$$r_{t+2}L_{t+2} \leq \phi Y_{t+1}. \tag{4}$$

4. There could be a similar constraint at date t, but it is never binding precisely because of the demand for liquidity. The results are similar if we assuming that capital is used as collateral instead of output, as in Bacchetta and Benhima (2015).

Let λ_{t+1} denote the multiplier associated with this constraint. The entrepreneur's program yields the following first-order conditions:

$$F_{K_{t+1}}\left(1+\phi\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right)=r_{t+1}r_{t+2}\left(1+\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right); \tag{5}$$

$$F_{l_{t+1}}\left(1+\phi\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right)=w_{t+1}r_{t+2}\left(1+\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right). \tag{6}$$

When the production function is Cobb-Douglas, that is, $F(K, Zl) = K^{\alpha}(Zl)^{1-\alpha}$, the first-order conditions (5) and (6) give a straightforward relationship between the liquidity needs, $w_{t+1}l_{t+1}$, and capital, K_{t+1}:

$$w_{t+1}l_{t+1}=\frac{1-\alpha}{\alpha}r_{t+1}K_{t+1}. \tag{7}$$

With log utility, it can be shown that an entrepreneur who invests at t consumes a fixed fraction of his revenue:

$$c_t=(1-\beta)W_t. \tag{8}$$

Using the Euler equation at t, we get the following rule for consumption at $t + 1$:

$$c_{t+1}=\beta(1-\beta)r_{t+1}W_t. \tag{9}$$

From equations (2) and (8), saving at t is as follows:

$$S_{t+1}=A_{t+1}+K_{t+1}=\beta W_t. \tag{10}$$

Equation (10) states that saving at t is a constant fraction of total revenues. When the constraint at $t + 1$ is binding, the availability of funds to finance the wage bill at $t + 1$ is limited. The fraction of saving allocated to liquidity, A_{t+1}, therefore depends on the liquidity needs at $t + 1$, $w_{t+1}l_{t+1}$. To determine K_{t+1}, we use equation (3), the binding credit constraint (4) and equations (9) and (10) to get

$$K_{t+1}+\frac{w_{t+1}l_{t+1}}{r_{t+1}}=\beta^2 W_t+\phi\frac{Y_{t+1}}{r_{t+1}r_{t+2}}. \tag{11}$$

This consolidated budget constraint states that in present-value terms, firms have to use their saving, along with their external finance capacities, to pay for inputs. Combining this equation with equations (7) and (10), we can jointly determine K_{t+1}, l_{t+1} and A_{t+1} in the constrained case.

To determine whether entrepreneurs are constrained or not, it is useful to look at labor market conditions. Entrepreneurs are constrained ($\lambda_{t+1} > 0$) whenever the market wage is lower than the first-best wage. Define

$$\hat{w}\left(r_{t+1}, r_{t+2}, Z_{t+1}\right) = Z_{t+1}\left(1-\alpha\right)\left(\frac{\alpha^{\alpha}}{r_{t+1}^{\alpha} r_{t+2}}\right)^{1/(1-\alpha)}$$

as the first-best wage. Entrepreneurs are constrained when $w_{t+1} < \hat{w}_{t+1}$.[5] In that case, the entrepreneur could make infinite profits by increasing the production scale, but is prevented by the binding credit constraint. If $w_{t+1} = \hat{w}_{t+1}$, the production scale is undetermined, because of constant returns to scale. There is no reason for the entrepreneur to be constrained in that case.

1.3 Labor Market

Each entrepreneur has access to a project every two periods. There are two groups of entrepreneurs, each with mass one, with overlapping projects. One group of entrepreneurs gets a project in odd periods, while the other group gets a project in even periods. In a given period, the demand for labor comes from the group of entrepreneurs in their production period, so the aggregate demand for labor is given by equation (7).

Labor is supplied domestically by a continuum of hand-to-mouth workers of mass one who do not have access to the production technology and consume all their income: $c_t^{\,w} = w_t l_t$. We assume that workers have the following labor supply:

5.This can be seen by combining the first-order conditions in equations (5) and (6) in the benchmark case, which yields

$$w_{t+1}\left[\left(1+\frac{\lambda_{t+1}c_{t+2}}{\beta}\right)\Big/\left(1+\phi\,\frac{\lambda_{t+1}c_{t+2}}{\beta}\right)\right]^{1-\alpha} = \hat{w}\left(r_{t+1}, r_{t+2}, Z_{t+1}\right).$$

$$l_t = \left(\frac{w_t}{\bar{w}} \right)^{\eta} , \tag{12}$$

where η and $\bar{w}$ are positive constants, and η is the Frisch elasticity of labor supply. When $\eta = 0$, the labor supply is inelastic at $l = 1$.

Using the labor demand equation (7), we can then infer the equilibrium labor as a function of aggregate capital, K_{t+1}:

$$l_{t+1} = \left[\left(\frac{1-\alpha}{\alpha} \right) \left(\frac{r_{t+1}}{\bar{w}} \right) K_{t+1} \right]^{\frac{\eta}{\eta+1}} . \tag{13}$$

When firms are constrained, the aggregate stock of capital is limited by total saving, W_t, and so is equilibrium labor, preventing the equilibrium wage from reaching the first-best wage.

In equilibrium, l is less sensitive to r when η is low. This is because the equilibrium wage responds to the interest-rate-induced increase in labor demand, which mitigates the equilibrium increase in labor, and the more so as the elasticity is low. In the extreme case where $\eta = 0$, labor demand is inelastic and $l = 1$ in equilibrium. In this case, the increase in the equilibrium wage offsets the increase in r. At the opposite end of the spectrum, if η goes to infinity, labor supply is hyperelastic at the wage $w_{t+1} = \bar{w}$, and any increase in labor demand is satisfied, so

$$l_{t+1} = \frac{(1-\alpha) r_{t+1} K_{t+1}}{\alpha \bar{w}} .$$

1.4 The Net Demand for Bonds and Equilibrium on the World Bond Market

Entrepreneurs can lend or borrow at the world interest rate, r_t. We assume that $r_t < 1/\beta$, which ensures that credit constraints are binding in the steady state and around it.[6] The aggregate net demand for bonds, B_{t+1}, is equal to the net saving of the Emerging country. At each period t, there are two groups of entrepreneurs: those who invest and those who produce. As mentioned above, the saving of investing

6. This is true in our two-country economy as long as both countries have sufficiently strong credit constraints (ϕ and ϕ^* are low).

entrepreneurs is $A_{t+1} + K_{t+1}$. The saving of producing entrepreneurs is simply $-L_{t+1}$. Aggregate net saving is then equal to total saving, $A_{t+1} + K_{t+1} - L_{t+1}$, minus investment, K_{t+1}. Therefore, the aggregate net saving in the Emerging country is the aggregate net demand for bonds, which is $B_{t+1} = A_{t+1} - L_{t+1}$.

The description of the Developed economy is identical to the Emerging one. For a given world interest rate r_{t+1}, the Developed country has a net demand for bonds of $B^*_{t+1} = A^*_{t+1} - L^*_{t+1}$. The world interest rate has to be such that the world bond market clears:

$$B_{t+1} + B^*_{t+1} = 0 \ . \tag{14}$$

1.5 An Asymmetric World Economy with Global Imbalances

We assume that the Emerging and Developed countries differ by their level of credit tightness, due to different levels of financial development, and by their level of technology. We assume $\phi^* > \phi$ and $Z^* > Z$. The asymmetry in ϕ has strong implications for the world equilibrium and for its reaction to shocks. In particular, it implies that the Emerging country will, in general, lend to the Developed country, that is, $B_{t+1} > 0$ and $B^*_{t+1} < 0$. Thus, the model is consistent with the pattern of global imbalances.

To understand why the country with a tighter borrowing constraint lends to the country with a looser borrowing constraint, it is key to understand the behavior of the two groups of entrepreneurs.[7] At each period t, one group of entrepreneurs is in the production period and borrows L_{t+1} (L^*_{t+1}) and the other group is in the investment period and accumulates liquid assets A_{t+1} (A^*_{t+1}). With a loose credit constraint in the Developed country, L^*_{t+1} can be large while the need for liquid assets A^*_{t+1} is small. Thus, $B^*_{t+1} < 0$. In the Emerging country, since the credit constraint is tight, L_{t+1} is small and the need for liquid assets A_{t+1} is large. Thus, $B_{t+1} > 0$.

The difference in credit tightness also affects the way the demand for bonds reacts to shocks. Consider an increase in growth in the Developed country. This increases output and relaxes the credit

7. For convenience, in this paper we assume that the constraint is always binding in both countries. Bacchetta and Benhima (2015) analyze the case where the constraint is never binding for the Developed country and may not always be binding for the Emerging country.

constraint (equation 4). This allows borrowing from producing entrepreneurs to increase. This effect dominates, and overall the country has a lower net demand for foreign bonds, that is, B^*_{t+1} becomes more negative. Now consider an increase in growth in the Emerging country. The impact on borrowing is small since ϕ is low. On the other hand, there is a stronger need to finance the labor input, so that A_{t+1} and thus B_{t+1} increase. This implies that an increase in growth increases the magnitude of global imbalances, whether this increase occurs in the Developed or in the Emerging country.[8]

2. Spillovers

In this model, the international spillover of shocks goes exclusively through the world interest rate. To have a clear understanding of spillovers, it is useful to analyze the impact of interest rate shocks. For this purpose, we first consider the Emerging country as a small open economy. We can then study the effect of a change in the world interest rate, both theoretically and numerically.

2.1 Three Spillover Channels

There are three potential channels for a change in r. First, as apparent in the labor demand equation (7), a lower r_{t+1} makes firms substitute capital for labor. This is the substitution channel. Second, according to the consolidated budget constraint (equation 11), a lower r_{t+1} makes the wage bill more costly, because it decreases the return of bonds that are used to finance it. This is the liquidity channel. Third, a lower interest rate increases the financing capacity of firms by relaxing the credit constraint. This is the collateral channel.

To study these channels, we analyze two extreme cases that are of particular interest: the case with an extreme borrowing constraint ($\phi = 0$) and the case with an inelastic labor supply ($\eta = 0$). We then simulate the behavior of an economy hit by a negative shock on the world interest rate, for these extreme cases and for intermediate cases.

8. Bacchetta and Benhima (2015) examine the dynamic impact of a growth acceleration in the Emerging country.

2.1.1 Extreme borrowing constraint

The case with $\phi = 0$ shuts down the collateral channel and enables us to focus on the substitution and liquidity channels. In that case, the consolidated budget constraint makes the capital level depend on wealth, W_t, in a straightforward way, according to equation (11). The resulting dynamics are summarized in the following proposition.

Proposition 1. If $\phi = 0$ and the credit constraint is binding, a negative shock on r_{t+1} has a negative effect on labor and output on impact, but no effect on capital. Capital, labor and output are negatively affected in subsequent periods when the interest rate shock is persistent.

Proof. The level of capital is inferred from equation (11) where $\phi = 0$. Labor is then determined by the equilibrium equation (13). Output is obtained by replacing K_{t+1} and l_{t+1}. Finally, $W_{t+1} = Y_{t+1}$, because $\phi = 0$. This gives

$$K_{t+1} = \alpha\beta^2 W_t \ ;$$

$$l_{t+1} = \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{r_{t+1}}{\bar{w}}\right)\alpha\beta^2 W_t\right]^{\frac{\eta}{\eta+1}} \ ;$$

$$Y_{t+1} = W_{t+1} = Z_{t+1}^{1-\alpha}\left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{r_{t+1}}{\bar{w}}\right)\right]^{(1-\alpha)\eta/(\eta+1)}\left(\alpha\beta^2 W_t\right)^{\alpha+(1-\alpha)\eta/(\eta+1)} .$$

The impact of a decrease in r_{t+1} is then straightforward.

Whereas capital is not affected by r_{t+1} on impact, labor is negatively affected by a decrease in r_{t+1}, which then affects output negatively. This is the result of the combination of the substitution and liquidity channels. Through the liquidity channel, inputs are more costly, which decreases total inputs. Through the substitution channel, resources are reallocated within inputs toward capital at the expense of labor. All in all, the demand for capital stays unchanged, while the demand for labor drops.

The magnitude of the equilibrium effect of r_{t+1} on l_{t+1} depends on the Frisch elasticity of labor, η. In equilibrium, the decrease in labor demand depresses the wage, which mitigates the equilibrium effect of

the interest rate on labor. In the case where labor supply is inelastic ($\eta = 0$), the decrease in the wage perfectly offsets the decrease in the interest rate, so labor stays constant at $l = 1$. In that extreme case, r_{t+1} has no effect on l_{t+1} and thus no effect on the economy. We now consider more generally the case of $\eta = 0$.

2.1.2 Inelastic labor supply

The case with $\eta = 0$ shuts down the substitution and liquidity channels and enables us to focus on the collateral channel. In that case, the following proposition applies.

Proposition 2. If $\eta = 0$ and the credit constraint is binding, then a negative shock on r_{t+1} has a positive effect on capital.

Proof. If $\eta = 0$ and the credit constraint is binding, then for a given W_t,

$$l_{t+1} = 1;$$

$$Y_{t+1} = Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha};$$

$$W_{t+1} = (1-\phi) Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha}.$$

The consolidated budget constraint defines K_{t+1} implicitly as a function of W_t:

$$\left(\frac{K_{t+1}}{\alpha}\right) - \left(\frac{\phi Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha}}{r_{t+1} r_{t+2}}\right) = \beta^2 W_t.$$

By differentiating the above equation, we find

$$\left(1 - \frac{\phi F_{Kt+1}}{r_{t+1} r_{t+2}}\right)\left(\frac{\partial K_{t+1}}{\partial r_{t+1}}\right) = -\left(\frac{\phi Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha}}{r_{t+1}^2 r_{t+2}}\right).$$

Using equation (5), we can show that the first term in parentheses is positive as long as $\lambda_{t+1} > 0$, which implies that $\partial K_{t+1} / \partial r_{t+1} < 0$.

A decrease in r_{t+1} relaxes the credit constraint and allows firms to borrow more. It therefore has a positive effect on capital and hence on production. This is the collateral channel.

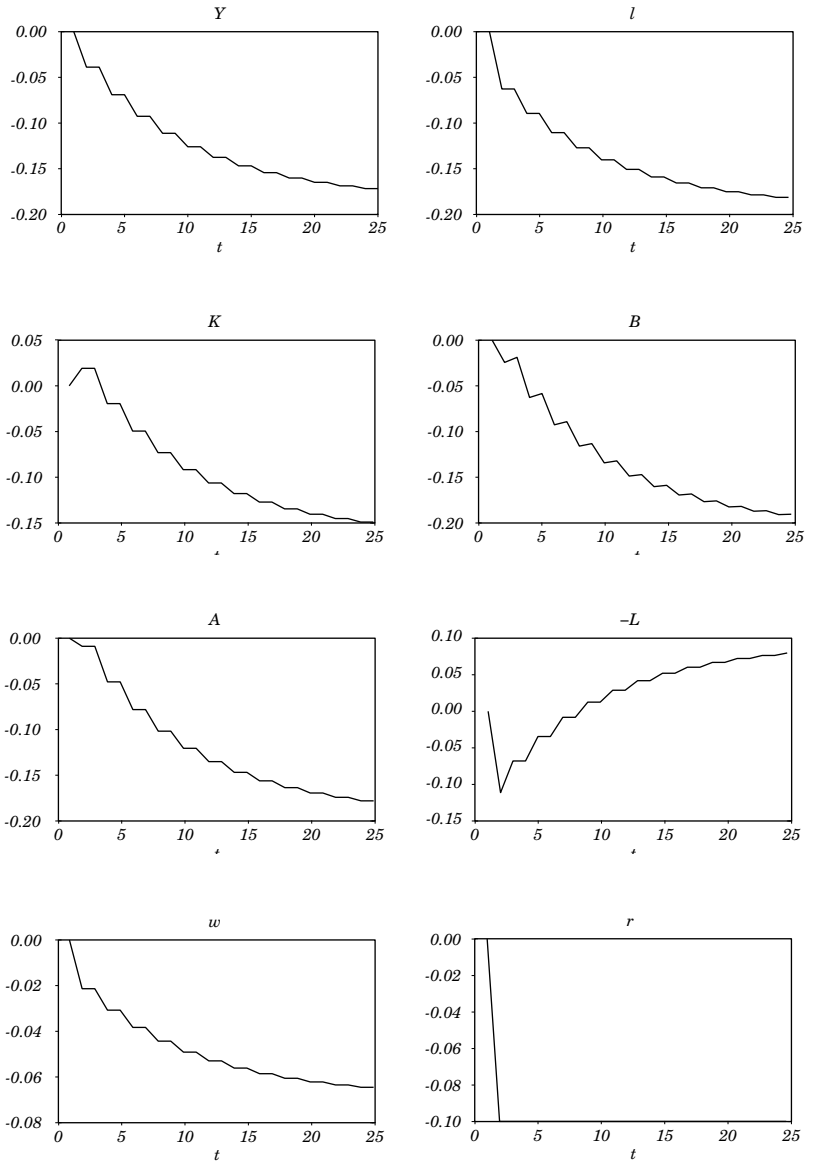
2.2 Numerical Analysis: Interest Rate Shocks

Here we simulate the effect of a permanent decrease in the world interest rate on the Emerging country for different values of ϕ and η. We first define a benchmark case with the following parameter values. The capital share α is set to 0.3, the discount factor β is set to 0.95, η to 3.0 and ϕ to 0.05. We normalize Z to 1.0 and $\bar{w}$ is set so that in the steady state $l = 1$. The steady-state interest rate is set at the same value as the one that holds in the two-country steady state.

We then look at the impact of a permanent 10 percent decrease in the interest rate, r. Figure 4 shows the evolution of output, labor, capital, gross bond positions, the net demand for bonds and wages. We observe a decline in output and labor, which indicates that the substitution and liquidity channels are at work; wages decline in line with labor. Capital increases on impact, to decline afterward. The dynamics of capital combine the results of Propositions 1 and 2: the initial increase represents a positive collateral effect, which is subsequently dominated by the negative liquidity channel. We also observe a decline in net bond holdings, B: as production decreases, the demand for liquid assets decreases. The evolution of B is actually determined by the decline in A. Borrowing L by producing firms initially increases due to the collateral effect, but then declines with the level of output. However, since L is small, it has little impact on B.

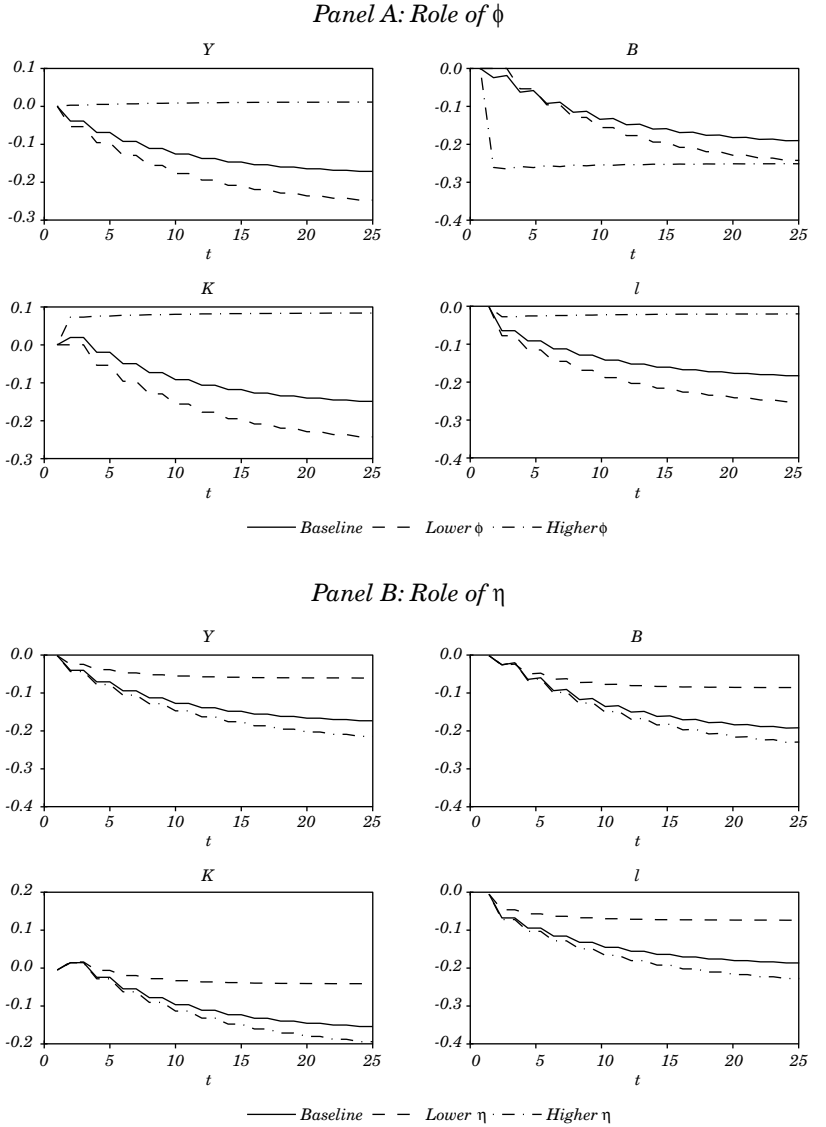
Figure 5 shows the impulse responses for deviations from the benchmark case. Panel A considers different levels of the credit constraint, measured by ϕ. We compare the benchmark value of $\phi = 0.05$ with a low value $\phi = 0$ and a higher value $\phi = 0.1$. A lower value of ϕ reduces the collateral effect and leads to a larger decline in output, while capital hardly increases on impact. The decline in bond holdings is also larger. In contrast, a higher value of ϕ gives a dominant role to the collateral channel. This leads to a sustained increase in capital and even to an increase in output. The decline in labor is much smaller. There is also a very strong decline in bond holdings. The reason is again that the collateral channel is stronger. A decrease in the interest rate leads to a stronger increase in borrowing and therefore to a decline in net bond holdings.

Figure 4. Negative Shock on *r*



Note: Percentage deviation from steady state.
Source: Authors' elaboration.

Figure 5. Sensitivity Test: Role of ϕ and η
Yearly growth



Note: Percentage deviation from steady state.
Source: Authors' elaboration.

Panel B of Figure 5 shows the impact of different levels of labor supply elasticity. We compare the benchmark value of $\eta = 3$ with a low value $\eta = 1$ and a high value $\eta = 4$. As suggested by Proposition 2, a higher elasticity reinforces the liquidity channel and therefore amplifies the decline in output, labor, capital and net bonds. A lower elasticity has the opposite effect.

3. Global Rebalancing

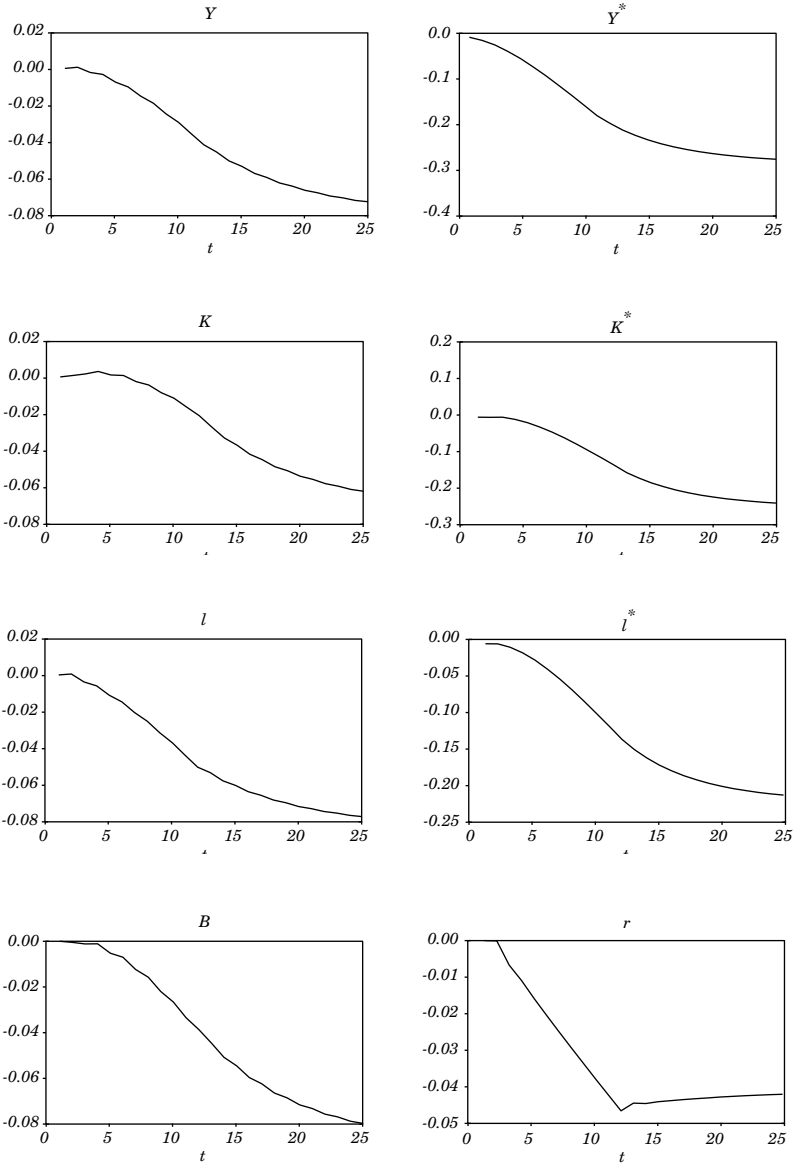
We now consider different scenarios leading to global rebalancing in the two-country model: a growth slowdown and a credit crunch in the Developed country and a growth slowdown in the Emerging country. We simulate the dynamic impact of these shocks in a benchmark version of the model. We set the parameters in the Emerging country as in the benchmark calibration described earlier. To generate heterogeneity in net foreign asset positions, we set $\phi^* = 0.3 > \phi$ in the Developed country. We also set $Z^* = 4Z$, and $\overline{w}^*$ is set so that $l^* = 1$ in the steady state. The other parameters are identical to the Emerging country. With this calibration, the Emerging country is a net lender ($B > 0$), and the Developed country is a net borrower ($B^* = -B < 0$).

3.1 Lower Growth and Credit Crunch in the Developed Country

We first examine the impact of a decline in productivity, Z^*, in the the Developed country. We assume that Z^* declines by 1 percent over ten periods.[9] The resulting dynamics are shown in figure 6. The impact of such a shock on the Developed country is relatively standard. The lower productivity naturally lowers output, but it also reduces borrowing from producing firms due to a tighter credit constraint (equation 4). This lowers capital and labor and further decreases output. Lower borrowing implies an improvement in the net asset position, B^* (declining debt), and a decline in the world interest rate.

9. For convenience, we do not consider steady-state growth in this paper. The gradual decline in Z^* implies a period of negative growth and has similar implications as a growth slowdown. See Bacchetta and Benhima (2015) for a full analysis with steady-state growth.

Figure 6. Negative Shock on Z^*



Note: Percentage deviation from steady state.
Source: Authors' elaboration.

The Emerging country is affected through the lower interest rate. The impact is naturally smaller than for the Developed country. Based on the analysis of section 2, we know that in the benchmark calibration, the substitution and liquidity channels dominate, so output and labor decline over time, while capital initially increases before declining. The decline in net bonds B matches the increase in B^*.

Figure 7 shows the impact of a permanent tightening of the credit constraint, that is, a 30 percent permanent decline in ϕ^* (from 0.30 to 0.21). Producing firms reduce their borrowing, so that net bond demand, B^*, increases (net debt decreases) and the world interest rate declines. Output and labor also decline, but capital increases. This somewhat surprising result is explained by a decline in the wage bill, which increases entrepreneurs cash flow to finance capital. The impact on the Emerging country is the same as with a decline in productivity, as the spillover goes through the decline in the world interest rate. However, in this case the impact is larger than in the Developed country.

To summarize, both the decline in growth and the credit crunch in the Developed country lead to rebalancing, with a decline in the world interest rate. Output declines in both countries.

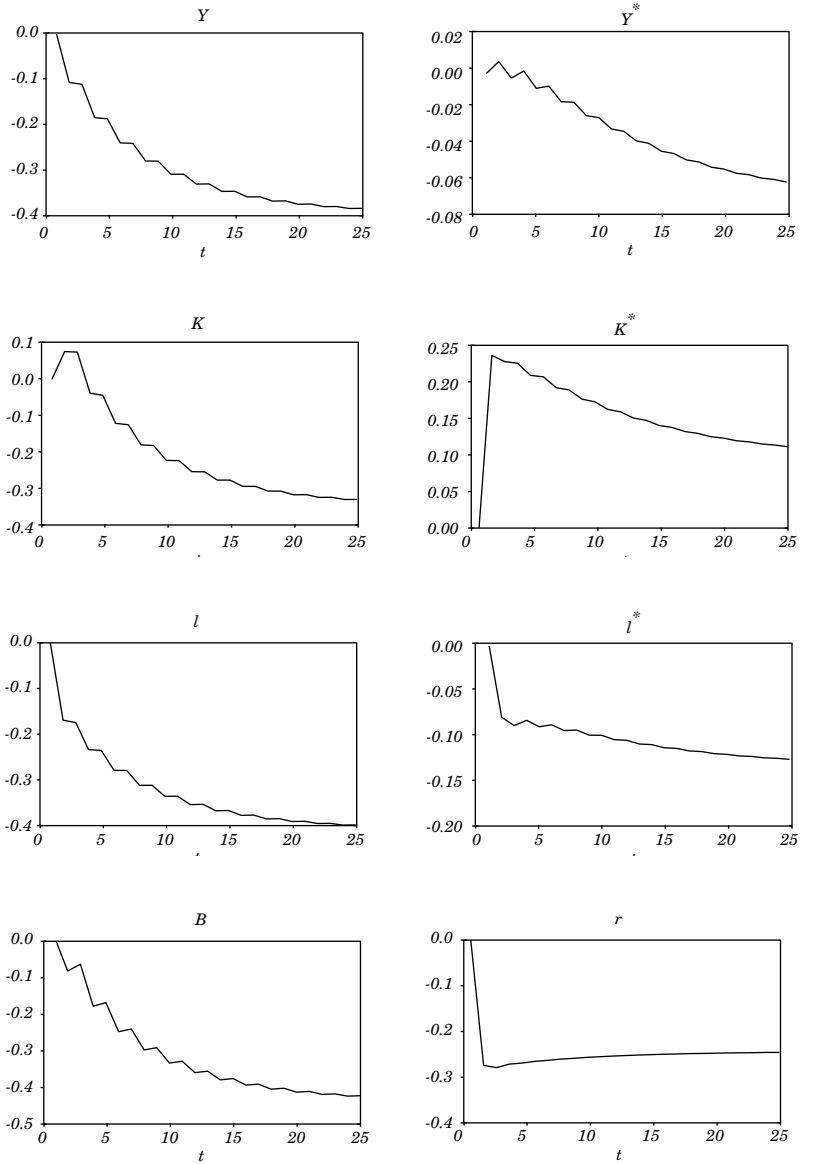
3.2 Lower Growth in the Emerging Country

Consider now a decline in productivity growth in the Emerging country. We assume that Z declines by 1 percent over ten periods. The dynamics are presented in figure 8. The decline in productivity growth reduces output, labor and capital in the Emerging country. This also leads to a decline in the net demand for bonds. The reason is that firms need to hold less liquidity in their production period, while their reduced borrowing in the investment period has a smaller impact. The reduced demand for bonds leads to an increase in the world interest rate.

The Developed country is affected negatively by the interest rate increase since the collateral effect dominates. The impact is smaller than in the Emerging country. Consequently, we also observe a decline in output, capital and labor, while the net foreign asset position improves.[10]

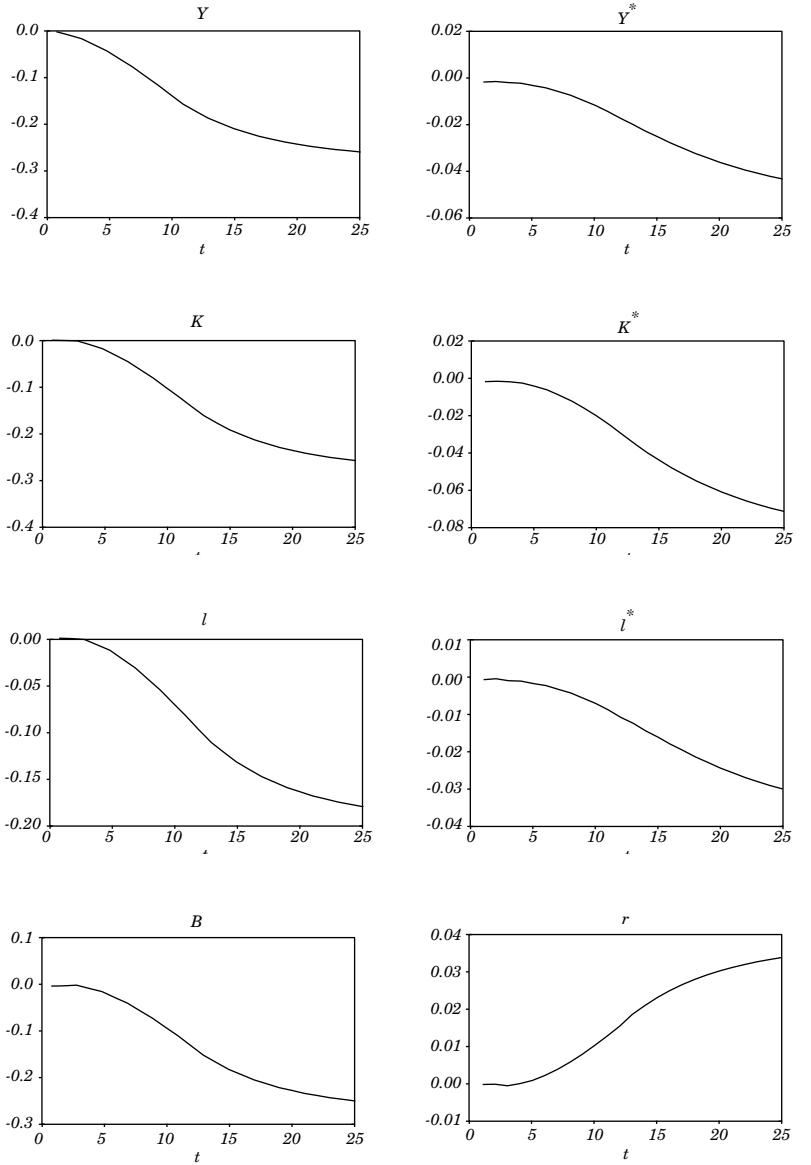
10.. The result would be similar if the Developed country was not constrained. Instead of a collateral channel, there would be a standard cost-of-funds channel and a higher interest rate would decrease the capital stock.

Figure 7. Negative Shock on ϕ



Note: Percentage deviation from steady state. Reduction of ϕ^* by 30 percent.
Source: Authors' elaboration.

Figure 8. Negative Shock on *Z*



Note: Percentage deviation from steady state. Reduction of Z by 1% over 10 periods.
Source: Authors' elaboration.

3.3 International Comovements and the World Interest Rate

The results presented in this section show that a decline in growth, either in the Emerging country or in the Developed country, leads to a reduction in net foreign asset positions. Moreover, there is a positive output comovement, since a growth decline that starts in one country is transmitted to the other country. This positive comovement differs from the outcome of growth shocks in standard models. However, the channel of transmission is different if the shock occurs in the Emerging or the Developed country. The impact on the world interest rate is also of opposite sign: a negative growth shock in the Developed country decreases the interest rate, while a negative shock in the Emerging country increases it.

Growth shocks have a different impact on both the demand for bonds and the interest rate spillover to the other country. A negative growth shock in the Developed country increases the demand for bonds of this country by decreasing its borrowing. The resulting lower interest rate has a negative effect on the Emerging country since the liquidity and substitution effects dominate. In contrast, a negative growth shock in the Emerging country decreases the demand for bonds due to a lower need for corporate liquidity. Then, the higher world interest rate has a negative impact on the Developed economy since the collateral effect dominates.

4. Conclusion

Numerous factors determine global net capital flows. In this paper, we have focused on a specific aspect, namely, corporate saving and investment. By introducing realistic sources of asymmetry between an Emerging and a Developing economy, we have presented a model that is consistent with the stylized facts and has interesting implications in the context of global rebalancing. An alternative perspective would have been to focus on household saving and a demand for liquid assets emanating from credit-constrained consumers. For example, Bacchetta, Benhima and Kalantzis (2013) develop such a model based on the first model in Woodford (1990). Growth and credit shocks would have similar implications for total saving as in this paper when there are only consumers. However, there would be no impact on investment and output.

A more speculative question has to do with the medium-term perspectives for rebalancing. Our model predicts that a growth recovery would again increase global imbalances, so the rebalancing would only be a temporary phenomenon. However, this is a *ceteris paribus* prediction. Besides growth, there may be other factors that will change in future years. In particular, a reduction in financial restrictions in emerging markets (for example, financial liberalization in China) may decrease the need for high corporate saving and liquid asset holdings. This effect would clearly reduce global imbalances.

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