

Credit Constraints and Growth in a Global Economy

Nicolas Coeurdacier (Sciences-Po Paris and CEPR)

Stephane Guibaud (LSE) Keyu Jin (LSE)

February 15, 2011

Abstract

In a period of rapid integration and accelerated growth in emerging markets, three striking trends have been (1) a large and persistent increase in the private savings rate in emerging markets and fall in advanced economies, (2) large net capital outflows away from emerging markets, and (3) a sustained decline in the world interest. We add to an additional important fact: private savings is the main driver of the cross-sectional variation in the current account in the past data. Standard models do poorly in accounting for these facts. We show that incorporating asymmetric household credit constraints in a global general-equilibrium model can deliver qualitatively consistent and quantitatively significant results. An important implication of our model is that countries with identical preferences may see opposite responses of the savings rate to changes in the common world interest rate.

JEL Classification: **F21, F32, F41**

Key Words: Globalization, capital flows, credit constraints, current account, demographics, social security.

1 Introduction

Two of the most important developments in the global economy of the recent decades have been the integration of developing economies and their rapid growth, particularly in certain parts of Asia. Accompanying these changes have been three striking and unprecedented trends: (1) a large and persistent increase in the private savings rate in emerging Asia and a fall in the private savings rate in advanced economies; (2) the emergence of global imbalances with developing countries running a large current account surplus and advanced economies a current account deficit; (3) a sustained decline in the world long-term interest rate. When facing a common world interest rate—countries display asymmetric savings behavior, leading to the popular caricature of ‘debt ridden’ U.S. versus ‘thrifty’ Asia. The goal of this paper is to build a framework that simultaneously explains these features of the data.

Part of the growing interest in these phenomena stems from the fact that they stand in direct opposition to the predictions of the standard neoclassical open economy growth model. In that context, when capital-scarce emerging markets integrate with the rest of the world, or when these countries grow at a faster rate, they should be importers of capital rather than exporters. The reason is that higher expected growth engenders more borrowing from abroad to finance greater consumption needs and investment demands. Thus, the net effect of a fall in savings and a rise in investment should invariably cause a current account *deficit* in these countries. At the same time, the world interest rate should *rise* due to the high productivity of capital in fast-growing economies. Savings rates, on the other hand should respond similarly to changes in the interest rate across countries with identical preferences and tend to *converge* over time.

Lucid empirical analysis on the current account down to the basic question of what is its main driver remains scant, not to mention the lack of closer empirical investigation on the various theories of the current account that have emerged very recently. One of the contributions this paper makes is to take a closer look at the data. Our main finding is

that the cross-sectional variation of the current account is predominantly driven by savings, rather than by investment—something that is largely overlooked by the literature. Private savings, moreover, seems to have been the most important factor contributing to the current account, especially in the last two decades. Therefore, any theory trying to account for the recent episode of global imbalances must be one that emphasizes savings. One would need to explain not only why savings can outpace investment in the growing economy for a sustained period of time, such as in emerging Asia, but also why savings behavior across countries can diverge in response to changes in the common world interest rate, leading to the large and persistent dispersion in the savings rate that we observe.

Together, these empirical facts motivate the theory developed in this paper. We focus on private savings and in particular, household savings behavior because of its importance is evident from its strong comovement with the current account featured in the data. Against this background, we show that a global equilibrium model with household liquidity constraints paves the path for understanding how a variety of shocks and trends—notwithstanding capital market integration, fast growth in emerging markets and heterogeneous demographic developments—can replicate the observed private savings behavior and current account dynamics, and lead to markedly different results from those of the standard model.

Our benchmark framework is a two-country growth model characterized by an overlapping generations structure, in which agents live for three periods. This structure provides scope for both international and intergenerational borrowing. In all economies, young agents are subject to a liquidity constraint, but the tightness of constraint is more severe in some countries than in others. We show that a country’s aggregate saving places a greater weight on the (dis)savings of the young for less liquidity-constraint economies and greater weight on the middle-aged’s savings for more constraint economies. These different weightings can lead to sharp differences in the response of an economy’s aggregate savings to interest rate changes. A fall in world interest rates leads to greater borrowing (lower savings) of the young—through a positive wealth effect—while it leads to greater savings of the middle-

aged, through a dominant income effect. This implies that advanced economies which feature looser constraints can see a *fall* in savings rate whereas developing economies see a *rise* in savings rate. We show that in the context of capital market integration between advanced and emerging markets, and also when emerging markets experience growth accelerations—the world interest rate falls—leading to a savings rate divergence and a net capital outflow from emerging markets. These effects are absent in the standard model without liquidity constraint, but also absent in a model where liquidity constraints are symmetric across countries. An additional implication of our model is that whereas savings rates tend to diverge when the more constrained economies experience growth accelerations, they tend to converge when the less constrained economy grows faster. This scenario may apply to period of post-1980 between the U.S. and Europe.

A myriad of theories of global imbalances have emerged in recent years. Most have emphasized the importance of investment in accounting for the recent global imbalances across countries. Caballero, Gourinchas, and Farhi (2009) attribute the current account surplus in the emerging markets and the counterpart deficit in advanced economies to the collapse of investment opportunities in developing countries. While some of that is certainly true between the period 1995-2003, investment reverted back to its initial level by the end of the period, while global imbalances continued to rise steadily in subsequent periods, as shown in Figure 1. Other papers that have emphasized a suppression of investment demand due to financial frictions include Buera and Shin (2009), Benima (2009), and Song, Storesletten and Zilibotti (2009).

On the other hand, models of global imbalances revolving around a savings story have emphasized a strong precautionary savings motive emanating from uninsurable risk in developing countries. Mendoza, Quadrini and Rios-Rull (2009) show that lower risk sharing opportunities in developing countries increase precautionary savings so that when opening up to capital markets, these countries see a net capital outflows. However important risk may be, it is of second-order relevance compared to the rapid productivity growth in

emerging markets that raises their marginal productivity of capital. Thus, incorporating the growth into these frameworks lead to invariably the same result as that of the neoclassical growth model—saving falls while investment rises. This result can only be countered if growth is accompanied by a strong increase in idiosyncratic uncertainty, as in Carroll and Jeanne (2009), although the empirical evidence for this is unclear. Sandri (2010) on the other hand provides an explanation of why growth accelerations in developing countries can be associated with a current account improvements, based on the notion that uninsurable risk of losing invested capital forces entrepreneurs to rely on self-financing to fund growth-enhancing investment opportunities. Finally, in Benhima and Bachetta (2011), credit constrained entrepreneurs raise their demand of liquidity to finance investment in periods of high productivity growth leading to an increase of corporate savings and current account surpluses. However, none of these models can generate the long-run dispersion in the private savings rate (Fact 1) and asymmetric responses of savings rate to common world interest rate changes.

Our goal, thus, is to develop a theory that stands up to closer empirical scrutiny. In this paper, we first document the main driving forces of the current account in Section 2, before developing our benchmark theoretical framework in Section 3, in which we provide key intuition from certain analytical results. Section 5 investigates two key numerical experiments, capital market integration and faster growth in emerging markets, too see whether our model generates qualitatively consistent and quantitatively significant results. Section 6 concludes.

2 Empirical analysis

Despite the surge in literature on the theoretical analysis of global imbalances, there has been very little lucid empirical analysis aimed at assessing various theories. One of the most basic empirical questions is: to what extent are current account imbalances driven by savings

or by investment? by private savings versus public savings? In this section, we empirically document the main driving forces of the current account in past data. To do so, we assemble an unbalanced panel dataset that covers 91 countries over 26 years, for the period of 1982-2007. Key variables include private, public and the aggregate savings rate, investment rates and the current account. Appendix A gives a full description of the details in constructing the dataset.

By an accounting relationship, the current account can be written as

$$CA_{it} = S_{it} - I_{it} \quad (1)$$

$$= S_{it}^P + S_{it}^G - I_{it} \quad (2)$$

where CA_{it} denotes country i 's current account balance over GDP in period t , S_{it} denotes the country's aggregate savings rate, which can be decomposed into the private savings rate (gross private saving as a percentage of GDP), denoted as S_{it}^P , and the public savings rate (government primary fiscal surplus as a percentage of GDP), denoted as S_{it}^G , and the investment rate I_{it} . Different theories of the current account essentially give more or less importance to any of the three variables in driving the current account over time and across countries. However, both regression analyses and a variance decomposition of the current account demonstrate that empirically, private savings is the main driver of the variations in the current account across countries.

We examine the relationship between household savings rate and the current account for the few countries in which household savings data is available. The left panel in Figure 2 plots the current account (% of GDP) of the US against its household savings rate (% of disposable income) over 1970-2009. It is clear that the household savings rate is an important determinant of the US current account. The R^2 is as high as 73 percent over the sample period in the US. On the other hand, there is almost no relationship between domestic investment and the current account over the same period (right panel in Figure 2),

in the US. The regression coefficient is not significantly different from 0 and the R^2 is close to zero. Household savings has also played an important role in China, for the period between 1982-2007 when data is available, as shown in Figure ??.

For other countries, household savings data is not readily available and therefore we focus on aggregate, private and public savings rate data in our empirical analysis on the determinants of the current account. To examine the relationship between the current account and savings and investment more systematically across all countries and over time, we run both a cross-sectional (between) regression that uses country-averages of all variables, and a within regression that includes country and year fixed effects:

$$\begin{aligned}\overline{CA_{it}} &= \alpha + \beta \overline{S_{it}} + \gamma \overline{Z_{it}} + \varepsilon_i \text{ (Between Regression)} \\ CA_{it} &= \alpha_i + \alpha_t + \beta S_{it} + \gamma Z_{it} + \varepsilon_{it} \text{ (Within Regression)},\end{aligned}$$

where $\overline{CA_{it}}$ and $\overline{S_{it}}$ denote the average current account and savings rate over the sample period, and Z_{it} is a vector of controls. Regression results are provided in Table 1. Columns (1) and (2) report results for the cross-sectional regression, over different sample periods. Columns (3) and (4) report the within regressions. To the extent that Ricardian equivalence may be important, the omission of the public savings rate S_{it}^G leads to a bias in the regression coefficient of the private savings rate S_{it}^P when S_{it} is replaced by S_{it}^P in the regression specifications. We therefore separate the two components of aggregate savings rate in our regression analysis in column (5) and (6). Since data on fiscal positions are only widely available for developing countries after 1990, our sample period is limited to the past decade in these regressions. Overall, the results show that the β coefficient on savings is large and close to 1 for the recent sample period. The high R^2 reveals that a significant portion of the variation in the current account is explained by savings.

Table 1: Current Account and Savings

	(1)	(2)	(3)	(4)	(5)	(6)
β	0.78 (0.075)	0.85 (0.068)	0.62 (0.017)	0.80 (0.026)		
β^P					0.50 (0.07)	0.67 (0.024)
β^G					0.60 (0.014)	0.66 (0.034)
R^2	0.65	0.74	0.43	0.55	0.68	0.48
N_{obs}	2140	888	2140	888	1337	1337
Savings	Agg.	Agg.	Agg.	Agg.	Pr/Pub	Pr/Pub
Reg.	Bet.	Bet.	With.	With.	Bet.	With.
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Period	82-07	98-07	82-07	98-07	90-07	90-07

We then conduct a variance decomposition of the current account, taking the form of

$$var(CA_{it}) = \frac{cov(S_{it}, CA_{it})}{var(S_{it})} var(S_{it}) - \frac{cov(I_{it}, CA_{it})}{var(I_{it})} var(I_{it}) \quad (3)$$

$$= \beta_{SP}.var(S_{it}^P) + \beta_{SG}.var(S_{it}^G) - \beta_I.var(I_{it}). \quad (4)$$

The variance of the current account can be further decomposed into

$$var(CA_{it}) = \beta_{SP}.var(S_{it}^P) + \beta_{SG}.var(S_{it}^G) - \beta_I.var(I_{it}), \quad (5)$$

where β_{SP} and β_{SG} represent the regression coefficients associated with private savings rate and public savings rate, when regressing the current account on these factors.

The cross-sectional dispersion of the current account and its components for the period 1982-2007 in Figure 6. As is apparent, the cross-sectional variation in the current account has increased substantially in the past ten years, and is mostly driven by the increase in the variation of savings. The relationship contrasts with earlier periods where investment played a more important role. According to the variance decomposition in Eq. 4, the influence of each component on the cross-sectional dispersion in the current account depends both the regression coefficients β_s and β_I , as well as on its own cross-sectional variance. Figure 6

displays the contribution of savings and investment to the cross-sectional variation in the current account for the period 1982-2007. An average of about 70 percent of the variance of the current account is explained by savings, particularly pronounced in the last ten years. Investment's contribution has diminished both because of its low correlation with the current account and also because of its comparatively smaller cross-sectional variance.

For a smaller sample period, we can further decompose the variance of the current account into private and public savings, and investment, per Eq. 5. We find that private savings is the main driver of the cross-sectional variance in the current account. On average, private savings accounts for on 50 percent of the variance in the current account. These contributions of various components are shown in the second panel of Figure ??.

What justifies our regression analysis as well as our theoretical motivation in deciphering whether savings or investment drives the current account is the fact that the Feldstein Horioka puzzle, the strong cross-sectional correlation of savings and investment, has essentially disappeared over time. As in Figure... the coefficient β_{FH} from the regression coefficient $I_i = \beta^{FH} S_i + \epsilon_i$ has dramatically decreased and is close to 0 by 2007. This implies that β_S should be close to 1. Figure 3 plots the current account for all countries against the savings rate, for the year 2007. We cannot reject that β_S is close to 1. But most important is the fact that savings is the main driver of the current account, as reflected by the high R^2 in all of the regression analyses.

The conclusion one can draw from this analysis is that there is strong evidence that private savings is the primary determinant of the current account, across countries, especially pronounced in the past decade. Investment has, at best, played a role in certain periods of time and over a business cycle frequency and thus unlikely to be able to explain persistent divergences in current account imbalances. Any theory aimed at explaining the recent global imbalances patterns therefore must be anchored in a theory of savings. The challenge is to explain why savings tend to rise in rapidly growing economies, and moreover, why it can outpace investment. Equally important is to be able to explain why savings behavior can

differ across countries—often moving in opposite directions—even when facing the common global interest rate.

3 The Model Description

In this section, we develop a two-country general equilibrium framework that can account for the above facts. At center stage is the role of credit constraints on household borrowing, the extent of which differs across countries. In all other aspects our framework is standard: each of the two countries, Home (h) and Foreign (f), uses identical technology to produce one homogeneous good, which is used for consumption and investment, and is traded freely and costlessly. Preferences and production technologies are assumed to have the same structure and parameter values across countries. However, the technologies differ in two aspects: in each country, the labor input consists only of domestic labor, and firms are subject to country-specific productivity and labor force shocks. Henceforward, i denotes countries, where $i = h, f$.

3.1 Consumers

Both economies are characterized by overlapping generations economy in which consumers live for three periods. In every period, three generations coexist in each country: the young (y), the middle-aged (m), and the old (o). Consumers supply inelastically one unit of labor in middle age and do not work when young or old, while consuming in every period of their lives.

In period t , a continuum of consumers with measure $L_{y,t}^i$ are born in country i . The measure of young consumers $L_{y,t}^i$ grows at a rate $g_{L,t}$ in period t and follows

$$L_{y,t}^i = L_{y,t-1}^i(1 + g_{L,t}^i)$$

The lifetime utility of a consumer born at t in country i is

$$U_t^i = u(c_{y,t}^i) + \beta u(c_{m,t+1}^i) + \beta^2 u(c_{o,t+2}^i),$$

with standard CRRA preferences

$$u(c) = \frac{c^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}.$$

The discount factor β satisfies $0 < \beta < 1$, and $c_{\gamma,t}^i$ denotes the consumption of a consumer in country i and in stage $\gamma \in \{y, o, m\}$.

Young consumers earn no wage income and hence need to borrow in order to consume. Middle-aged consumers inelastically supply one unit of labor and earn the competitive wage w_t^i , which is used for consumption $c_{m,t}^i$, and saving. Old consumers consume all available resources. Let $s_{\gamma,t}^i$ denote the savings in period t of generation γ . Thus, an agent born in period t faces the following sequence of budget constraints:

$$c_{y,t}^i + s_{y,t}^i = 0 \tag{6}$$

$$c_{m,t+1}^i + s_{m,t+1}^i = w_{t+1}^i + R_{t+1}^i s_{y,t}^i \tag{7}$$

$$c_{o,t+2}^i = R_{t+2}^i s_{m,t+1}^i \tag{8}$$

where R_{t+1}^i is the gross interest rate earned between periods t and $t+1$.

We assume that young agents born in period t are subject to credit constraints: they can only borrow up to a fraction θ^i of the present value of their future labor income, captured by:

$$c_{y,t}^i \leq \theta^i \frac{w_{t+1}^i}{R_{t+1}^i}. \tag{9}$$

The tightness of the borrowing constraint, θ^i , can differ across countries.

3.2 Production Technologies

The production technology, identical in each country, uses capital and labor to produce a homogeneous good. Let Y_t^j be the gross production of the good in country i , K_t^i be i 's aggregate capital stock at the beginning of period t , and $L_{m,t}^i$ be the aggregate input of labor employed in country i at t :

$$Y_t^i = (A_t^i L_{m,t}^i)^\alpha (K_t^i)^{1-\alpha}, \quad (10)$$

where $0 < \alpha < 1$. The country-specific labor productivity, A_t^j represents and evolves according to

$$A_{y,t}^i = A_{y,t-1}^i (1 + g_{A,t}^i)$$

where $g_{A,t}^i$ denotes the growth rate of labor productivity in country i .

The capital used in producing good i in country j is augmented by investment goods, I_{it}^j , and the current capital stock K_t^j . The law of motion for capital stock is given by

$$K_{t+1}^i = (1 - \delta) K_t^i + I_t^i \quad (11)$$

where δ is the rate of depreciation.

Factor markets are competitive so that each factor, capital and labor, earns its marginal product. The wage rate per unit of labor in sector i in country j is

$$w_t^i = \alpha \frac{Y_t^i}{L_{m,t}^i}. \quad (12)$$

$$(13)$$

The gross rate of return in period t is

$$R_{it}^j = (1 - \alpha) \frac{Y_t^i}{K_{it}^i}. \quad (14)$$

4 Equilibrium

We are interested in the case in which θ^i is low enough such that Eq. 9 is binding for all countries i . This leads to the first assumption

Assumption 1 θ^i is binding in both countries.

When credit constraints are binding, a young agent can only borrow up to a fraction of the present discounted value of their lifetime resources, which is the wage income earned in middle age. Thus, the (dis)savings of the young is given by

$$s_{y,t}^i = -\theta^i \frac{w_{t+1}^i}{R_{t+1}^i}. \quad (15)$$

From the Euler condition that links consumption of the same agent in middle age, $c_{m,t+1}^i$, and his consumption $c_{o,t+2}^i$ in the next period, $(c_{m,t+1}^i)^{-1/\sigma} = \beta R_{t+2}^i (c_{o,t+2}^i)^{-1/\sigma}$, we can derive the savings function for the middle aged, born in period t :

$$s_{m,t+1}^i = \frac{1}{1 + \beta^{-\sigma} (R_{t+2}^i)^{1-\sigma}} (1 - \theta^i) w_{t+1}^i \quad (16)$$

The middle-aged agent saves a share $\frac{1}{1 + \beta^{-\sigma} (R_{t+2}^i)^{1-\sigma}}$ of the remaining lifetime resources, which is the fraction $(1 - \theta)$ of the wage income w_{t+1} in period $t + 1$. The rate of return affects the middle-aged agents savings only through the income and the substitution effect, the strength of which is governed by the parameter σ . The income effect tends to dominate when $\sigma < 1$. Since agents do not earn wage income in the last period of their lives, the middle-aged agents are not subject to a wealth effect due to changes in the interest rate. With these assump-

tions, the relationship between savings of the middle-aged and the rate of return is positive.

Savings Function

Examining the impact of interest rate changes on the long run on aggregate savings behavior elucidates the mechanism through which it operates on savings in the short run. Under Eq. 15 and 16, the long-run savings function of country i is given by

$$s_y^i + s_m^i = \left(-\frac{\theta^i}{R} + \frac{1 - \theta^i}{1 + \beta^{-\sigma} R^{1-\sigma}} \right) w^i,$$

which reveals three distinct ways in which changes in the long run world interest rate, denoted as R , affect a country's savings. The standard substitution effect and the income effect impact the middle-age consumers' decision (the second term on the right hand side), while the young consumers are subject to a wealth effect (the first term). Assuming that $\sigma > 1$, the income effect dominates the substitution effect and a fall in R is associated with a rise in s_m . On the other hand, a fall in R raises the lifetime wealth of a young borrower—inducing a fall in s_y . These effects are thus competing in determining the behavior of aggregate savings. For a high θ country (advanced economy), more weight is put on the (negative) savings of the young, so that the wealth effect tends to dominate the income effect and causes a *fall* in savings in response to lower interest rates. For a lower θ country (developing economy), more weight is put on the savings of the middle age, and a fall in the interest rate engenders a *rise* in savings. This demonstrates the extent to which savings responses may be *asymmetric* cross countries. Figure 8 displays the savings function of two economies with different levels of θ , for a range of interest rate values. It illustrates the important point that savings tend to diverge across countries when R falls, and converge when R rises.

In what follows, we make the additional assumption that

Special case: log preferences ($\sigma = 1$)

When constraints are binding (Assumption 1), the saving of the young remain the same as that of Eq. 15. The optimal savings of the middle age become:

$$s_{m,t+1}^i = \frac{\beta}{1+\beta}(1-\theta^i)w_{t+1}^i. \quad (17)$$

One can show that constraints are binding if and only if $\theta^i < 1/(1+\beta+\beta^2)$.¹

4.1 Closed-Economy Equilibrium

We turn to the autarkic equilibrium with a particular emphasis on the determination of the rental rate of capital R . In autarky, the capital stock accumulated at the end of period t for use in period $t+1$ must be held by the young and the middle-aged consumers, with

$$K_{t+1}^i = L_{y,t}^i s_{y,t}^i + L_{m,t}^i s_{m,t}^i. \quad (20)$$

It is convenient to focus on $\tilde{k}_t$, the ratio of the capital stock to the augmented amount of labor, defined as

$$\tilde{k}_t = \frac{K_t}{A_t L_t^m}.$$

We can derive analytical solutions of the evolution of $\tilde{k}_t$ when making the additional assumption that capital depreciates fully in every period:

¹When constraints given by Eq. 9 are not binding, the optimal consumption of an agent in youth and in middle age is a constant fraction of the present value of lifetime resources, which in this case, is the wage income earned in middle age. Therefore, a consumer born in period t chooses consumption levels in t and $t+1$ such that

$$s_{y,t}^i = -\frac{1}{1+\beta+\beta^2} \frac{w_{t+1}^i}{R_{t+1}} \quad (18)$$

$$s_{m,t+1}^i = \frac{\beta}{1+\beta+\beta^2} w_{t+1}^i. \quad (19)$$

$$\delta = 1$$

With log utility and full depreciation, the capital stock at the end of period t evolves according to:

$$k_{t+1}^i = \frac{\beta}{(1+\beta)(1+g_{t+1}^i)} \frac{\alpha(1-\alpha)(1-\theta^i)}{1-\alpha+\alpha\theta^i} (k_t^i)^{1-\alpha},$$

where θ is replaced by $\frac{1}{1+\beta+\beta^2}$ in the case of perfect markets ($\theta \geq \frac{1}{1+\beta+\beta^2}$). Liquidity constraints tend to reduce the dissavings of the young and raise the savings of the middle age. It is evident then that tighter borrowing constraints (lower θ) leads to a higher path of capital stock at every point along the transition path. In the long run, with effective labor force $A_{m,t}^i L_{m,t}^i$ growing at a constant rate g , the steady-state capital stock per unit of efficiency is determined by

$$\tilde{k}_{ss}^i = \left[\frac{\beta}{1+\beta} \frac{\alpha(1-\alpha)(1-\theta^i)}{(1+g)(1-\alpha+\alpha\theta^i)} \right]^{1/\alpha} = \tilde{k}_{ss}^i(\theta^i) \quad (21)$$

$$(22)$$

where θ is replaced by $\frac{1}{1+\beta+\beta^2}$ in the case of perfect markets. The steady state level of capital stock in an economy with liquidity constraints ($\theta < \frac{1}{1+\beta+\beta^2}$) is higher than in an economy with perfect markets ($\theta \geq \frac{1}{1+\beta+\beta^2}$); and in the former case, the steady state level of capital stock is higher when borrowing constraints are tightened (θ falls). This implies that the steady-state rate of return in country i ,

$$R_+^i(\theta^i) = \frac{1+\beta}{\beta\alpha}(1+g)\frac{1-\alpha+\alpha\theta^i}{1-\theta^i},$$

depends on θ and is lower in an economy with liquidity constraints ($\theta < \frac{1}{1+\beta+\beta^2}$). Likewise, the rate of return tends to be higher in countries with looser borrowing constraints (higher θ^i).

4.2 Open-Economy Equilibrium

In the open economy, capital can flow across borders, with the resource clearing constraint requiring

$$\sum_i K_{t+1}^i = \sum_i (L_{y,t}^i s_{y,t}^i + L_{m,t}^i s_{m,t}^i). \quad (23)$$

Let $\lambda_t^i \equiv \frac{A_t^i L_{m,t}^i}{\sum_j A_t^j L_{m,t}^j}$ denote the relative country size of i . When borrowing constraints are binding in both countries $i = h, f$, the law of motion for capital stock in i becomes

$$k_{t+1} = \frac{\beta}{1+\beta} \frac{\alpha(1-\alpha) \left[\sum_i \frac{\lambda_{t+1}^i}{1+g_{t+1}^i} (1-\theta^i) \right]}{1-\alpha + \alpha \left(\sum_i \lambda_{t+1}^i \theta^i \right)} k_t^{1-\alpha}. \quad (24)$$

Note that $\frac{\lambda_{t+1}^i}{1+g_{t+1}^i} = \frac{A_{t+1}^i L_{m,t+1}^i}{\sum_j A_{t+1}^j L_{m,t+1}^j}$. In the steady state, where the growth rate of the effective labor force grows at the same rate across countries ($g^i = g$), the steady-state level of capital stock in country i is

$$\tilde{k}^i = \left[\frac{\beta}{1+\beta} \frac{\alpha(1-\alpha)}{1+g} \frac{1 - \sum_i \lambda^i \theta^i}{1-\alpha + \alpha \left(\sum_i \lambda^i \theta^i \right)} \right]^{1/\alpha}, \quad (25)$$

where λ_i denotes the steady state constant level of country i 's relative size. In the open economy, the steady-state world rate of return becomes

$$R = \frac{1+\beta}{\beta\alpha} (1+g) \frac{1-\alpha + \alpha \left(\sum_i \lambda^i \theta^i \right)}{1 - \sum_i \lambda^i \theta^i}$$

where the weighted-average constraint $\sum_i \lambda^i \theta^i$ replaces θ^i in the autarkic steady-state interest rate given by Eq. 23. The world interest rate R_{aut}^i can be written as a weighted average of the country-specific autarky interest rates:

$$R = \sum_i \mu_i R_a^i, \quad (26)$$

where $R_a^i = \frac{1+\beta}{\beta\alpha}(1+g)^{\frac{1-\alpha+\alpha\theta^i}{1-\theta^i}}$, from Eq. 23, with weights $\mu_i = \frac{\lambda^i(1-\theta^i)}{\sum_j \lambda^j(1-\theta^j)}$. Country i thus exerts a greater impact on the world interest rate when its relative size is large (high λ^i) and/or when it tends to be more liquidity constrained (high θ^i).

More generally, with any level of the elasticity of substitution σ , combined with full depreciation yields a steady state world interest rate that satisfies

$$F(R) = \sum_i \mu_i F(R^i)$$

with $F(R) = \frac{R}{1+\beta-\sigma R^{1-\sigma}}$. Eq. 23 shows that if country i is less liquidity constrained than j ($\theta^i > \theta^j$), it must be that $R_a^i > R > R^j$. Capital market integration will lead to capital outflows from j to i and induce j to run a current account deficit.

The preceding relationships show that when countries open up to international capital markets, the less constrained economy sees a fall in the world interest rate, while the more constrained economy sees a rise in the world interest rate. Additionally, with perfectly integrated financial markets, higher growth in the more constrained economies causes the world interest rate to fall further.

4.3 Aggregate Savings, Investment and the Current Account

Aggregate savings in country i in period t is the sum of aggregate savings of the young, the middle age and the dissavings of the old. By definition, it is

$$S_t^i \equiv L_{y,t}^i s_{y,t}^i + L_{m,t}^i [s_{m,t}^i - (1-\delta)s_{y,t-1}^i] - L_{o,t}^i (1-\delta)s_{m,t-1}^i.$$

Under Assumptions 1, 2, and 3, the aggregate savings of country i becomes

$$S_t^i = -\theta^i \frac{\alpha}{1-\alpha} A_{t+1}^i L_{m,t+1}^i k_{t+1}^i + \frac{\beta}{1+\beta} (1-\theta^i) \alpha A_t^i L_{m,t}^i (k_t^i)^{1-\alpha}, \quad (27)$$

with savings rate given by

$$\frac{S_t^i}{Y_t^i} = \alpha \frac{\beta}{1+\beta} \left\{ 1 - \theta^i - \theta^i (1 + g_{t+1}^i) \frac{\alpha \left(\sum_j \frac{\lambda_{t+1}^j}{1+g_{t+1}^j} (1-\theta^j) \right)}{1-\alpha + \alpha \left(\sum_j \lambda_{t+1}^j \theta^j \right)} \right\}. \quad (28)$$

Aggregate investment rates, on the other hand, are determined by the world interest rate.

With Assumption 1, 2, and 3,

$$\frac{I_t^i}{Y_t^i} = \frac{\beta}{1+\beta} (1 + g_{t+1}^i) \frac{\alpha(1-\alpha) \left[\sum_j \frac{\lambda_{t+1}^j}{1+g_{t+1}^j} (1-\theta^j) \right]}{1-\alpha + \alpha \left(\sum_j \lambda_{t+1}^j \theta^j \right)} k_t^{-\alpha}$$

and

$$\frac{I_t^H/Y_t^H}{I_t^F/Y_t^F} = \frac{1 + g_{t+1}^H}{1 + g_{t+1}^F},$$

which shows that investment rates are equalized across countries in the long run when $g^H = g^F = g$, unlike savings rate, which diverges in the long run.

We follow the convention that NFA_t^i is measured at the beginning of period t , and define

$$NFA_t^i = (1-\delta) NFA_{t-1}^i + CA_{t-1}^i. \quad (29)$$

Let K_t^{ij} denote the quantity of capital bought by the middle-aged of country i in country j in period $t-1$, B_t^i the quantity of one-period bonds they buy in period $t-1$, and $S_{y,t-1}^i$ the position of one-period bonds taken by the young generation of country i in period $t-1$.

Another way of writing the current account of country i in period t is

$$CA_t^i \equiv NX_t^i + r_t NFA_t \quad (30)$$

$$= NX_t^i + r_t (K_t^{ij} - K_t^{ji} + B_t^i + S_{y,t-1}^i). \quad (31)$$

where NX_t^i is country i 's trade balance at t . Given the above definition, the current account is equivalent to

$$CA_t^i = S_t^i - I_t^i, \quad (32)$$

where S_t^i is given by Eq. 27 and I_t^i by Eq. 11.

5 Calibration

The following section investigates whether the two most relevant global changes of the past two decades—capital markets integration and the rapid growth of the latter—can generate the savings divergence and current account imbalances observed in the data. In the subsequent numerical analyses we relax Assumptions 2 and 3 of a unitary elasticity of substitution ($\sigma = 1$) and full depreciation ($\delta = 1$). In order to provide intuition on the mechanism at hand, we first explore the implications of each experiment separately. We show that the implications on the aggregate economy are in stark contrast to those of a standard two-country OLG model in the absence of credit constraints and those in the absence of an *asymmetry* in the degree of credit constraints.

5.1 Calibration

Each period is 20 years. Advanced economies start from their steady states and grow at an annual rate of 2 percent. Emerging Asia, however, is assumed to be in autarky and capital

scarce. According to data from Hall and Jones (2002), the capital/effective labor ratio is about 2 percent of the advanced economies in 1989. The initial relative size of emerging markets in 1990 is about 20 percent of the size of advanced economies (Figure 1), so therefore $\lambda^E = 0.2$.

Preference parameters are standard. The intertemporal elasticity of substitution is assumed to be $\sigma = 0.5$, and the discount factor $\beta = 0.85$ which reflects an annual discount factor of 0.99. Depreciation rate is set at 10 percent per year which gives $\delta = 0.85$ over a 20 year period. The labor share α is set at 0.72.

In choosing θ^i , we make the assumption that advanced economies can borrow up to 35 percent of the present value of their future income, whereas emerging Asia can only borrow up to 5 percent of the present value of their future income.

5.2 Capital Markets Integration

In the first experiment, countries begin in their autarkic equilibrium. Unlike advanced economies, which are in steady state, Emerging Asia is on a transition path towards its steady state and its capital scarcity implies a relatively high rate of return, despite the credit constraints which tend to lower the rate of return (Figure 9). However, this process is accelerated by the stringency of the liquidity constraints which foster higher aggregate savings in the economy, and the rate of return falls rapidly. It is actually lower than the autarkic rate of return in the developed economy one period before countries open up to international capital markets in period $t = 0$. Since capital stock is fixed for one period, the rates of return across countries are not equalized until $t = 1$. Because the world interest rate is simply a weighted average of the autarky returns, from the perspective of advanced economies, the interest rate falls, while it rises for Emerging Asia.

In anticipation of the rise in the interest rate after opening up to capital markets, emerging Asia's savings rate falls slightly, before integration takes place. This is due to the fact that from the standard parameters that we assume, the income effect which tends to depress

the savings of the middle age outweighs the substitution effect which tends to raise it, and also because a lower weight is placed on the young consumers' (dissavings) than that of the middle aged in a highly constrained (low θ) economy. In the long run, the savings rate increases (albeit fairly small) compared to its initial level, in Emerging Asia, in contrast to the (small) decline in savings rate in advanced economies. This corresponds to the intuition given by Eq. 4 on the long-run savings behavior, illustrated in Figure 8. In this experiment, the impact of opening up of Asia is fairly weak due to its relative small importance in the world economy (low λ). Increasing its initial size or θ^E will tend to magnify the effect. However, it is clear that in the long run, the savings rate is permanently higher in emerging markets than in advanced economies.

Investment rates, unlike savings rate, tend to converge in the long run, as it is determined by the common world interest rate. Emerging Asia runs a current account surplus, initially due to the faster drop in investment rates than savings rates. Per our definition of the current account in Equation 29, it never reverts to zero in the long run.

5.3 Faster Growth in Emerging Markets

We next turn to examining the impact of faster productivity growth in emerging markets when capital markets are already integrated. In 1970, the relative size of Emerging Asia (as a share of advanced economies' GDP) was 0.2. By 2008, it had reached a relative size of 0.8 (Figure 1). Thus, the experiment we consider is where emerging markets grow at an accelerated rate of 6.25% per year in the first period ($t = 2$) and 5% per year in the second period ($t = 3$)—to match the growth in its relative size over the last 40 years (2 periods in the model). Growth rates become the advanced economies' steady state annual growth rate of 2 percent thereafter. In this experiment, we assume that both countries start from their initial steady-state. Other parameter values are identical to the previous experiment.

Figure 10 shows the results. The rate return initially increases, during the period of rapid growth in Asia, before permanently falling to a lower steady state level. The long run decline

in the world interest rate is due to the sharp increase in the relative weight of Emerging Asia, which features a low steady-state interest rate, in the world.

The savings rate in Emerging Asia falls slightly in the first period but increases permanently in the future. Due to anticipated high present value of future wages, young people's savings initially falls one period before the growth acceleration episode. The middle-aged agents' savings also falls because wages remain constant in the current period, but higher expected future interest rates depresses its savings motive through the strong income effect. However, this initial dip in savings rate disappears if the growth episodes were unexpected. In the subsequent periods, the high growth in emerging markets lead to high wage growth of the middle age in emerging Asia. The savings of these agents rise both because of their high income growth and because of the dominance of the income effect in raising the savings rate when the interest rate falls. However, the ability to borrow against future income is severely limited for the current generation of young agents in Asia, and thus they do not end up borrowing by much more. The net effect is a rise in the savings rate in Asia. By contrast, the savings rate falls in developed economies as the positive wealth effect encourages the current generation of young agents in advanced economies to borrow more. Savings rate permanently diverges across the two regions.

Initially, high investment demand due to rapid growth in Asia leads to a deterioration of the current account for one period, and a sharp improvement in the current account in subsequent periods.

The more realistic experiment entails the conjoining of the capital markets integration and emerging markets growth experiment. We now perform the experiment where Asia starts to grow at an accelerated rate of 6.25 percent one period (1970) before the opening of capital markets (the year 1990), at which date it grows at 5 percent per year. In subsequent periods, both economies grow at the same rate of 2 percent per year. All parameter values are again identical to previous experiments. Savings rate and current account imbalances diverge at the outset, and remain permanently at different levels in the long run. Figure11

displays key results, and shows that the model is able to generate predictions qualitatively consistent with the experience of the past decades, and at the same time deliver quantitatively significant results.

5.4 Comparisons

The standard results, in the absence of credit constraints, display markedly different results from the case with asymmetric credit constraints. First observe that the rate of return increases for multiple periods before reverting back to its initial level, in contrast to the long run decline in the case with asymmetric credit constraints. Moreover, savings rate tend to comove across countries before converging to the *same* level in the long run. Savings initially fall in both countries, mostly due to the higher expected future rate of return, and subsequently rises as the rate of return falls to its original level, and as wages rise—in the case of Asia. The similar response of savings rate to changes in the interest rate is in direct contrast to the divergence in the savings rate obtained in the previous experiments. The high investment demand in Asia, due to rapid growth, causes a sharp increase in the investment rate and thus a current account deficit. Advanced economies run a current account surplus as capital flows into emerging markets to finance higher consumption and investment demand. The external imbalances are not permanent and reverts to 0 after a few periods. These patterns are all in stark contrast to those of our benchmark credit-constrained economies and also opposite of what we observe in the data.

We also ask whether the asymmetry between θ across countries is vital for our results. Figure 12 displays the results for the same experiment as previous ones except that θ^i is taken to be 0.2 for both countries. As is clear from the graph, the existence of credit constraints alone is insufficient to generate the divergence in savings rate and consistent current account patterns with the data. In this case, since the same weight is attributed in the two economies to the young versus the middle aged in determining aggregate savings behavior, it tends to

respond similarly, and comoves across countries, as in the case without credit constraints.

What happens if the less constraint economy grows faster? A relevant scenario applies to Europe and the US over the period 1980-2007. In 1980, Europe was roughly the same size as the US, but reached to only 75 percent of the latter in 2007. For illustration sake, we assume that $\theta^{us} = 0.175$ and $\theta^{eur} = 0.35$. The US grows at an accelerated rate of 3.5 percent per year for one period, whereas Europe maintains a constant rate of growth at 2 percent per year. The experiment assumes that capital markets are already integrated.

As seen from Figure 13, the rate of return permanently *rises* as the weight of the less constraint economy (with the higher autarky interest rate) increases due to the growth acceleration episode of the US. The permanent increase in the interest rate now generates a *convergence* in the savings rate—uniformly falling in both countries—as both middle aged and young agents’ savings decline. This again corresponds to the intuition provided by Figure 8 when world interest rate rises. Finally, the high investment demand generates a deficit in the US, and the current account converges over time although never reverting to balance in the long run.

6 Conclusion

This paper develops a global general equilibrium model with asymmetric household liquidity constraints. Financial integration, along with rapid growth in Emerging markets, can lead to a persistent decline in the world interest rate, which causes a divergence in the savings rate across countries with different levels of credit constraints. Less constrained economies place greater weight on the (dis)savings of the young, who respond to a lower interest rate by borrowing more; more constrained economies place a greater weight on the savings of the middle-aged, who respond to a lower interest rate by saving more. Asymmetric weights on the savers of the economy can lead to opposite responses of the savings rate on the aggregate level in the event of a drop in the interest rate. Even though Emerging markets experience

greater investment demand due to high growth rates, higher savings due to liquidity constraints can outpace investment and lead to a net capital outflow.

An important implication of this framework is that in a cross section of countries, responses to a fall in the interest rate will generate a cross-section of savings rate, depending on the degree of heterogeneity of credit constraints imposed on those economies. A rise in the world interest rate, on the other hand, leads to a convergence in the savings rate. Since investment rates are determined by the world interest rate, our model predicts a convergence in the investment rate in the long run. Thus, savings become the main driver of the current account across countries. Our predictions are consistent with the broad stylized facts, and also with the findings from a closer dissection of the data. We point to the importance of liquidity constraints in being a potentially important factor in explaining the recent divergence in global imbalances and savings rate between advanced and emerging markets.

A Data

References

- [1] Benhima K., and Bachetta P., 2011, The Demand for Liquid Assets, Corporate Saving, and Global Imbalances, mimeo HEC Lausanne.
- [2] Caballero, Gourinchas, and Farhi, 2008, An Equilibrium Model of ‘Global Imbalances’ and Low Interest Rates, *American Economic Review*, 98(1).
- [3] Buera and Shin, 2010, Productivity Growth and Capital Flows: The Dynamics of Reforms. Manuscript, UCLA.
- [4] Carroll and Jeanne, 2009. A Tractable Model of Precautionary Reserves, Net Foreign Assets, or Sovereign Wealth Funds. Manuscript, Johns Hopkins University

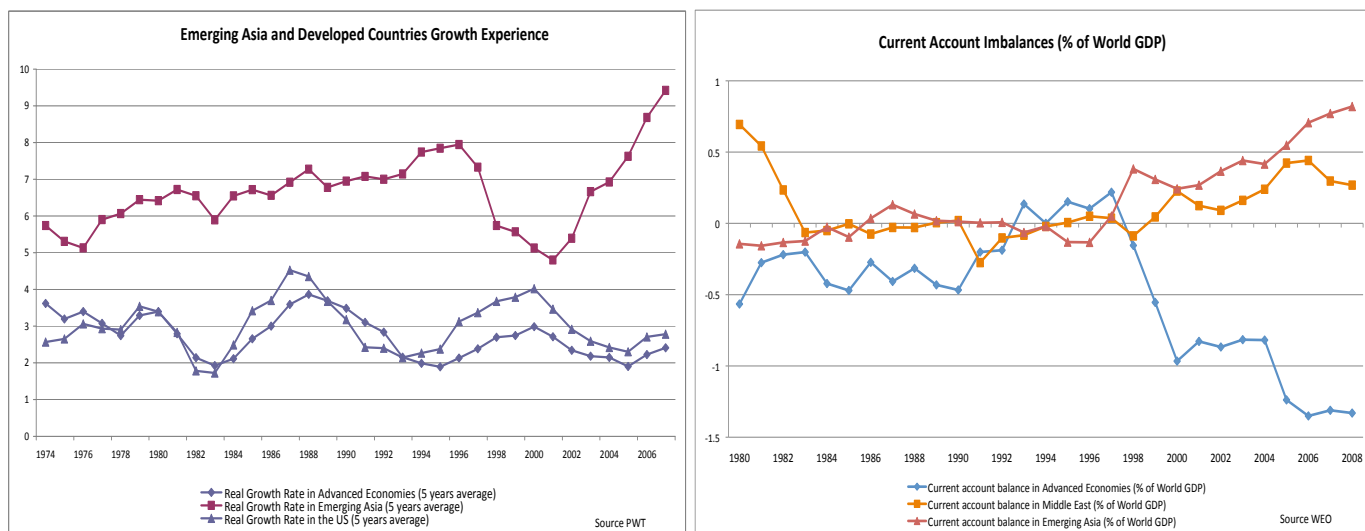


Figure 1: Growth in Emerging Markets and Global Imbalances

- [5] Mendoza, Quadrini and Rios-Rull, 2009. Financial Integration, Financial Development and Global Imbalances, *Journal of Political Economy*, 117(3).
- [6] Song, Storesletten and Zilibotti, 2009. Growing like China. *American Economic Review*, forthcoming.
- [7] Sandri, 2010. Growth and Capital Flows with Risky Entrepreneurship, Working Paper, International Monetary Fund.

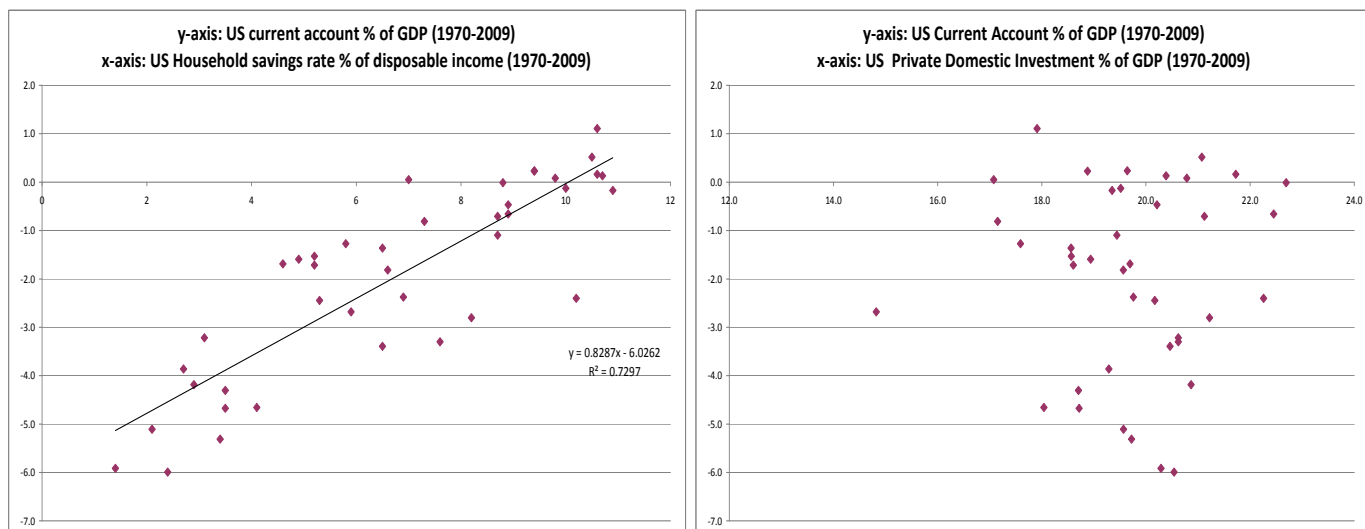


Figure 2: Savings, Investment, and the Current Account in the U.S.

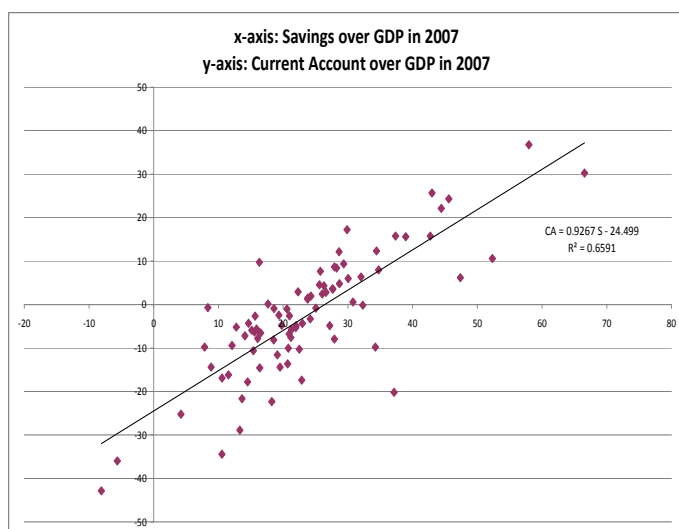


Figure 3: The savings and the current Account relationship in 2007, across all countries.

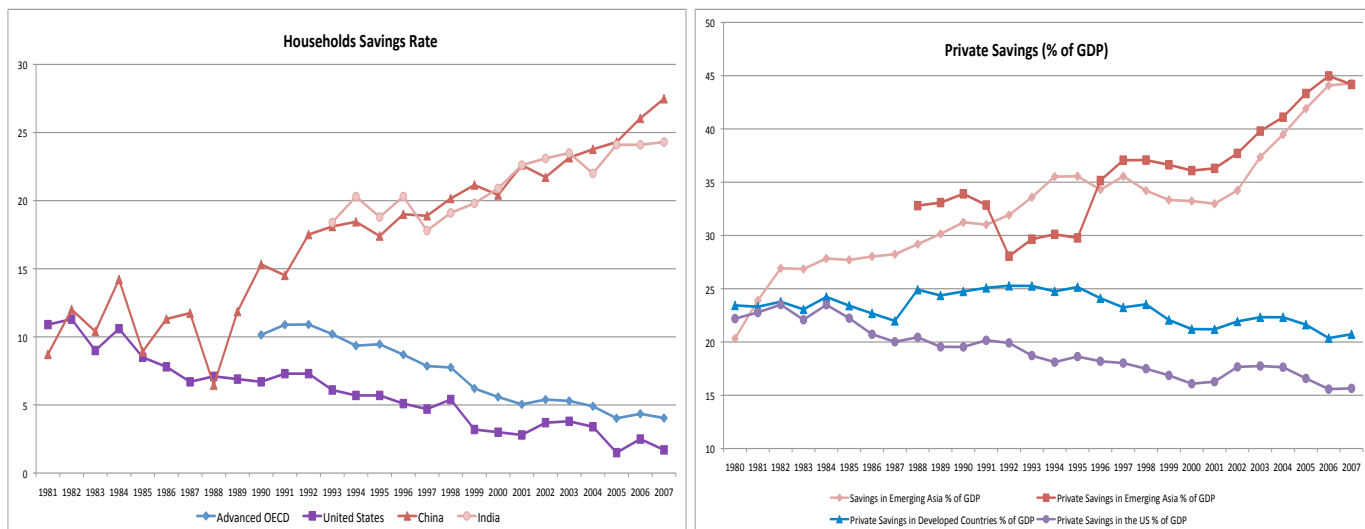


Figure 4: Savings Rate Across Regions

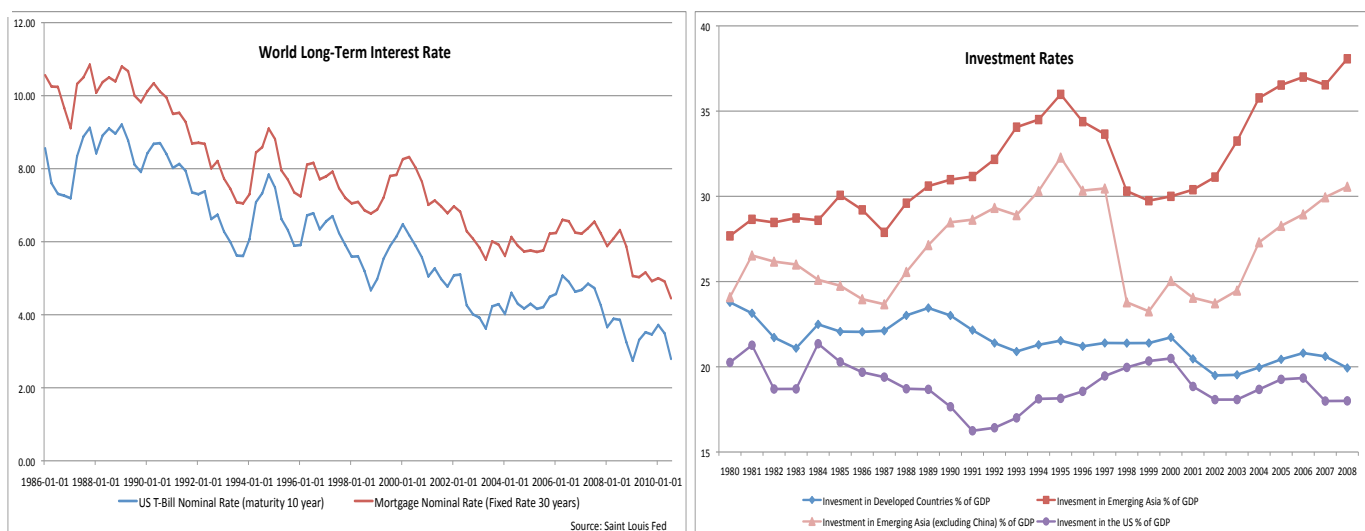


Figure 5: World Interest Rate and Investment Rates

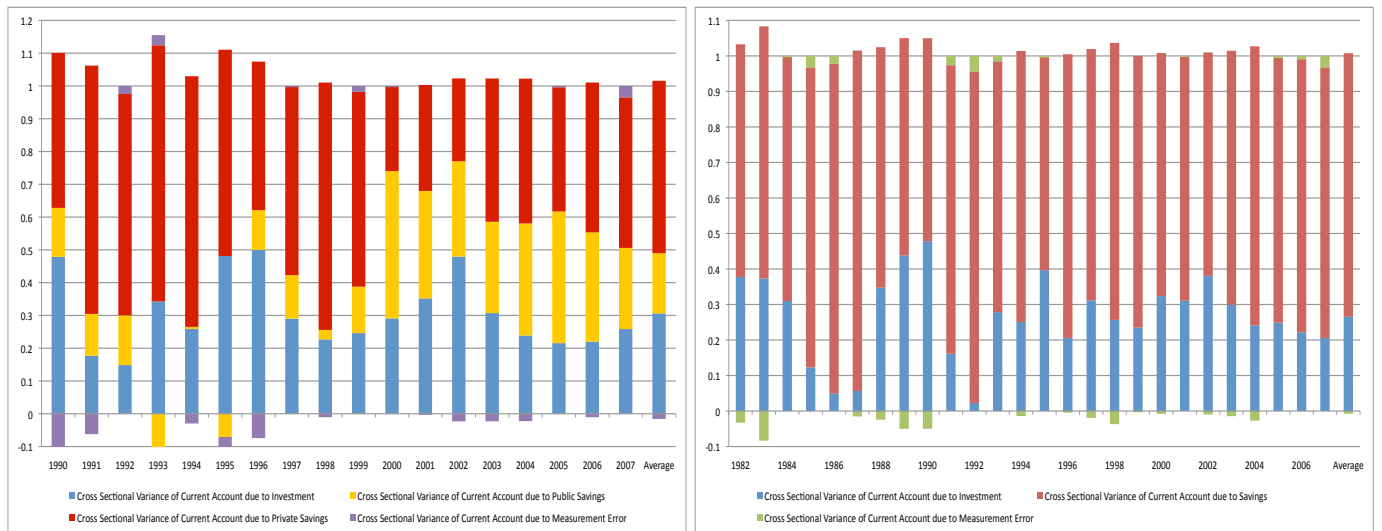


Figure 6: Variance Decomposition

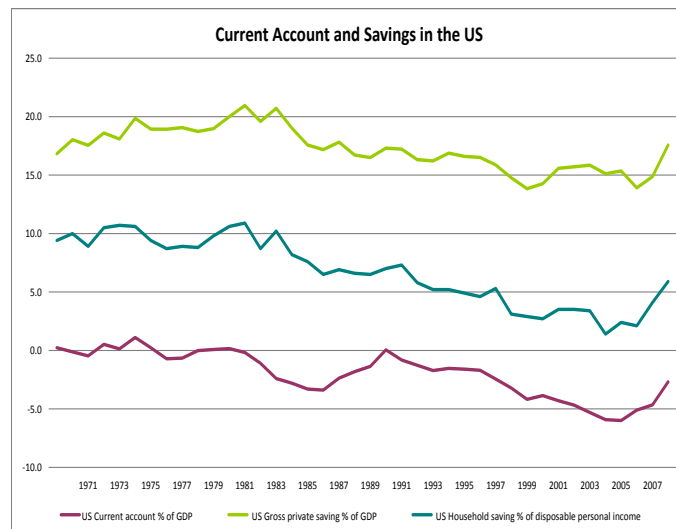


Figure 7: Standard deviation of various components in U.S.

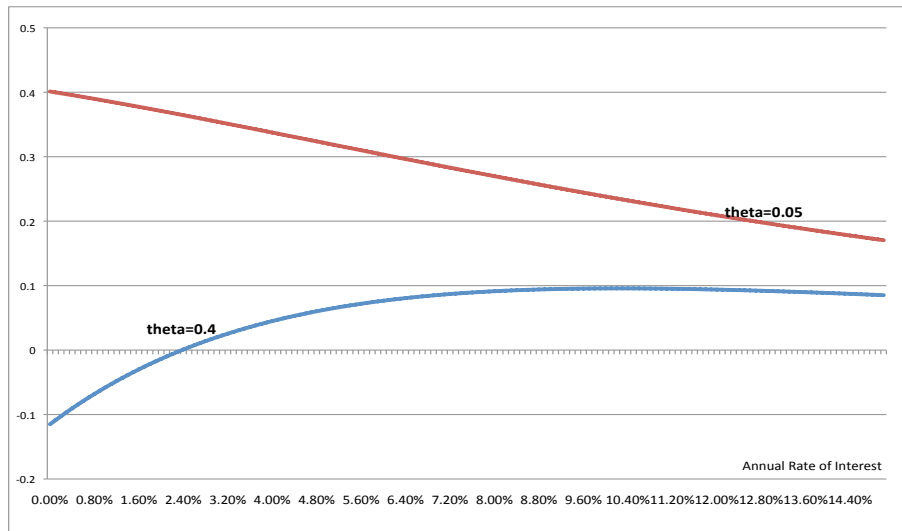


Figure 8: Savings Function

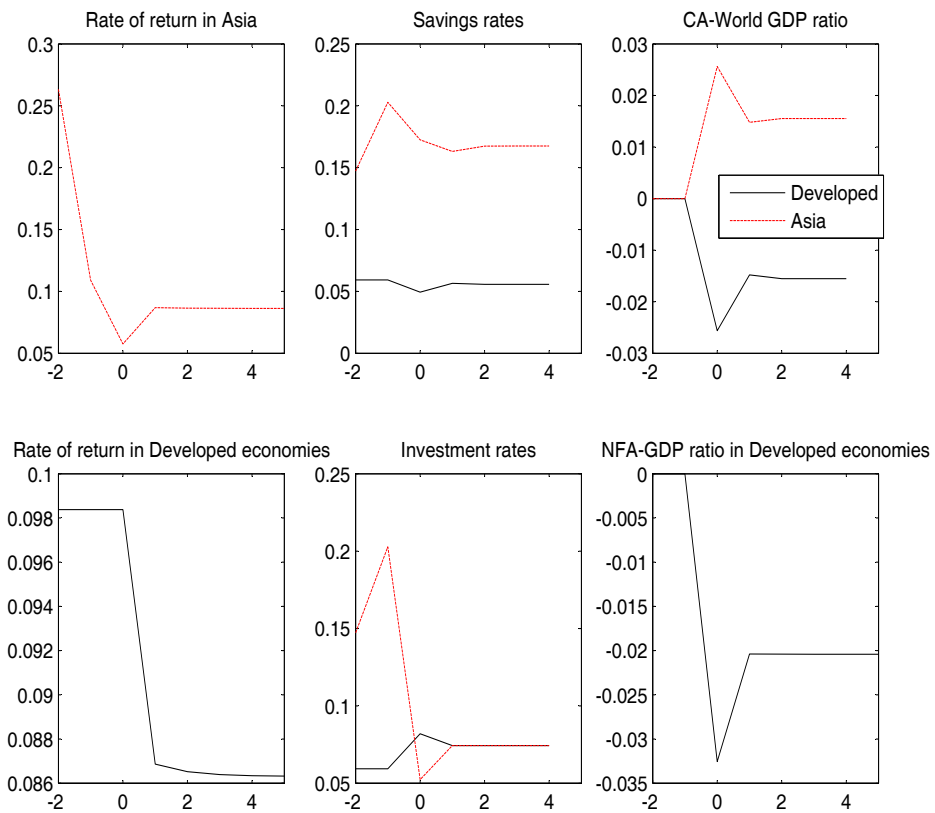


Figure 9: Integration of advanced economies and emerging asia.

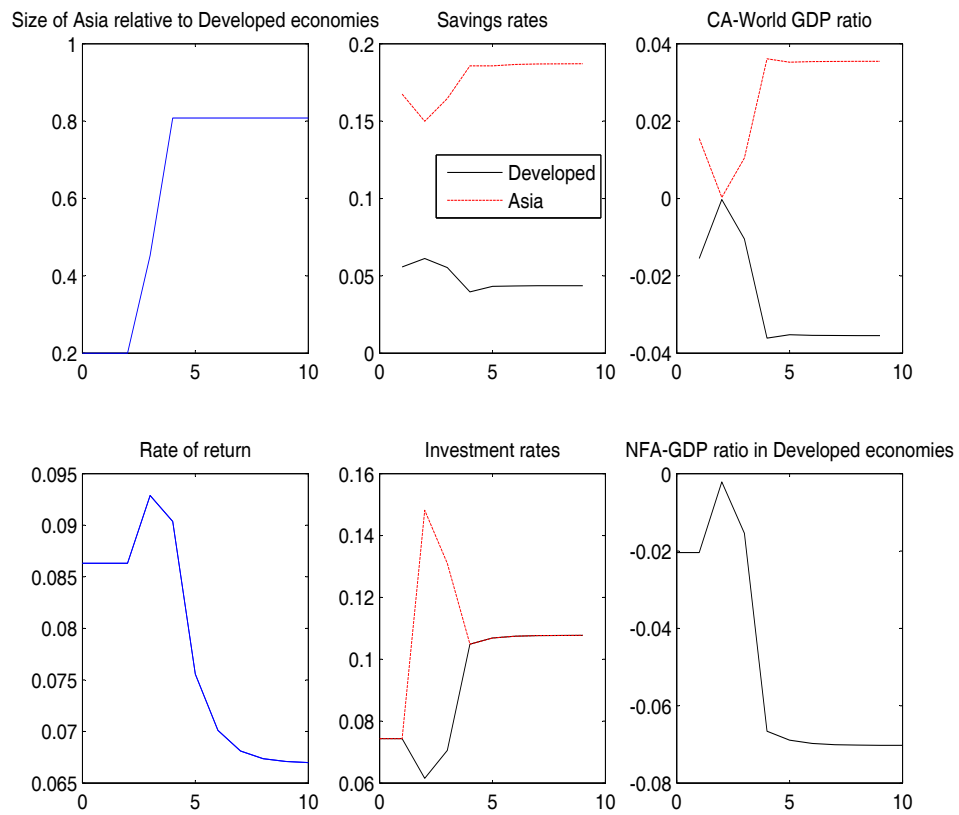


Figure 10: High growth in emerging asia.

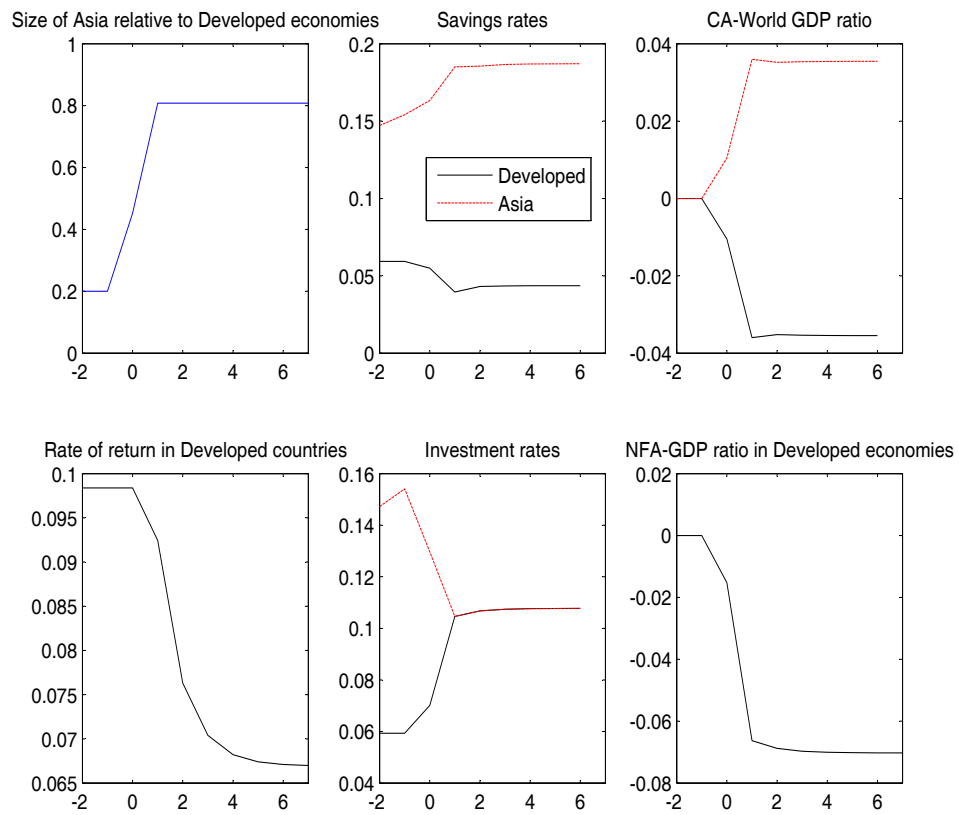


Figure 11: Capital markets integration and faster growth in emerging asia.

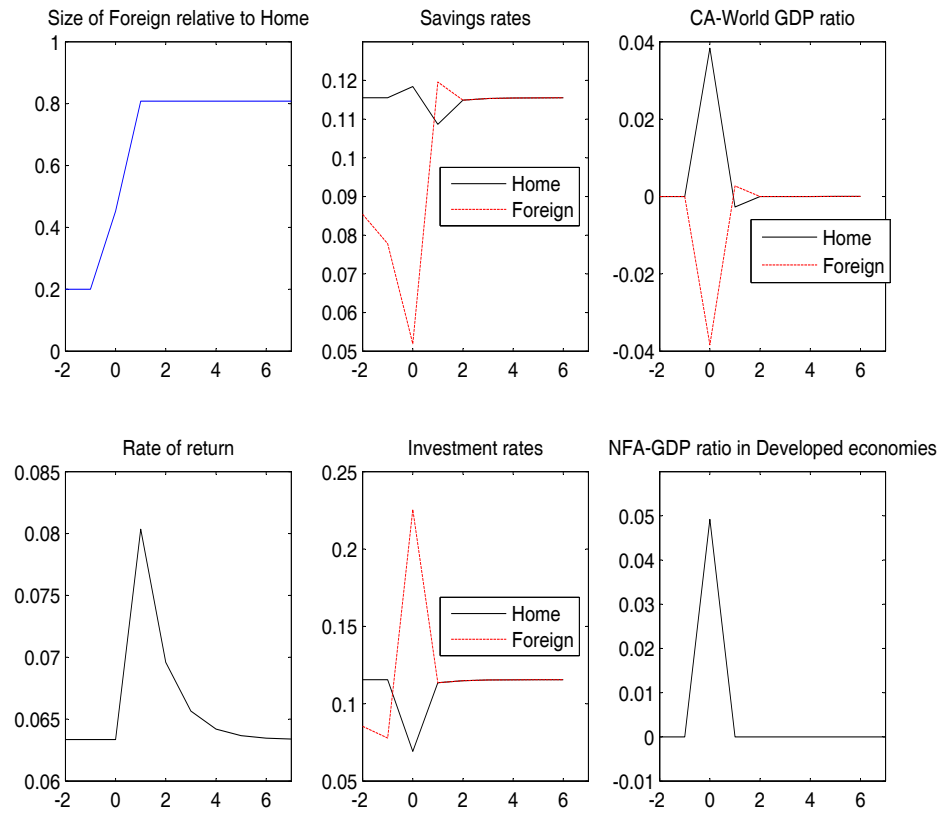


Figure 12: Emerging markets growth and integration with symmetric liquidity constraints.

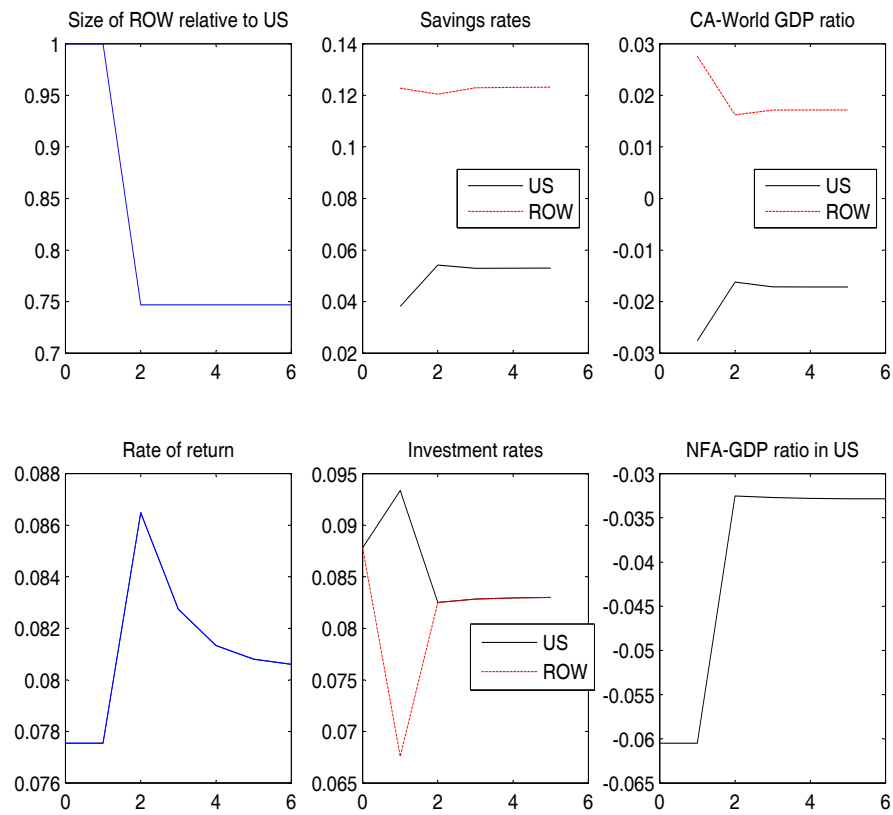


Figure 13: Faster growth in less-constrained economies.