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# External Adjustment, Global Imbalances, Valuation Effects*

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# Contents

# 1 Introduction

The question of external adjustment is a central issue in international macroeconomics. Early approaches such as Hume (1752)'s price specie flow mechanism emphasized the self-regulating nature of international exchanges through settlements in hard currency. Following the disruptions of the interwar period, the early Keynesian analyses of Machlup (1943), Meade (1951) or Metzler (1960) focused instead on the role of monetary and fiscal policy in achieving a desired level of internal and external balance. These static models focused on nominal price and wage rigidity and did not feature any self-correcting force that would ensure long-term stability. When Mundell (1968) asked "To what extent should surplus countries expand; to what extent should deficit countries contract?" the debate was about the relative merits of expenditure-switching and expenditure-reducing policies, that is, policies that would alter the composition of demand between domestic and foreign goods, versus policies that would directly affect patterns of aggregate demand. Subsequent research, started by Hamada (1969) and Bruno (1970) and summarized in Obstfeld and Rogoff (1995) borrowed from the optimal growth theory of Ramsey (1928), Cass (1965) and Koopmans (1965). Since the current account measures the difference between national saving and domestic investment, both forward looking decisions, proper modeling of the external adjustment requires an explicit theory of economic agents' consumption/saving and investment decisions. The resulting synthesis, in the form of the 'intertemporal approach to the current account' characterized the dynamics of the current account as the result of forward-looking decisions by households and investment decisions by firms, set in market structures of varying degrees of complexity. This was the focus of Obstfeld and Rogoff (1995) in the previous volume of the handbook, and constitutes a natural starting point for this chapter. Conceptually, the intertemporal approach ascribes movements in a country's current account to the difference between the current situation of a country, and its long run circumstances. Formally, it states that countries should borrow whenever their current income is below their permanent income, or whenever the return to domestic capital is higher then the cost of borrowing. The precise amount of borrowing is then pinned down by the requirement that debts be repaid, and returns to capital be equated across locations.[1]

From a conceptual point of view, this approach constitutes a giant leap forward. From an empirical perspective, however, the theory has yielded mixed results and its key empirical predictions have often been rejected by the data, a point already noted by Obstfeld and Rogoff (1995).[2] We

[1] This chapter does not deal with situations where countries may decide not to repay their debts. For a discussion of the specific issue of sovereign debt, see the chapter by Mark Aguiar and Manuel Amador in this Handbook.

[2] For instance, Nason and Rogers (2006) found that the present-value-model of the current account was soundly rejected for Canada over the post-war period. In general, the current account balances ascribed by the theory tend

emphasize here two particularly relevant empirical shortcomings, which we document in section 2: first, the model performs particularly poorly in explaining the empirical pattern of *net* long term capital movements, both between developing and mature economies and across developing countries. Second, the model does not take into account that the current account represents an increasingly imperfect measure of the change in a country's net foreign asset position since the latter also reflects changes in the market value of cross-border claims and liabilities. The relative importance of these '*valuation effects*' is particularly high for advanced economies, but increasingly so too for emerging ones. The growing empirical importance of these valuation effects require that we look more closely at the determinants of international portfolios.

We explore these two dimensions in turn. Understanding the source of 'global imbalances' –deficits in advanced countries, surpluses in rapidly growing emerging ones– constitutes the principal objective of sections 3 and 4. Section 3 lays out a simple model of long term capital flows. The starting point is the neo-classical growth model in continuous time under perfect foresight, a standard framework which allows us to derive many key results without having to spend too much time on the necessary machinery. The model's predictions regarding capital flows rests on two key elements. First, capital will tend to flow from countries with low autarky returns to countries with high autarky returns. Second, the model identifies two key determinants of a country's autarky returns: capital scarcity and long run growth prospects both taken as exogenous and country-specific. Putting both things together, the theory unambiguously points to advanced economies as countries with low autarky interest rates, and emerging ones as countries with high autarky interest rates. Hence capital should flow 'downstream' from rich to poor countries.

Existing attempts to explain the observed pattern of global imbalances introduce additional determinants of autarky interest rates. The various models put forward in the literature, surveyed in section 4, all share the feature that advanced economies –chiefly the U.S.- can exhibit *higher* autarky real returns than the rest of the world, especially emerging economies. Equivalently, these countries have high *desired* saving (or low *desired* investment) relative to the U.S. Hence, these theories predict that capital should flow from South to North, as observed in the data. Most of these theories rely on asymmetries between financial and economic development in advanced and

to be much smaller and less variable than their empirical counterpart. Put another way, output fluctuations appear much more persistent to the econometrician's eyes than actual current account movements suggest. There are some important exceptions. For instance, Aguiar and Gopinath (2007) find that the current account fluctuations of small emerging economies are consistent with the theory precisely once one takes into account that productivity shocks appear much more persistent in emerging economies. Obstfeld and Rogoff (2000) show that introducing transportation costs in an otherwise standard model helps understanding the Feldstein and Horioka (1980) puzzle of small current account imbalances and also allows to make progress on other important international macroeconomics puzzles.

emerging countries. Caballero et al. (2008a), for instance, assume that developing countries face a shortage of stores of value. This shortage depresses the autarky rates of returns of these countries, and rapid growth in this part of the world can exacerbate global imbalances. Other theories, such as Mendoza et al. (2009) or Angeletos and Panousi (2011), emphasize cross-country differences in the ability to insure away idiosyncratic risk. In a Bewley-type model, these differences translate into different strength of the precautionary saving motive. Less financially developed countries, faced with higher residual levels of idiosyncratic risk will save more, depressing autarky rates of return. Yet other theories, such as Antràs and Caballero 2009, emphasize the interactions between financial frictions and international trade.

Most of these models do not feature aggregate uncertainty and do not have an international diversification motive. They make predictions about *net* capital flows, that is, about the intertemporal transfer of resources across countries. Section 5 follows a different track. It starts by observing that the current account does not, in general, coincide with the change in a country's net foreign asset position. The latter also reflects changes in the *market value* of claims and liabilities underlying a country's net position, including exchange rate movements. As documented in section 2 and by Lane and Milesi-Ferretti (2001) these *valuation changes*, ignored in much of the earlier literature, have grown tremendously in importance since the 1980s, to the point where over a given period, their fluctuations can easily dominate the current account balance. Obtaining precise estimates of these valuation changes is not an easy task, and we discuss the empirical methodological advances that have allowed researchers to make progress on that front. Valuation changes would not matter much for the underlying process of external adjustment if they were purely unexpected and random. We present a simple framework to analyze the structure of total external returns and their predictability. We discuss how such returns can be constructed from underlying balance sheet position, with a particular attention to the relevant empirical caveats that are involved in any exercise of this nature. Section 5 also focuses more specifically on the U.S. external balance sheet and presents updated estimates of the excess return the U.S. enjoys on its external balance sheet. We discuss the origin of what has sometimes been called an 'exorbitant privilege.' We show how the predictable component of this excess return contributes to relaxing the external constraint of the United States. A legitimate question to ask then is to what extent existing theories and in particular to what extent the new stream of literature featuring dynamic stochastic general equilibrium models can accommodate the valuation channel of adjustment in their dynamics of the net foreign asset positions.

Finally, our discussion on the structure of external balance sheets of countries has a bearing on the functioning of the International Monetary and Financial System which we take up in section 6. Traditionally the country at the centre of the system, -the UK in the 19th century and before the first world war or the US after the second world war-, has been described as a global liquidity provider. The centre country issues the currency used in most international exchanges whether on goods market or on financial markets. By emphasizing the heterogeneity in risk profiles of the different countries, the role of the center country can be reinterpreted as one not only of a liquidity provider but also one of a global insurer. After all, the dollar is not merely a very liquid international mean of exchange but is it also the currency denomination of U.S. Treasuries, which are held as reserve assets all over the globe. We discuss how the endogenous structures of portfolios of countries affects net returns on the external asset position and leads to potentially very large wealth transfers in crisis times.

We conclude with a review of intriguing research questions left open by the literature.

## 2 Stylized facts

We begin by highlighting some important stylized facts characterizing recent developments in international capital markets.

### 2.1 Global imbalances, world interest rates and allocation puzzle

Over the last twenty years capital has flown from South to North, and especially towards the United States, arguably among the most advanced economies in the world. The large current account deficits of the United States have started to expand after the Asian Crisis to reach 5.3% of US GDP in 2004, 5.8% in 2005 and about 6% in 2006. Figure 1 illustrates this pattern by reporting the current account balances of various groups of countries, as a fraction of world output between 1980 and 2012. Table 1 reports average ratios of current accounts to world output for three periods: between 1980 and 1996 (before the Asian financial crisis); from 1997 to 2006 (between the Asian and global financial crises); and since 2007.[3] U.S. current account deficits have been financed by a broad array of creditors, mostly Japan in the 1980s and early 1990s, oil producing economies and emerging Asia since 1996, and especially China over the recent period.[4] These massive net capital flows into the world's dominant capital market have been referred to as "global imbalances."

[3]Current account balances in table 1 do not sum to zero because of the discrepancy between global saving and investment. The missing surplus (or deficit in recent years) averages about 0.5% of world output.

[4]See Blanchard and Milesi-Ferretti (2009) for a detailed account of the evolution of global external deficits.

Figure 2 reports the world real interest rate over the same period.[5] We observe a dramatic decline in the world real interest rate, from 5-6% at the beginning of the 1980s, to -2% by the end of 2011. As Bernanke (2005) observed in his early and influential piece on the 'savings glut,' any account for the pattern of global imbalances needs also to be consistent with the evidence on real interest rates.

**Stylized Fact 1 (Global Imbalances)** *The largest and arguably most advanced world economy, the United States, has been a net capital importer since 1982 and has been increasingly financed by fast growing emerging economies. The absolute value of world current account balances scaled by world GDP, the "global imbalances," have been increasing starting in 1996 -with a short dip at the time of the 2001-02 recession and a more sustained one since 2008-. The emergence of these global imbalances coincides with a general decline in world real interest rates.*

Moreover, the pattern of *total* net capital inflows to developing countries stands also in contradiction with the basic theory. Figure 3, reproduced from Gourinchas and Jeanne (forth.), plots average productivity growth between 1980 and 2000 (horizontal axis) against the average net capital inflows relative to GDP. According to the theory, the relationship should be strongly positive. Instead, the figure exhibits a strong negative correlation, which the authors label the 'allocation puzzle.' Gourinchas and Jeanne (forth.), Aguiar and Amador (2011) and Alfaro et al. (2011) find that this negative correlation between growth and capital flows is mostly driven by public flows, while private capital inflows appear positively correlated with productivity fundamentals.

**Stylized Fact 2 (Allocation Puzzle)** *Aggregate net capital inflows tend to be negatively correlated with productivity growth across developing countries. This pattern is largely driven by public sector capital flows.*

## 2.2 The growth of cross-border gross positions

Another key stylized fact in international economics since the 1990s has been the massive increase in *gross* capital flows. As capital controls were taken down, as financial regulation and transaction costs decreased, the gross external asset positions of countries underwent a remarkable surge. At the beginning of the 21st century, some small open economies invested abroad and/or owed to foreigners several times their level of annual output. The example, of Iceland, which in 2007 owned about 524% of its annual GDP in external assets while owing foreigners 636% of its annual GDP

[5]The world real interest rate is defined as the GDP-weighted average of 3-months nominal interest rates minus realized inflation, for the countries of the G-7. The figure also reports two measures of ex-ante long-term US rates.

is particularly striking but not isolated: for instance, in 2010, the gross external assets of the UK were 488% and 507% of annual output respectively.[6]

In pioneering work, Lane and Milesi-Ferretti (2001) and Lane and Milesi-Ferretti (2007a) constructed an annual panel of cross border assets and liabilities for a large number of countries. A simple and widely used measure of *de facto* financial integration is the sum of cross-border financial claims ($A$) and liabilities ($L$), scaled by annual GDP: $(A + L)/Y$.[7] As reported in Lane (2012), this measure of financial integration has risen from 68.4% in 1980 to 438.2% in 2007 for advanced economies.[8] Meanwhile, the same measure for emerging market economies increased from 34.9% in 1980 to 73.3% in 2007. Financial integration has therefore been a general phenomenon. But unlike trade globalization, which was mostly driven by emerging markets, financial integration has been more pronounced so far for advanced economies. Using the latest update of the Lane and Milesi-Ferretti (2007a) dataset with data up to 2010, figure 4 reports the sum of gross external assets and liabilities, scaled by world GDP for the G7 economies as well as for four large and fast growing emerging economies -the so-called BRICs (Brazil, Russia, India, China)-. The magnitude of financial globalization for G-7 economies increased sharply from 75% of world output in 1990s to 210% at its peak in 2007. For the BRIC economies, it increased tenfold, from 2% in 1990 to 20% in 2010.

**Stylized Fact 3 (Increase in cross-border gross flows and positions)** *Cross-border gross asset and liability positions have massively increased since the 1980s and especially in the 1990s and 2000s. This increase has been particularly pronounced for advanced economies.*

Furthermore, the type of cross border positions taken by different economies, i.e. the *composition* of the balance sheets, is very heterogeneous across countries. While it is relatively common to find that "risky" assets (portfolio equity or FDI investments) account on average for a large share of the asset side of the balance sheet of advanced economies (49% for the United States, 50% for Canada, 26% for the UK, 31% for France ), emerging markets' external portfolios have a lower weight on risky assets (India 5%, Indonesia 5%, Russia 18%, China 9% , Brazil 21%), as

[6]Source: Lane and Milesi-Ferretti (2007a) updated until 2010. We report gross external assets and liabilities excluding financial derivatives. Data on financial derivatives are available towards the end of the sample for most countries. For the United States, they are available since 2005. At that date they amounted to $1.2 trillion on the asset side and to $1.1 trillion on the liability side. In 2010 derivatives had grown to represent $3.6 trillion on the asset side (i.e. 18% of gross assets) and $3.5 trillion on the liability side (i.e. 16% of gross liabilities).

[7]There are also *de jure* measures of financial integration based on the institutional framework as described in the IMF Annual Report on Exchange Arrangements and Exchange Restrictions and refined in Quinn (1997), Quinn and Toyoda (2008) or Chinn and Ito (2008). Other *de facto* measures are based on convergence in asset prices, rather than quantities traded. All these measures indicate increased financial integration since 1970, especially so for advanced economies.

[8]These numbers exclude countries with annual GDP smaller than 10 billion dollars.

these economies tend to invest in safer securities such as government bonds.[9] Interestingly, and in particular since the 1990s, the BRICs (Brazil, Russia, India, China) have taken increasingly net short positions in risky assets while the G7 economies, which often double up as important financial centers (the US, the UK, large euro area countries) are increasingly long in risky assets.[10] Figure 5 reports the net risky position of these two groups of countries as fraction of the groups' annual GDP. Starting in the 1990s, the expansion of the external balance sheet of countries has been accompanied by a marked heterogeneity in their structure across countries, with advanced economies increasingly involved in international maturity and liquidity transformation.

**Stylized Fact 4 (Heterogeneity in Gross Flows and Positions)** *The asset composition of the external balance sheet of countries is heterogeneous with advanced economies tending to be long in risky assets and emerging markets short in risky assets.*

### 2.3 The importance of valuations for the external balance sheet

Large and heterogenous leveraged portfolios open the door to potentially important wealth transfers across countries when asset prices and exchange rate fluctuate. In turn, these capital gains and losses are bound to affect the external asset positions of countries. To illustrate, figures 6-7 compare the Lane and Milesi-Ferretti (2007a)'s measure of a country's net external position with a measure obtained simply by cumulating current account balances for a group of advanced economies (figure 6) and a group of emerging ones (figure 7). Since the current account does not -by definition- incorporate fluctuations in the value of existing assets and liabilities, the two measures differ from one another in theory by the cumulated value of capital gains and losses on the country's external position.[11] As figure 6(a) shows for the United States, simply cumulating the balance on the US current account since 1970 would lead to a severe underestimate of the US external position, by about 36% of US GDP in 2010. A contrario, this suggests that the US has enjoyed important

[9] The share of risky assets is calculated as the sum of FDI assets and equity assets as a ratio of total assets. The average is taken between 1970 and 2010 except for Russia (1993-2010) and China (1981-2010).

[10] The net risky position is defined as the difference between portfolio equity and direct investment assets and liabilities. Other components of the external balance sheet also include risky assets: portfolio debt includes long-term corporate and sovereign bonds. Cross border banking positions also involves long-term syndicated loans. However, these asset categories also include shorter term or safer fixed-income assets, such as official reserves, government securities or short-term loans. It is possible that some of the asymmetries we now observe *across* asset categories were present in the past *within* asset categories. For instance, Despres et al. (1966) argue that the United States was providing liquidity to the rest of the world by lending long term and borrowing short term, transactions that would both be recorded in the 'other' categories of the international investment position. The observed asymmetry coupled with the increase in the size of the external balance sheet leaves little doubt that these activities have, if anything, increased over time.

[11] In practice, data discrepancies between the Balance of Payments and the International Position surveys can also account for the gap between the two series. We revisit this issue at length in section 5.

net capital gains on its net external asset positions over this period. These *valuation effects* are economically quite sizable: they represent the equivalent of an additional surplus of the US current account of about 2% of output, for every year between 1970 and 2010. Figures 6(b)-6(d) show smaller cumulated valuation gains for the other advanced economies we consider.[12] Figure 7 shows that the BRIC economies tended to experience significant cumulated valuation losses since 2000, between 10% of output for China and 40% for Russia. Figures 6-7 illustrate the asymmetry between the US (large positive valuation gains) and emerging economies (large valuation losses). By contrast, figures 6(b)-6(d) show that cumulated current accounts provide a roughly accurate guide to the low frequency movements in the net external position of other advanced economies, although the valuation component can be large in any given year. Table 2 documents the average magnitude of absolute valuation effects (as a percentage of GDP), as well as the average of the absolute value of current accounts of a number of countries over four periods.[13] For most countries, including emerging economies, the importance of valuation effects has been increasing over time. For economies very open to cross border investments, such as Ireland, the average valuation change per annum reaches more than 13% of GDP in the most recent period (it reaches 11.8% for Switzerland). The absolute value of current accounts has also increased over these four periods for all the countries considered. Except for Germany, Japan and to a lesser extent China, the average magnitude of the current accounts, though rising over time, tend to be dominated by the average magnitude of valuation effects.

**Stylized Fact 5 (The growing importance of valuation effects)** *Valuation effects, which are capital gains and losses on gross external assets and liabilities, account for an important and increasing part of the dynamics of the net foreign asset positions of countries. For the U.S., valuation effects have tended to be positive and economically large.*

## 3 Long Term Capital Flows in the Neoclassical Growth Model

This section presents the prototype neoclassical model of long term capital flows. We begin with a riskless infinite-horizon model in continuous time, that corresponds to the open economy version of the Ramsey (1928), Cass (1965) and Koopmans (1965) model. We assume that the reader has

[12] The UK external position is underestimated by about 20% of GDP in 2010 while the German and Japanese positions are overestimated by 11% and 1.5% of GDP respectively.

[13] Specifically, we calculate $\bar{VA} = 1/T \sum_t \left| \frac{NA_t - NA_{t-1} - CA_t}{GDP_t} \right|$ and $\bar{CA} = 1/T \sum_t \left| \frac{CA_t}{GDP_t} \right|$ over the four periods 1971-1980; 1981-1990; 1991-2000; 2001-2010 where $NA_t$ denotes the net foreign asset position and $CA_t$ the current account.

enough familiarity with the details of this model and skip many intermediate derivations in the interest of conserving space.[14]

### 3.1 The set-up

Time is continuous and there is no uncertainty, aggregate or otherwise. Consider a country with one homogenous good and a population $N_t$ that grows at a constant rate $n = \dot{N}_t/N_t$. The population can be viewed as a large family that maximizes the integral utility

$$U_t = \int_t^\infty e^{-\rho(s-t)} N_s u\left(c_s\right) ds, \tag{1}$$

where $\rho > 0$ is the rate of time preference, $c_t$ denotes consumption per capita, and $u\left(c\right) = c^{1-\gamma}/\left(1-\gamma\right)$ is an isoelastic instantaneous utility function with an intertemporal elasticity of substitution $1/\gamma$. Since there is no disutility of labor, labor is supplied inelastically and the labor force equals the population, $N_t$. Output is produced with physical capital and labor, according to a Cobb-Douglas production function:

$$Y_t = K_t^\alpha \left(\xi_t N_t\right)^{1-\alpha}, \tag{2}$$

where $0 \leq \alpha \leq 1$ represents the share of capital income and $\xi_t$ is an exogenous labor-augmenting productivity term that grows at a constant rate $g = \dot{\xi}_t/\xi_t$.

Output can be consumed, or invested:

$$Y_t = C_t + I_t, \tag{3}$$

where $C_t = c_t N_t$ denotes aggregate consumption and $I_t$ aggregate gross investment. For simplicity, we assume away capital adjustment costs, so that capital accumulates according to:[15]

$$\dot{K}_t = I_t - \delta_k K_t, \tag{4}$$

where $\delta_k$ is the constant rate of depreciation of physical capital. Given some initial conditions $K_0,\ \xi_0,\ N_0 > 0$, the set-up is complete.

[14] A full detailed treatment can be found in Blanchard and Fischer (1989, chap.2).

[15] Adjustment costs to capital are relatively unimportant for the model's predictions regarding long term capital flows.

### 3.2 Financial autarky

Consider, to begin with, the case where the country is in financial autarky. With a single good, and no possibility of intertemporal trade, this corresponds to the textbook closed economy neoclassical growth model. Following standard steps, it is immediate to show that optimal consumption/saving and investment decisions by the representative household yield a consumption path that satisfies the usual Euler equation:

$$\frac{d\ln c_t}{dt} = \frac{1}{\gamma}\left(\alpha\tilde{k}_t^{\alpha-1} - \delta_k - \rho\right), \tag{5}$$

where 'tilde' denotes variables expressed in efficient units per capita: $\tilde{x} = X/(\xi N)$. Equation (5) states that consumption per capita grows if the *autarky real interest rate* $r_t^a = \alpha\tilde{k}_t^{\alpha-1} - \delta_k$ exceeds the rate of time preference $\rho$. In that case, along the optimal plan, the representative household prefers to reduce consumption in order to benefit from the high return delivered by the additional unit of saving. The strength of that effect on consumption growth is controlled by the willingness of the household to shift consumption across periods, that is, by the elasticity of intertemporal substitution $1/\gamma$.[16]

Different countries with the same technology parameters $\alpha$ and $\delta_k$ will face different autarky interest rates only to the extent that they have different *levels* of capital per efficient unit. That is, if we consider two countries $i$ and $j$ : $r_t^{a,i} > r_t^{a,j}$ if and only if $\tilde{k}_t^i < \tilde{k}_t^j$: autarky rates are high if countries are *capital-scarce*.

#### 3.2.1 Relation to the Lucas Puzzle

This argument forms the basis for the well-known Lucas (1990) puzzle. Lucas observed that if countries had access to the same technology $\alpha$ and $\xi$, then the ratio of their marginal product of capital $MP_k = \alpha\tilde{k}^{\alpha-1}$ can be expressed simply as a function of relative output per worker: $MP_k^i/MP_k^j = \left(y^i/y^j\right)^{1-1/\alpha}$.

Applying this calculation to India and the US, where Lucas estimated a 15-fold difference in output-per-worker and assuming $\alpha = 0.4$, the ratio of marginal products equals a whopping $(1/15)^{1-1/0.4} = 58$! Of course, the assumption that technology $\xi$ is the same in India and the U.S. is a strong one, and a 'trivial' way to solve the Lucas puzzle is to allow for differences in productivity levels.[17] There is no puzzle if differences in productivity entirely offset differences in output

[16] The rate of growth of population $n$ does not affect consumption growth under our choice of preferences. With faster population growth, a unit of output saved today yields fewer units of consumption per capita tomorrow. But because flow utility is scaled by population, future consumption per capita is also valued more and the two effects cancel exactly.

[17] One of Lucas' proposed explanation for the puzzle was to take into account how external effects of human capital

per worker: $\xi^i/\xi^j = y^i/y^j$. Indeed, the literature on development accounting has found significant differences in productivity or social infrastructure across countries. For instance, Gourinchas and Jeanne (2006) using data for 1995, estimate an average 6-fold difference in labor-augmenting productivity for 65 non-OECD economies relative to the U.S.[18] Clearly, cross-country differences in productivity levels are important.

Other factors can also account for the Lucas puzzle. Most prominently, Caselli and Feyrer (2007) find that, despite large differences in capital-output, marginal products of capital $MP_k = \alpha Y/K$ are remarkably close across countries, after properly adjusting the effective share of capital $\alpha$ for differences in the share of reproducible capital and the relative price of investment to output across countries.[19] An alternative approach is to note that countries may face domestic capital market distortions. Suppose that the *private* return to capital is $r = (1-\tau)(MP_k - \delta_k)$ where $\tau$ denotes a wedge between social and private returns. This wedge is a shorthand for all the distortions that potentially affect the return to capital: credit market imperfections, taxation, expropriation, bribery and corruption.... With open capital markets, we would expect private returns to be equated, and differences in capital-output ratio to reflect differences in capital wedges. This approach is followed empirically in Gourinchas and Jeanne (forth.). Calibrating the capital wedge in each country to match the long run investment rate, the measured private rates of returns $r$ are remarkably similar across countries.

To sum up, the evidence indicates that private returns to capital are fairly well equated across countries, either because of differences in productivity, in the share or price of reproducible capital, or because of country-specific wedges between the private and the social return to capital. This is an important observation since it indicates that international financial frictions are likely to be small, and that direct observation of *realized* rates of return provides little if any information about the *autarky* rates that determine the direction of capital flows.

### 3.2.2 Steady state autarky rates

We now focus on the *long run* interest rate that obtains once the economy has settled into its steady state. It is easy to verify that the steady state is characterized by constant levels of capital and

accumulation translate into differences in productivity.

[18] Gourinchas and Jeanne (2006, Table 9 p.736) reports a development accounting gap of 0.11 and a contribution of 0.58 and 0.2 respectively for exogenous labor augmenting productivity and human capital (in log-share). We obtain the number reported in the text as $\exp(-(0.58+0.2)\ln(0.11))$. Hall and Jones (1999) and Caselli (2005) document similar results. Alfaro et al. (2008) also confirm that controlling for institutional quality differences removes the puzzle for direct and portfolio equity investments.

[19] Since the price of investment relative to output is high in poor countries, this tends to depress the marginal return to capital in these countries.

consumption per efficient units, $\tilde{k}_{ss}$ and $\tilde{c}_{ss}$. This implies that consumption per capita grows at the same rate as technology $d\ln c_t/dt = g$. Substituting into the Euler equation, we obtain:

$$\tilde{k}_{ss} = \left(\frac{\alpha}{\rho + \gamma g + \delta_k}\right)^{1/(1-\alpha)} \quad ; \quad r^a_{ss} = \rho + \gamma g \tag{6}$$

This expression tells us that, once initial capital scarcities are eliminated (the gap between $\tilde{k}$ and $\tilde{k}_{ss}$), differences in autarky interest rates across countries with similar preferences are driven by differences in productivity growth: $r^{a,i}_{ss} > r^{a,j}_{ss}$ if and only if $g^i > g^j$.

### 3.3 Open economy and the direction of capital flows

#### 3.3.1 Small open economy

Consider now the case of a small open economy that opens its financial account at time $t = 0$ and faces a constant world real interest rate $r$ at which it can borrow or lend. Optimal investment requires that the marginal return to capital equals the world interest rate:

$$\alpha \tilde{k}_t^{\alpha-1} - \delta_k = r. \tag{7}$$

This pins down the stock of capital per efficient units at $\tilde{k}(r) = (\alpha/(r+\delta_k))^{1/(1-\alpha)}$, a decreasing function of the world interest rate. Denote the financial wealth of the country by $W = K + B$ where $B$ represents net foreign claims. Along the optimal plan, consumption and wealth evolve according to:

$$\frac{d\ln c_t}{dt} = \frac{1}{\gamma}(r - \rho) \quad ; \quad \frac{d\tilde{w}_t}{dt} = (r - n - g)\tilde{w}_t + (1-\alpha)\tilde{y}(r) - \tilde{c}_t \tag{8}$$

where $\tilde{y}(r) = \tilde{k}(r)^{\alpha}$ represents the constant level of output and $(1-\alpha)\tilde{y}(r)$ represents the part of output that is not paid out as capital income. According to (8), the growth rate of consumption per capita is constant and equal to:

$$g_c = \frac{1}{\gamma}(r - \rho - \gamma g) + g = \frac{1}{\gamma}(r - r^a_{ss}) + g \tag{9}$$

Consumption per capita grows faster (resp. slower) than the rate of domestic productivity growth if the world interest rate is higher (resp. lower) than the autarky interest rate.

To fix ideas further, we can think of the rest of the world as a closed economy that has reached its steady state. In that case, the world interest rate $r$ satisfies $r = \rho + \gamma\bar{g}$, where $\bar{g}$ is the growth

rate of world productivity. Substituting into equation (9), we obtain: $g_c = \bar{g}$: the rate of growth of consumption per capita equals the world's growth rate of productivity, regardless of domestic output growth per capita $g$.

Under the assumption that $r > n + \max\langle g, \bar{g}\rangle$ and after a few tedious but elementary steps of algebra, we can substitute back into the dynamic budget constraint (8) and integrate to obtain:

$$\tilde{c}_t = (r - n - \bar{g}) \left[ \tilde{w}_t + \frac{(1-\alpha)\,\tilde{y}\,(r)}{r - n - g} \right]. \tag{10}$$

The consumption rule is linear in total wealth with a propensity to consume equal to the interest rate minus the growth rate of aggregate consumption $n+\bar{g}$. Total wealth consists of financial wealth $\tilde{w}_t$ and the present value of labor income $(1-\alpha)\,\tilde{y}\,(r)\,/\,(r-n-g)$. After a few extra steps, one can also solve for the path of external wealth and the current account (noting that $CA_t = \dot{B}_t$):[20]

$$\tilde{b}_t = \left( \tilde{w}_0 + \frac{(1-\alpha)\,\tilde{y}\,(r)}{r-n-g} \right) e^{(r - r^a_{ss})t/\gamma} - \frac{(1-\alpha)\,\tilde{y}\,(r)}{r-n-g} - \tilde{k}\,(r)\,. \tag{11a}$$

$$c\tilde{a}_t = (n+\bar{g}) \left( \tilde{w}_0 + \frac{(1-\alpha)\,\tilde{y}\,(r)}{r-n-g} \right) e^{(r - r^a_{ss})t/\gamma} - (n+g) \left( \frac{(1-\alpha)\,\tilde{y}\,(r)}{r-n-g} + \tilde{k}\,(r) \right) \tag{11b}$$

Inspection of these expressions reveals that the long term external position depends on the gap between the world and autarky interest rates $r - r^a_{ss}$, proportional to the gap between world and country productivity growth, $\bar{g} - g$. We can distinguish three cases:

- case 1: $r^a_{ss} < r$. From the preceding discussion, this occurs when $g < \bar{g}$. The first term in the expression for $c\tilde{a}_t$ and $\tilde{b}_t$ asymptotically dominates the dynamics. Eventually the country runs a *current account surplus* and holds a positive net foreign position. Because optimal consumption grows at a higher rate than output, the country needs to accumulate growing claims against the rest of the world.[21]

- case 2: $r^a_{ss} = r$. In that case $g = \bar{g}$ and the current account and net foreign asset positions are driven by initial capital scarcity and external claims: $c\tilde{a}_t = (g+n)\left(\tilde{w}_0 - \tilde{k}_{ss}\right)$ and $\tilde{b}_t = \tilde{w}_0 - \tilde{k}_{ss}$. The country runs a permanent current account deficit if it is initially capital scarce or has initial external liabilities. If initial capital scarcities and external claims are small, so that $\tilde{w}_0 \approx \tilde{k}_{ss}$, then $c\tilde{a} = \tilde{b} = 0$.

[20] In this expression, $\tilde{w}_0 = \tilde{k}_{0-} + \tilde{b}_{0-} = \tilde{b}_0 + \tilde{k}(r)$, where $\tilde{k}_{0-}$ and $\tilde{b}_{0-}$ denote the stock of capital and the net external position immediately before the financial account opening at time $t = 0$. At the time of the opening, initial external debt positions are rolled over and the country finances any capital shortfall through external borrowing: $\tilde{b}_0 = \tilde{b}_{0-} + \tilde{k}_{0-} - \tilde{k}\,(r)$ .

[21] Expressed in *world* efficient units, $B$ stabilizes at $B/\tilde{\xi}N = \tilde{w}_0 + (1-\alpha)\,\tilde{y}\,(r)\,/\,(r-n-g) \geq 0$.

- case 3: $r < r^a_{ss}$. From the preceding discussion, this corresponds to $\bar{g} < g$. The first term in (11a) and (11b) disappear asymptotically and the economy becomes a *net borrower* and runs a *current account deficit*. Since the country's output grows faster than the rest of the world, foreigners want to invest domestically.[22]

The preceding analysis reveals that countries export (resp. import) capital when the autarky interest rate is below (resp. above) the world interest rate. The determinants of *intertemporal* trade are thus similar to those of *intratemporal* trade and dictated by the principles of comparative advantage: just as countries export goods that are relatively abundant (i.e. with low autarky prices), countries export capital when capital is relatively abundant, i.e. when autarky real interest rates are relatively low.[23]

### 3.3.2 Large open economy

Consider now the case of two economies (home and foreign), not necessarily small, with open financial accounts. One can characterize the pattern of capital flows and net foreign positions by following the same steps as above, now with the condition that $B_t + B^*_t = 0$ at any instant where $*$ denotes foreign variables. Assuming that the technology parameters $\delta_k$ and $\alpha$ are the same in both countries, free capital mobility ensures that $\tilde{k}_t = \tilde{k}^*_t$, so that the world interest rate satisfies $r_t = \alpha \tilde{k}_t^{\alpha-1} - \delta_k$. Faced with a common real return to capital, optimal consumption plans in both countries satisfy:

$$\gamma \frac{d \ln c_t}{dt} + \rho = \gamma^* \frac{d \ln c^*_t}{dt} + \rho^* = r_t, \tag{12}$$

so that with common preferences ($\gamma$ and $\rho$) the rate of growth of consumption per capita $g_c$ is the same in both countries and $r = \rho + \gamma g_c$.

Without lack of generality, assume that home has a higher growth rate of productivity than foreign: $g > g^*$. Equation (6) then implies that home has a higher autarky interest rate: $r^a_{ss} > r^{a*}_{ss}$. Assume further that there are no initial capital scarcities, so that we focus on differences in productivity growth. It is easy (but tedious) to show that the world interest rate $r$ is located somewhere between home and foreign interest rates: $r^{a*}_{ss} \leq r \leq r^a_{ss}$. Since $r = \rho + \gamma g_c$, one can equivalently show that the growth rate of consumption per capita is located between the domestic and foreign productivity growth rates $g^* \leq g_c \leq g$. Countries with an autarky interest rates above

[22] In that case, the country will not permanently remain small relative to the rest of the world. Eventually, the world interest rate will have to converge to the domestic autarky rate $r^a_{ss}$. The country will still run a current account deficit $c\tilde{a}_{ss} = (n+g)\,\tilde{b}_{ss}$ since it will have accumulated large net foreign liabilities $\tilde{b}_{ss} < 0$ along the way to the steady state.

[23] Obstfeld and Rogoff (1996, chap. 2) present a similar analysis in a two-period model.

the equilibrium world interest rate will experience capital inflows; those with autarky interest rates below the world interest rate will experience capital outflows.[24]

### 3.4 Current account movements and productivity differentials

For the preceding theory to account for the empirical evidence on capital flows from emerging economies to advanced ones, two conditions need to be met. First, initial capital scarcities must not be too large for the developing world: $\tilde{k}_0 \approx \tilde{k}_{ss}$. This will be the case if productivity levels are lower or if capital market distortions ($\tau$) are higher in poorer countries. Second, productivity growth must be higher in advanced economies than in developing ones.

This interpretation of the theory would be relatively bad news for developing countries: the direction of capital flows would simply reflect a broader pattern of economic *divergence* that would see advanced economies pulling further and further away from developing ones.[25] Fortunately, it does not survive careful empirical scrutiny. Instead, the empirical evidence indicates that it is precisely the (developing) countries with the strongest productivity growth that also experienced the strongest capital *outflows* (stylized fact 2).

Large net capital inflows in the eurozone's periphery (Blanchard and Giavazzi (2002)) or in Eastern European economies (Alfaro et al. (2011)) in the early 2000s were held as strong examples of the validity of the neo-classical theory. However, given the ongoing eurozone crisis, the deep structural adjustment in many Eastern European economies, and the fact that many of these capital inflows appear to have fueled ultimately unsustainable residential housing and financial booms, the argument that net capital flows in both regions were triggered by strong productivity growth as predicted by the neoclassical growth model is not so clear cut anymore.

If differences in productivity growth are not the main driver of capital flows over long periods of time, what is? The next section of this chapter reviews recent theoretical advances that help us understand the pattern of 'global imbalances' (stylized facts 1 and 2).

## 4 Models of Global Imbalances

The previous section established two results. First, capital flows to countries with high autarky returns to capital, until returns are equalized. Second, productivity growth is one of the main

[24] A source of global imbalances in that model arises from differences in impatience $\rho$. More patient countries will have lower autarky rates, and run current account surpluses. See Ghironi et al. (2008) for a model along these lines.

[25] Although, under financial integration and common preferences, the rate of growth of consumption per capita would remain equal in advanced and developing economies. See equation (12).

determinants of autarky returns in the neoclassical growth model. Existing attempts to explain the pattern of observed external imbalances maintain the first element but relax the second. They all share the feature that some other ingredient depresses autarky interest rates in emerging economies relative to advanced ones. Equivalently, these countries feature a high *desired* saving (or low *desired* investment) relative to the U.S. As first analyzed by Bernanke (2005), this can account simultaneously for the external deficits of the U.S. and the observed low world real interest rates (stylized fact 1). Bernanke identified a number of potential culprits for the increase in global desired savings: the increased savings and reserve accumulation in emerging economies following the East Asian financial crisis of 1997-1998; the rapidly aging population in many advanced economies (and some emerging ones), requiring additional saving to provide for an increasingly large retired population; and the sharp increases in oil prices and the corresponding swing toward current account surpluses of oil exporting economies (see figure 1). Contemporaneously, Dooley et al. (2004a) and Dooley et al. (2004b) emphasized the role of export-led growth development strategies in developing Asia, with an undervalued currency and the accumulation of official claims on the center country.

We begin with a review of theories relying on asymmetries in financial development between countries at different stages of development. The form that these financial frictions takes does matter. For instance, consider the capital wedge $\tau$ introduced in section 3.2.1. In the steady state of the neoclassical model, this capital wedge does not affect the private rate of return to capital, still equal to $\rho+\gamma g$: the effect of the financial friction $\tau$ falls entirely on the marginal product of capital: $MP_k = (\rho+\gamma g)/(1-\tau)+\delta_k$. Instead, we emphasize below financial frictions that also influence the autarky interest rate. In the model we consider, these financial frictions simultaneously drive up the equilibrium marginal product of capital and drive down the autarky risk free rate. The first such model argues that developing countries suffer from a shortage of 'stores of value.' This shortage tends to drive up the price of financial assets, that is, to drive down the equilibrium interest rate. We use that framework to also explore the role of demographic factors, in particular population aging, and the interaction between demographic forces and financial frictions. The second model borrows from Bewley (1987) and Aiyagari (1994) and emphasizes the general equilibrium effects of precautionary saving. In that model, agents try to self insure against idiosyncratic risk. In equilibrium this depresses autarky interest rates below the riskless rates of the neoclassical model. The stronger the precautionary saving motive, the lower the autarky interest rate. Differences in idiosyncratic risk then translate into differences in autarky interest rates. The third class of models focuses on the interaction between financial frictions and international trade. Lastly, we discuss the role of public vs. private capital flows and reserve accumulation.

### 4.1 Asset Shortages

We begin with a model of asset shortage. The model captures the notion that financial markets in many emerging economies are not sufficiently developed and that these countries suffer from a shortage in stores of value. It generalizes Caballero et al. (2008a) to a production economy with overlapping generations. In the model, the demand for stores of value arises from the asynchronicity between income and consumption decisions.[26] That idea is implemented in a perpetual youth model à la Blanchard (1985) and Weil (1987). The model exhibits an essential *non-Ricardian* feature: households currently alive are unable to trade in claims on the resources of yet unborn generations. The lower the share of total income that accrues to the financial assets, the more acute is the resulting *shortage of stores of value*. Under financial autarky, this depresses equilibrium real interest rates. The model provides a link between levels of financial development, measured by the capacity of a country's financial system to capitalize streams of future income into real assets, and global imbalances.

#### 4.1.1 The individual problem and aggregate dynamics

At every instant, households face an i.i.d instantaneous probability of dying $\theta$. Since $\theta$ is common to all households, it represents the fraction of the population that dies every instant. A fraction $\theta$ of the population is also born every instant, so that total population remains constant, normalized to 1.[27] Since mortality risk is idiosyncratic, it is perfectly insurable: a competitive market for life-insurance will offer a rate of return $\theta$ per unit of wealth, in exchange for a claim on the household's estate when it dies.[28] Denote by $c(s,t)$, $w(s,t)$, $z(s,t)$ the consumption, financial assets and nonfinancial income at time $t$ of an individual born at time $s \leq t$. As of time $t$, the household maximizes

$$U_t = E_t \left[ \int_t^\infty e^{-\rho(u-t)} u\left(c\left(s,u\right)\right) du \right] = \int_t^\infty e^{-(\rho+\theta)(u-t)} u\left(c\left(s,u\right)\right) du, \tag{13}$$

where the expectation is taken over the -random- time of death. The second equality uses the fact that life expectancy is exponentially distributed. Mortality risk makes households more

[26] The focus on consumption-saving decisions is done mostly for modeling simplicity. One could equivalently focus on the asynchronicity between sales and investment decisions in a production economy, or on a precautionary motive due to liquidity shocks.

[27] It is straightforward to introduce population growth. One could simply assume that the fraction of the population that is born every instant is $n + \theta$. Alternatively, one could follow Weil (1987) and assume that each cohort is an infinitely lived dynasty, but new cohorts are born every period.

[28] The life insurance company breaks even under this scheme. If assets under management are $W_t$, it pays out $\theta W_t$ per unit of time, and receives $\theta W_t$ from households that just died.

impatient: they discount future flow utility at rate $\rho + \theta$ instead of $\rho$.

The budget constraint is

$$\frac{dw(s,t)}{dt} = (r_t + \theta) w(s,t) - c(s,t) + z(s,t), \tag{14}$$

where $r_t$ is the risk-free interest rate, and we used the fact that the life-insurance company pays a premium $\theta w(s,t)$. Following standard steps, the optimal consumption plan of a household with iso-elastic utility $u(c) = c^{1-\gamma}/(1-\gamma)$ satisfies the following Euler condition:

$$\gamma \frac{d \ln c(s,t)}{dt} = r_t - \rho. \tag{15}$$

This is the same Euler equation as in the infinite horizon model (see equation (5)). The intuition is simple: mortality risk makes the household more impatient. But she also receives a premium $\theta w$ that exactly offsets this effect. From now on, we limit the analysis to the case $\gamma = 1$ (logarithmic preferences).[29] Following standard (and tedious) steps, the consumption function takes a simple form:

$$c(s,t) = (\rho + \theta)[w(s,t) + h(s,t)]. \tag{16}$$

It is linear in the household's total wealth, defined as the sum of financial holdings $w(s,t)$ and nonfinancial wealth $h(s,t) = \int_t^\infty z(s,u) \exp\left(-\int_t^u (r_v + \theta)\, dv\right) du$ equal to the expected present discounted value of future nonfinancial income over the household's expected lifespan.

We can now derive aggregate variables by summing across existing cohorts. With obvious notation, the aggregate value $X_t$ of a variable $x(s,t)$ is defined as:

$$X_t = \int_{-\infty}^{t} x(s,t)\, \theta e^{-\theta(t-s)} ds \tag{17}$$

since the size of a cohort born at time $s$ as of time $t \geq s$ is $\theta e^{-\theta(t-s)}$. With linear budget constraints (14) and consumption rules (16), aggregate consumption and wealth follow:

$$C_t = (\rho + \theta)[W_t + H_t], \quad \dot{W}_t = r_t W_t + Z_t - C_t. \tag{18}$$

In this expression $H_t$ represents the present discounted value of nonfinancial income of all *currently alive* cohorts, but does not include the present discounted value of nonfinancial income

[29] With logarithmic preferences, income and substitution cancel out and the marginal propensity to consume does not depend upon the interest rate. The model can be solved in the general iso-elastic case, but the increased complexity does not deliver deep additional insights.

accruing to yet unborn cohorts. This *non-Ricardian* feature is essential for the results.[30]

To fix ideas, assume, as in Blanchard (1985) that cross-section income profiles decrease with age:

$$z(s,t) = \frac{\phi+\theta}{\theta} Z_t e^{-\phi(t-s)}, \quad \phi \geq 0 \tag{19}$$

Equation (19) states that, at any given time $t$, older workers (lower $s$) receive lower income with a slope controlled by $\phi$. In the limit of $\phi \to \infty$, all nonfinancial income is received by the newborn generation: $z(t,t) = Z_t$, $z(s,t) = 0$ for $s < t$, and $H_t = 0$. This case maximizes the asynchronicity between income and consumption decisions since all income is received at birth, but consumption decisions need to be sequenced over a -random- lifetime. Conversely, when $\phi = 0$, all households receive the same income, regardless of age, which mitigates the need for saving. Under assumption (19) , $H_t$ satisfies:

$$\dot{H}_t = (r_t + \theta + \phi) H_t - Z_t \tag{20}$$

#### 4.1.2 Financial Autarky

We close the model by specifying the market structure and technology available to the household. As in the previous section, suppose that output is produced with the aggregate production function $Y_t = K_t^{\alpha} (\xi_t N_t)^{1-\alpha}$ , where $\dot{\xi}_t/\xi_t = g$. Under financial autarky, physical capital $K$ is the only asset available, so $W_t = K_t$. We make two simplifying assumptions. First, we assume that there is no depreciation of capital: $\delta_k = 0$.[31] Second, we assume that the share of aggregate non-financial income in total income is constant: $Z_t = (1-\delta) Y_t$. $\delta$ is a key parameter. It controls the *supply of stores of value*. To see this, observe that the payments to capital $rK$ equal $\delta Y$ since there is no depreciation. It follows trivially that the value of the capital output ratio is:

$$K/Y = \delta/r. \tag{21}$$

For a given interest rate $r$, the market value of the capital stock (the supply of stores of value under financial autarky) varies one-to-one with $\delta$.[32] Under these two assumptions, it is simple but tedious to combine (18) and the equilibrium condition $W_t = K_t$ to show that the steady state

[30] If we define $\bar{H}_t = \int_t^{\infty} Z_u \exp\left(-\int_t^u r_v dv\right) du$ as the nonfinancial wealth of current and future generations, where $Z_t$ denotes aggregate nonfinancial income. It is easy to check that $H_t \leq \bar{H}_t$ with equality when $\theta = 0$.

[31] This assumption is innocuous but simplifies the algebra.

[32] One can also verify that $\delta$ maps directly into the capital wedge $\tau$ introduced in the previous: $\delta = \alpha(1-\tau)$.

autarky interest rate satisfies:

$$\left[r_{ss}^{a}-\delta\left(g+\rho+\theta\right)\right]\left(r_{ss}^{a}+\theta+\phi-g\right)=\left(1-\delta\right)r_{ss}^{a}\left(\rho+\theta\right). \tag{22}$$

A few cases are worth exploring:

- when $\phi=\theta=0$, the model collapses to the neoclassical benchmark of the previous section and $r_{ss}^{a}=g+\rho$ (recall that $\gamma=1$ with logarithmic preferences).[33]
- in the polar case where $\phi\to\infty$, we obtain instead:

$$r_{ss}^{a}=\delta\left(g+\rho+\theta\right). \tag{23}$$

  Compared to the neoclassical model, two parameters influence the autarky rate. First, the interest rate increases because the mortality risk $\theta$ makes agents more impatient, which reduces saving. Second, the interest rate decreases because only a share $\delta\leq 1$ of income is paid out as financial income. This second effect is due to the *scarcity of stores of value* in the non-Ricardian economy. When $\delta<\left(g+\rho\right)/\left(g+\rho+\theta\right)$, the second effect dominates and the interest rate falls below the autarky rate of the benchmark model. Economies with distorted domestic capital markets (low $\delta$ or high $\tau$) are more likely to have lower autarky interest rate.

- In the general case where $\phi,\theta>0$, one can check that the autarky interest rate lies in the interval $[\rho+g-\phi,\rho+g+\theta]$. The shortage of assets dominates if $\delta(\theta+\rho+g+\theta(\rho+\theta)/\phi)\leq\rho+g$. In that case the autarky interest rate decreases below the neoclassical benchmark: $r_{ss}^{a}<\rho+g$.

The main implication of the model is that low levels of financial development, associated with sufficiently low $\delta$, can depress autarky interest rates. It is then possible for a country to have a low autarky rate, despite a high growth rate of productivity $g$. When $\phi\to\infty$, the marginal product of capital remains constant and equal to: $MP_k=\alpha Y/K=\alpha\left(g+\rho+\theta\right)$, regardless of $\delta$. In that case, we obtain the opposite result from the neoclassical benchmark model: variations in $\tau$ (or $\delta$) are fully reflected in $r_{ss}^{a}$, and not in the marginal product of capital or the capital-output ratio. For the general case where $\phi,\theta>0$, one can show that the marginal product of capital increases with $\tau=1-\delta/\alpha$, while the autarky interest rate decreases. Hence the model provides simultaneously a rationale for high marginal product of capital and low autarky rates in countries with low levels of financial development.

[33] There is another solution with $r_{ss}^{a}=\delta g$. However, that solution is not valid since it implies a negative value of human wealth.

### 4.1.3 Open Economy and the direction of capital flows

**Small open economy.** Following the steps described in the previous section, consider now the case of a small open economy facing a constant real interest rate $r$. For simplicity, we limit ourselves to the case where $\phi \to \infty$. With a constant interest rate $r$, it is easy to check that the following equations hold:[34]

$$\frac{W_t}{Y_t} = \frac{1-\delta}{g+\rho+\theta-r}; \quad \frac{K_t}{Y_t} = \frac{\delta}{r}. \tag{24}$$

The first equation expresses domestic wealth, i.e. the domestic *demand for stores of value* per unit of output, $W/Y$, as a function of the world interest rate. A higher interest rate increases the demand for stores of value since wealth accumulates at a higher rate. The second equation expresses the *domestic supply of stores of value* (here capital) as a function of the interest rate. A higher interest rate depresses the present discounted value of the payments to capital $\delta Y$, which lowers the equilibrium capital-output ratio. The difference between $W$ and $K$ represents the net foreign asset position of the country, $B$. With some simple manipulations, it is easy to express the net foreign asset position and the current account as a function of the autarky and world interest rates, as in the preceding section:[35]

$$\frac{B_t}{Y_t} = \frac{W_t - K_t}{Y_t} = \frac{\delta\left(r - r^a_{ss}\right)}{r\left(r^a_{ss} - \delta r\right)}; \quad \frac{CA_t}{Y_t} = g\frac{\delta\left(r - r^a_{ss}\right)}{r\left(r^a_{ss} - \delta r\right)} \tag{25}$$

This expression makes clear that the net foreign asset position is positive (resp. negative) depending on whether the world interest rate is higher (resp. lower) than the autarky interest rate. From the previous discussion, we infer that it is now possible for capital to flow out of emerging countries, provided that they have a sufficiently low autarky interest rate, i.e. a sufficiently low supply of stores of value.

**Asymptotic Metzler diagram.** The previous results can be summarized in a version of the celebrated Metzler (1960) diagram. The vertical axis in figure 8 reports the real interest rate while the horizontal axis reports either the long run domestic financial wealth $W$ or the value of domestic assets $K$, scaled by output $Y$. By construction, the difference between domestic financial wealth and the value of domestic assets equals the country's long run net foreign asset position: $B = W - K$. From the previous discussion, the value of domestic assets decreases with the real interest rate, while the value of domestic wealth increases with the real interest rate. Financial

[34] We assume in what follows that $r < g + \rho + \theta$ so that domestic wealth is well-defined.
[35] The current account satisfies $N\dot{A}_t = CA_t$.

autarky corresponds to the situation where $W = K$. This pins down the autarky real interest rate $r^a_{ss}$. When $r > r^a_{ss}$, the small open economy runs an asymptotic current account surplus and is a net foreign creditor. Conversely, when $r < r^a_{ss}$ the country runs an asymptotic current account deficit and is a net foreign borrower.

**World economy.** Consider now a world economy composed of two countries, $a$ and $b$. The two countries are identical, except in terms of their level of financial development, captured by $\delta$. Assume that $\delta^a > \delta^b$. It follows that country $a$ will have a higher autarky interest rate than country $b$. Each country satisfies equations (18) and (21). Combining these equations, and denoting $\omega^a = Y^a/(Y^a + Y^b)$ the share of country $a$ in global output, the steady state world interest rate $r^a_{ss}$ is a weighted average of the autarky interest rate in both countries:

$$r^a_{ss} = \omega^a r^{a,a}_{ss} + (1 - \omega^a)\, r^{a,b}_{ss} = \bar{\delta}\,(g + \rho + \theta)\,. \tag{26}$$

$r^a_{ss}$ depends on the output-weighted level of financial development $\bar{\delta} := \omega^a \delta^a + (1 - \omega^a)\,\delta^b$. Since $r^{a,b}_{ss} < r^a_{ss} < r^{a,a}_{ss}$, following a financial liberalization, capital will flow from $b$ to $a$, and $a$ will run an asymptotic negative net foreign asset position given by:

$$\frac{B^a}{Y^a} \to \frac{(1 - \omega^a)}{r^a_{ss}\left(1 - \bar{\delta}\right)}\left[\delta^b - \delta^a\right] < 0; \quad \frac{CA^a}{Y^a} \to \frac{g\,(1 - \omega^a)}{r^a_{ss}\left(1 - \bar{\delta}\right)}\left[\delta^b - \delta^a\right] < 0. \tag{27}$$

According to the model, a simultaneous decline in world interest rates and the emergence of global imbalances (stylized fact 1) can be the result of the integration of countries with low financial development –low $\delta$– into the world economy (e.g. China after 1980), or the decline in the *market perception* of financial development in some countries (e.g. emerging Asia after the Asian financial crisis of 1997).

**Assessing the model.** We can think of a variety of reasons why countries may be unable to pledge a high share of future output. Government, managers or insiders can dilute and divert a substantial share of profits. $\delta$ can thus capture a number of capital market frictions, from explicit taxation, lack of enforcement of property rights, corruption or rent-seeking etc... Many of these features tend to be associated with developing economies, as measured by indicators of social infrastructure. A small set of papers in the empirical literature have explored the reduced-form link between indicators of financial development and global imbalances, following the popular panel-regression approach of Chinn and Prasad (2003), with somewhat mixed results (Chinn and

Ito (2007), Gruber and Kamin (2009)). For instance, Gruber and Kamin (2009) finds that quantity measures of financial development, such as the ratio of credit to GDP, do not systematically predict larger current account deficits. One issue is whether quantity measures such as credit to GDP accurately capture the level of a country's financial development when some countries' financial systems are bank-based, while others' are market based. Gruber and Kamin (2009) also finds that real long-term interest rates are similar in the US and other industrial countries. But the model predicts that under integration the risk-free rates should be equalized, so differences in observed long term interest rates should simply reflect risk characteristics, and not differences in autarky interest rates. A deeper question is why excess savings from emerging markets should flow disproportionately towards the United States, and not other industrial countries. One answer is that external balances worsened in other industrial economies too, such as the United Kingdom and Australia, or many peripheral eurozone economies such as Spain, Ireland, or Portugal. But this was offset by growing current account surpluses in Germany and Japan. Another possible answer is that even if the U.S. offers similar levels of financial development (high $\delta$) as other industrialized economies as a whole, it experiences more robust growth (high $g$) and therefore should have higher autarky interest rates.[36] Another part of the answer, to which we return later in this chapter, is that the US dollar remains the leading international reserve currency.

### 4.1.4 Productivity and financial frictions

In the model of the previous section, external imbalances arising from differences in levels of financial development, as measured by $\delta$, are amplified by differences in productivity growth. To see why, consider the two-country model from the previous section, but now suppose country $b$ grows faster: $g^b > g^a$. The world interest rate is still the output weighted average of the two autarky rates: $r^a_{ss,t} = \omega^a_t r^{a,a}_{ss} + (1 - \omega^a_t) r^{a,b}_{ss}$. The difference is that $\omega^a_t$ tends to zero so the world interest rate converges to $r^{a,b}_{ss}$. As long as $g^b$ is not too high, so that $r^{a,b}_{ss} < r^{a,a}_{ss}$, this leads to *larger* capital flows from $b$ to $a$, unlike the neoclassical growth model where $g^b > g^a$ leads to capital flows from $a$ to $b$. A similar mechanism is at work in Buera and Shin (2009). That paper models an emerging economy that experiences a growth acceleration. In the model individuals choose between supplying labor (worker) or becoming entrepreneurs. In an efficient allocation, low productivity individuals choose to become workers and high productivity ones become entrepreneurs. The economy, however, suffers from two frictions: idiosyncratic wedges that distort the allocation of factors away from

[36] Engel and Rogers (2006) argue along those lines that the US current account deficit can be explained by the country's higher growth relative to other industrial countries.

efficiency, and financial frictions. Both frictions lower total factor productivity (TFP). The paper then considers the effect of a program of structural reforms that increases TFP, while keeping the financial friction unchanged. This is similar to an increase in $g$ while keeping $\delta$ low in our model. Initially, this reform lowers investment and increases savings. Investment decreases due to the exit of low-productivity firms, while high productivity ones are constrained by the financial friction. The response of aggregate saving is more complex. Workers face an upward wage profile due to the rise in TFP. This tends to decrease savings. On the other hand, incumbent entrepreneurs experience temporarily high profits, since wages are initially low. In addition, individuals with high productivity but little wealth will choose a high saving rate to overcome the financial frictions. The net effect is an increase in saving, and net capital outflows. Song et al. (2011) present a similar model tailored specifically to the experience of China after the economic reforms of 1978. At the beginning of the reform process, the economy features high productivity private firms with limited access to credit markets, and inefficient state owned firms with better access to credit. The paper shows that the financial frictions slow down the reallocation of factors towards efficient private firms, while sustaining high returns to capital during the transition. It can also lead high productivity firms to specialize initially in labor intensive activities, where the financial frictions are less relevant. In these papers, it is the *interaction* between financial friction and productivity growth that triggers external surpluses in emerging economies.

### 4.2 Demographics and global imbalances

As noted by Bernanke (2005), demographic characteristics can also explain global imbalances. In general, demographics can have complex effects on net savings. A faster rate of population growth increases investment as a larger workforce increases the marginal return to capital, increasing autarky rates. Faster population growth also increases the fraction of young (savers) relative to old (dissavers), increasing aggregate saving and reducing the autarky rate.[37] In general, the impact of demographic factors on the autarky rate and capital flows depends on the age-structure of the working age population and the age-profile of income. Aging countries should save more to provide sufficient resources in retirement for the increasing number of retirees per worker. Lane and Milesi-Ferretti (2001) find strong empirical support for this claim when studying the determinants of net foreign asset position, with a negative impact of the share younger age cohorts and a positive effect of the share of workers near retirement. Domeij and Flodén (2006), in a calibrated overlapping generation model, find that demographic variables account for a small but significant fraction of

[37] See Obstfeld and Rogoff (1996).

capital flows for OECD countries between 1960 and 2002. Ferrero (2010) explores the effect of population aging in a two-country extension of Gertler (1999)'s model of 'perpetual youth and perpetual retirement,' calibrated to the US and the G-6. The model allows for differences in fiscal policy, as well as productivity growth and finds that the more pronounced aging of the population in the G-6 (relative to the U.S.) accounts for a significant share of the deterioration in the US trade balance and the decline in global real interest rates. We illustrate the basic mechanism with a simple extension of our model. Households evolve through two distinct stages of life: work and retirement. While working, households earn labor income. With some instantaneous probability $\lambda$, i.i.d. across workers, they retire. Once in retirement, they do not earn income any longer and die with instantaneous probability $\theta$, as before. We maintain total population constant, so that the dependency ratio –the ratio of retirees to workers – is equal to $\lambda/\theta$. A decline in mortality rate (a decline in $\theta$) will increase the dependency ratio for a given length of the working life (equal to $1/\lambda$). To simplify further the analysis, suppose that households only consume when they are about to die. Aggregate consumption must then equal $\theta W_t^r$ where $W_t^r$ denotes the aggregate financial wealth of retirees. Since aggregate output is given by $Y_t$, this pins down the aggregate wealth of retirees: $W_t^r = Y_t/\theta$. Consider now the wealth accumulation dynamics of retirees and workers respectively:

$$\dot{W}_t^r = r_t W_t^r - \theta W_t^r + \lambda W_t^w, \tag{28a}$$

$$\dot{W}_t^w = r_t W_t^w + (1-\delta)\, Y_t - \lambda W_t^w. \tag{28b}$$

Equation (28a) states that the retirees' wealth increases with the interest rate $r_t$, decreases with consumption, and increases with the arrival of newly retired workers. Equation (28b) states that the aggregate wealth of workers $W_t^w$ increases with savings (equal to nonfinancial income) and decreases when workers retire. In steady state, the aggregate wealth of both groups must increase at rate $g$. Substituting the expression for $W^r$ and $W^w$, it follows that the autarky interest rate satisfies:

$$(1-\delta)\,\lambda\theta = (g + \theta - r_{ss}^a)\,(g + \lambda - r_{ss}^a) \tag{29}$$

It is easy to verify that $r_{ss}^a < g + \delta\lambda < g + \lambda$ and that $\partial r_{ss}^a/\partial\theta > 0$: population aging lowers the autarky interest rate. This result allows us to understand why economies with rapidly aging populations, such as Germany, Japan or China, run sizable external surpluses.[38]

[38] According to United Nations projections, the dependency ratio, defined as the ratio of population aged 65 or over to population aged 20-64 is 21.8% in the U.S. in 2010. For Germany, Japan and China, the corresponding numbers are 33.4%, 38.3% and 12.7%. By 2050, the dependency ratio will have increased to 39.5% for the U.S., and 62%, 76.4% and 45.4% for Germany, Japan and China respectively.

In a recent paper, Coeurdacier et al. (2012) explore further the interaction of demographic characteristic and financial frictions for an emerging economy such as China. In their three-period overlapping generation models, young workers in emerging economies (the South) face tighter credit constraints, preventing them from borrowing against their middle-age income. As a result, autarky interest rates are lower and following financial integration, capital flows to industrial countries (the North). The model also features higher growth in the South, so that the world interest rate declines over time – a consequence of the rising share of the South in global output, as discussed above. The model can explain why a decline in global interest rates leads to a decrease in saving rates in the North and an increase in the South. The reason is twofold. First, the substitution effect dominates for younger workers in the South: they would like to borrow more but are prevented to do so by the financial friction. Second, the income effect dominates for middle-aged workers in the South: they want to save more, since they have fewer debts to repay. The paper documents through a careful analysis of cohort-level saving in the U.S. and China that the savings of the young decreased more in the US than in China, while the savings of middle-aged workers increased more in China than in the US. One simple way to re-interpret their model is to observe that a tighter borrowing constraints on young workers is equivalent to a more steeply declining age-income profile, a higher $\phi$ in equation (19). A larger $\phi$ causes more asynchronicity between income and consumption decisions, increasing saving and depressing the autarky interest rate.[39]

### 4.3 Bewley models and precautionary savings.

The previous section showed how lack of financial development can simultaneously depress real autarky interest rates and generate global imbalances (stylized fact 1) in a model without risk. We now consider a complementary explanation, based on idiosyncratic risk and precautionary saving in a Bewley (1987)-type economy. In this class of models, agents face uninsurable idiosyncratic risk. Yet, because risk is purely idiosyncratic, there is no aggregate uncertainty.[40] Idiosyncratic risk triggers a precautionary saving motive. The strength of this precautionary term depends on the households' level of prudence and the volatility of the uninsurable idiosyncratic shocks. Under financial autarky, the additional demand for saving depresses the equilibrium interest rate. This is the central result of Aiyagari (1994). Willen (2004) and Mendoza et al. (2009) were the first to consider the implications in an open economy. In Mendoza et al. (2009), differences in levels of financial development imply that some countries can better insure against idiosyncratic shocks.

[39] From equation (22), one can check that $\partial r^a_{ss}/\partial\phi < 0$.

[40] This greatly simplifies the analysis since the distribution of wealth becomes time-invariant in the steady-state. Models that allow for idiosyncratic and aggregate risk need to keep track of the dynamics of the wealth distribution.

Hence countries face different autarky interest rates and capital will tend to flow from countries with higher levels of residual uninsurable idiosyncratic risk (i.e. less financially developed) to countries with lower levels of risk (i.e. more advanced financial systems).

Unlike Caballero et al. (2008a), it is not differences in the ability to supply *riskless* stores of value, i.e. the pledgeability of future income, that matters but the ability to supply *contingent* assets, i.e. differences in the degree of risk sharing. These differences in risk sharing translate into differences in the demand for stores of value, thus affecting equilibrium interest rates. A similar mechanism is at work in Sandri (2010).[41] Our presentation follows Angeletos and Panousi (2011) which allows for investment risk in a continuous time setting similar to that of the previous section.[42]

### 4.3.1 The set-up.

Consider a country populated with a continuum of infinitely-lived households uniformly distributed over $[0,1]$. Each household supplies one unit of labor inelastically to a competitive labor market, so that the aggregate labor supply is constant and equal to 1. In addition, each household runs a 'privately-held' firm. This firm operates with capital $k_{it}$ and labor $n_{it}$ and produces $y_{it} = k_{it}^{\alpha} (\xi_t n_{it})^{1-\alpha}$, where productivity $\xi_t$ is common to all firms and grows at a constant rate $g$. In addition to capital invested in their own firm, households can trade a riskless bond in zero net supply. Denote $w_{it} = k_{it} + b_{it}$ the domestic financial wealth of household $i$, composed of holdings of physical capital $k_{it}$, and bond holdings $b_{it}$. The budget constraint for household $i$ is:

$$dw_{it} = d\pi_{it} + [r_t b_{it} + z_t - c_{it}]\, dt \tag{30}$$

where $z_t$ denotes labor income, equal to the wage since each household supplies one unit of labor, $r_t$ is the equilibrium riskfree rate and $d\pi_{it}$ denotes the household's capital income. Labor income and the interest rate are deterministic due to the absence of aggregate risk. Household capital income $d\pi_{it}$ is subject to idiosyncratic and uninsurable risk:

$$d\pi_{it} = [y_{it} - z_t n_{it} - \delta_k k_{it}]\, dt + \sigma k_{it} d\omega_{it} \tag{31}$$

[41] In addition, in that model entrepreneurs need to accumulate wealth to relax their borrowing constraint, as in Buera and Shin (2009) and Song et al. (2011).

[42] See also Corneli (2009). Mendoza et al. (2009) allow for both investment and income risk. The case with investment risk only is more tractable and delivers as an additional result that the capital-output ratio is low (and hence the marginal product of capital is high) when the level of financial development is low. Instead, in the Aiyagari (1994) set up with labor income risk, there is no risk premium and precautionary saving increases the capital stock above its complete market level. This would imply the counterfactual result that capital-output is high (and marginal product of capital low) in less financially developed countries.

The first term in brackets represents the deterministic part of the capital income, equal to output minus labor costs and depreciation. The second part represents the stochastic component. $d\omega_{it}$ is a standard Wiener process, i.i.d. across agents and time, akin to an obsolescence shock. Importantly, while the shock is idiosyncratic –and therefore perfectly insurable with complete markets– we assume that markets remain incomplete. More specifically, $\sigma$ measures the *residual idiosyncratic risk* faced by households, after all available formal and informal domestic risk sharing opportunities have been exhausted. The case of complete markets then corresponds to $\sigma = 0$. A country with a higher level of financial development –and therefore more opportunities to diversify risk domestically– will have a lower $\sigma$.[43]

### 4.3.2 Individual consumption and portfolio decisions

Assume that labor demand decisions are taken *after* the realization of the idiosyncratic shock. Since production exhibits constant returns to scale, this implies that employment and capital income will be proportional to capital with $n_{it} = \bar{n}_t k_{it}/\xi_t$, where $\bar{n}_t = \left((1-\alpha)\,\xi_t/z_t\right)^{1/\alpha}$, and $d\pi_{it} = \bar{r}_t k_{it} dt + \sigma k_{it} d\omega_{it}$, where $\bar{r}_t = \alpha \bar{n}_t^{1-\alpha} - \delta_k$ represents the expected return to capital, common to all firms, and therefore also the average expected return to capital in the economy.

The linearity of the budget constraint in capital implies that the problem is a simple variant of the standard Samuelson (1969)-Merton (1971) optimal consumption and portfolio problem. Define $h_t$ the present discounted value of current and future nonfinancial income, which is common across households since labor supply and the wage are identical: $h_t = \int_t^\infty e^{-\int_t^s r_v dv} z_s ds$. Define also total wealth $x_{it} = w_{it} + h_t$ as the sum of financial and human wealth.

One can then show that optimal consumption and investment plans are linear and independent of the household, with:[44]

$$c_{it} = m_t x_{it} \;;\; \frac{\dot{m}_t}{m_t} = m_t + \frac{(1-\gamma)\,\hat{\rho}_t - \rho}{\gamma}, \tag{32a}$$

$$\phi_t := \frac{k_{it}}{x_{it}} = \frac{\bar{r}_t - r_t}{\gamma \sigma^2}, \tag{32b}$$

where $\hat{\rho}_t = r_t + (\bar{r}_t - r_t)^2 / \left(2\gamma\sigma^2\right)$ is the risk-adjusted return on the portfolio. The first equation states that consumption is linear in total wealth and characterizes the evolution of the marginal propensity to consume $m_t$, common to all households. In the case of logarithmic preferences

[43] Of course, this interpretation may not be warranted. For instance, one could imagine situations where higher levels of financial sophistication allow for better sharing of idiosyncratic risk, at the expense of a higher exposure to aggregate risk. Since the model does not feature aggregate risk, this is not a feature we explore here.

[44] See the online appendix for detailed derivations.

($\gamma = 1$), $m_t$ is constant and equal to $\rho$. The second equation shows that the share of investment in the domestic physical capital stock $\phi_t$ satisfies the familiar formula: it increases with expected excess return $\bar{r}_t - r_t$ and decreases with idiosyncratic risk $\sigma$ and risk aversion $\gamma$.

With linear consumption and investment rules, the model aggregates very easily. Observe that equilibrium on the labor market requires $\int n_{it} di = 1$ from which we can recover the aggregate wage as a function of the aggregate stock of capital: $z_t = \xi_t (1-\alpha) (K_t/\xi_t)^{\alpha}$ with the obvious notation for aggregate capital: $K_t = \int k_{it} di$. Substituting into the expression for $\bar{r}_t$, one obtains the familiar expression for the expected return to capital: $\bar{r}_t = \alpha (K_t/\xi_t)^{\alpha-1} - \delta_k$.

### 4.3.3 Financial Autarky

Consider the case of financial autarky: $B_t = 0$, or $W_t = K_t$. In steady state, all aggregate variables grow at the same rate: $d \ln C_t/dt = d \ln K_t/dt = d \ln Y_t/dt = d \ln H_t/dt = g$. Solving the aggregate Euler equation for the risk-adjusted return $\hat{\rho}$, one obtains:

$$r = \hat{\rho} - \frac{\gamma}{2}\phi^2\sigma^2 \leq \hat{\rho} = \rho + \gamma g - \frac{\gamma^2}{2}\phi^2\sigma^2 \leq \rho + \gamma g. \tag{33}$$

This condition states that in equilibrium the precautionary motive depresses both the riskless rate $r$ and the risk-adjusted return $\hat{\rho}$ below the benchmark return in the risk-less economy, $\rho + \gamma g$. Investing in capital is risky, so the precautionary motive increases the demand for riskless bonds. In equilibrium these bonds are in zero net supply so the risk free rate has to decrease up to the point where households decide not to hold them. This is the same logic as in Aiyagari (1994). The precautionary motive also tends to depress the demand for capital, since it is the source of risk. Therefore, capital has to offer a premium in equilibrium. Substituting the definition of $\hat{\rho}$ and $\phi$, and after simple manipulations, we obtain:[45]

$$\phi(r) = \left(\frac{2(\rho + \gamma g - r)}{\gamma\sigma^2(1+\gamma)}\right)^{1/2} \tag{34a}$$

$$\bar{r} = \alpha\tilde{k}^{\alpha-1} - \delta_k = r + \gamma\sigma^2\phi(r) \geq r \tag{34b}$$

The first equation expresses the share of wealth invested in the risky asset as a function of the riskless rate $r$. The second equation expresses the expected return to capital as a function of the riskless rate. It is immediate that in the riskless case $\sigma^2 = 0$, $\bar{r} = r$. It can be solved implicitly for the level of capital as a function of the riskless rate: $\tilde{k}(r)$. As Angeletos and Panousi (2011) show,

[45] Where we use our notation $\tilde{x} = X/(\xi N)$.

$\tilde{k}(r)$ is not monotonously decreasing with the interest rate. Instead, it is U-shaped, decreasing only if $r \leq \underline{r} \equiv \rho + \gamma g - (\gamma/(1+\gamma))\sigma^2/2$. The intuition is that a higher interest rate allows households to accumulate more wealth, making them more willing to take risks, and reducing the risk premium required by households to hold capital. It follows that for $r > \underline{r}$, an *increase* in the riskless rate is associated with a *decrease* in the marginal product of capital as the decline in the risk premium more than offsets the increase in the riskless rate.

One solves for the autarky interest rate by substituting $\tilde{k}(r)$ into the asset market equilibrium condition: $\phi(\tilde{k}(r) + \tilde{h}(r)) = \tilde{k}(r)$ where $\tilde{h}(r) = (1-\alpha)\tilde{k}(r)^{\alpha}/(r-g)$. This yields the implicit expression:

$$1 = \phi\left(r_{ss}^{a}\right)\left(1 + \frac{(1-\alpha)\,\tilde{k}\left(r_{ss}^{a}\right)^{\alpha-1}}{r_{ss}^{a} - g}\right) \tag{35}$$

It is immediate to check that $r_{ss}^{a} = \rho + \gamma g$ when $\sigma = 0$, and that $\partial r_{ss}^{a}/\partial\sigma < 0$: more uninsurable idiosyncratic risk depresses autarky rates.

#### 4.3.4 Open economy

**Small open economy.** Consider now the case of a small open economy facing a constant riskless interest rate $r$. From the previous derivations, the domestic capital stock (per efficient unit) will be given by $\tilde{k}\left(r\right)$ that solves (34b) while the portfolio share will be $\phi(r)$ that solves (34a). The demand for stores of value is $\tilde{w}(r) = \tilde{k}(r)/\phi(r) - \tilde{h}(r)$. The supply is $\tilde{k}(r)$, and the difference between the two determines the net foreign asset position $\tilde{b}(r) = \tilde{w}(r) - \tilde{k}(r)$. One can check that $\tilde{b}(r)/\tilde{k}(r)$ is always *increasing* with the interest rate: as the interest rate increases, the propensity to save in the riskless bond increases, relative to saving in the risky capital. If $r > r_{ss}^{a}$ (resp. $r < r_{ss}^{a}$), the small open economy is a net creditor (resp. borrower).

Following Kraay and Ventura (2000), we can use the model to ask how the current account should respond to transitory income shocks. To do so, rewrite equations (34) as:

$$\frac{\tilde{k}}{\tilde{x}} = \frac{\alpha\tilde{k}^{\alpha-1} - \delta_k - r}{\gamma\sigma^2} \tag{36}$$

and solve for the response of domestic capital $\tilde{k}$ to a change in domestic wealth $\tilde{x}$:

$$\frac{\partial\tilde{k}}{\partial\tilde{x}} = \frac{\gamma\sigma^2}{\gamma\sigma^2 + \alpha(1-\alpha)\tilde{k}^{\alpha-2}\tilde{x}}\frac{\tilde{k}}{\tilde{x}} \geq 0. \tag{37}$$

When $\sigma^2$ is close to 0 (full risk sharing), the marginal increase in domestic wealth is invested in international riskless bonds ($\partial\tilde{k}/\partial\tilde{x} \approx 0$). In this case, countries run current account surpluses in

response to transitory positive shocks. Conversely, when $\alpha \approx 1$, so that $\partial\tilde{k}/\partial\tilde{x} \approx \tilde{k}/(\tilde{k}+\tilde{b})$, the marginal increase in wealth is invested like the average unit.[46] The implication is that net creditor countries (for which $\tilde{b} > 0$) run current account surpluses in response to a transitory positive income shock, while net debtor countries (for which $\tilde{b} < 0$) run current account deficits. In a panel of 13 industrial countries between 1973 and 1995, Kraay and Ventura (2000) find that the interaction term between the share of gross national saving in GDP and the ratio of foreign assets to total assets is highly significant, with a $R2$ of 0.37.

**Large open economy.** Following the now familiar steps, suppose a world economy is composed of two otherwise identical countries facing different levels of residual uninsurable risks with $0 < \sigma < \sigma^*$ where $*$ denotes the foreign, less financially developed, economy. Assuming that the conditions are satisfied for $r_{ss}^{a,i} \geq \underline{r}^i$ in each country $i$, the equilibrium satisfies:

$$r_{ss}^a \leq r \leq r_{ss}^{a*} < \rho + \gamma g \tag{38a}$$

$$\tilde{k}(r_{ss}^{a*}) < \tilde{k}^* < \tilde{k} < \tilde{k}(r_{ss}^a) \tag{38b}$$

$$\tilde{b} < 0 < \tilde{b}^* \tag{38c}$$

The integrated risk-free rate settles somewhere between the two autarky rates, as usual. Moreover, the capital stock in the riskier economy is lower than in the safer one. This is because the risk premium effect dominates. This has two interesting implications. First, the capital stock increases in the less developed economy upon financial integration: $\tilde{k}(r_{ss}^a) < \tilde{k}(r)$: the increase in interest rates in the less financially developed economy makes them richer and willing to take more risk. Second, the marginal product of capital is higher –and the capital-output ratio is lower– in less financially developed economies, something that accords well with the empirical evidence.

**Cross border flows as safe asset flows.** Finally, this model predicts that the advanced economy is a net borrower while the less financially developed economy is a net creditor: $\tilde{b} < 0 < \tilde{b}^*$. In the model, all cross border flows take the form of *riskless loans*: there is no cross-border investment in risky projects. This provides a way to re-interpret the results: faced with larger uninsurable risks, households in the foreign country wants to invest in *safe assets*. The domestic country faces lower uninsurable risks, so it has less need for insurance and is willing to *supply* these safe assets to foreigners. Stated differently, the domestic economy has a *comparative advantage* in supplying

[46] We use the fact that $\tilde{h} \approx 0$ when $\alpha \approx 1$.

safe assets. In turn, it earns a premium that allows it to consume more than it produces along the transition to the new steady state (i.e. it runs a trade deficit). This result parallels Gourinchas et al. (2010) whom we will discuss later in this chapter.[47]

#### 4.3.5 Aggregate uncertainty.

The models considered so far only feature idiosyncratic uncertainty. Some recent models consider instead the impact of aggregate uncertainty.[48] In a business cycle framework, Fogli and Perri (2006) consider the effect of the Great Moderation (the decline in the volatility of the U.S. business cycle between the mid 1980s and the onset of the 2007 financial crisis). Faced with a decline in aggregate volatility, the U.S. representative household would reduce its precautionary holdings. This would result in a deterioration of the U.S. external balance. In a calibration of their model, they find that the Great Moderation can account for around 20% of the US external imbalance. Note however, that the decline in precautionary saving would be associated with an *increase* in global interest rates, in contradiction with stylized fact 1. In a recent paper, Coeurdacier et al. (2013) study jointly the gains from capital accumulation and risk sharing in a model with aggregate uncertainty. Using global numerical methods they study the dynamics of the model along the transition path from autarky to financial integration. They find that aggregate uncertainty interacts with the classical determinants of capital flows explored in section 3 and that the precautionary motive can overturn the direction of net capital flows as in the models explored in this section.

### 4.4 Financial frictions and international trade

Two recent papers focus on the interaction between trade flows and capital flows. Jin (2012) presents a stochastic two-country overlapping generations model with production and capital accumulation in which factor intensities are (exogenously) different across countries. The paper combines insights from the factor proportions trade literature with those of the standard neoclassical open economy growth model. In her model, there is both an inter-temporal motive for capital flows and an intra-temporal motive since capital will tend to flow to countries that are more specialized in capital intensive industries. Hence two competing effects determine the direction of net capital flows: the composition effect (linked to asymmetries in specialization across countries)

[47] Mendoza et al. (2009) also allow for investment risk. In their model, agents can invest in risky assets in foreign countries. As a result, in equilibrium, the financially developed country still runs a negative net foreign position, but holds a long position in foreign risky assets and earns excess returns on its external portfolio.

[48] These models abstract from idiosyncratic uncertainty. As mentioned earlier, in models with both idiosyncratic and aggregate uncertainty the wealth distribution varies over time and become a state variable.

and the standard efficiency effect (stemming from capital scarcity). A country hit by a positive productivity shock, or experiencing a relative increase in its labour force –as was the case for many emerging economies since 1990-, can nevertheless become a capital exporters if it specializes in labour intensive industries. Hence specialization is the key mechanism through which Jin (2012) may account for global imbalances.

Antràs and Caballero (2009) presents a model where financial frictions determine patterns of capital flows and trade flows. Countries are heterogeneous in terms of financial development and sectors differ in their degree of financial dependence. They feature a two-country (North and South, where South is financially underdeveloped), two-factor (capital and labour) two-sector general equilibrium model where a homogeneous good is internationally traded. Under trade *and* financial autarky, South invests disproportionately in the sector without financial frictions. This depresses wages and rental rates of capital. If capital is now allowed to move freely, but international trade in goods remains restricted, capital will flow out of the financially underdeveloped economy towards the financially developed one, as in the models presented in this section. By contrast, if international trade in goods is *also* liberalized, countries will specialize along the lines of comparative advantage: the financially underdeveloped South specializes (incompletely) in the sector unaffected by the financial friction. This raises the rental rate of capital in the South because of good price equalization, while domestic wages remain depressed, and this can reverse the direction of capital flows. Hence it is the difference in production structures due to the pattern of specialization induced by comparative advantage that interacts with financial liberalization to shape the direction of net capital flows. The pattern of specialization is thus endogeneously determined by cross country differences in financial development, echoing the main theme of this section.

### 4.5 Global Imbalances and Financial Fragility

An important theme developed in Bernanke (2005) is that other asset prices may adjust beside the global interest rates to a shortage of stores of value. In Caballero et al. (2008b), the decline in world interest rates can be so strong as to make the economy dynamically inefficient, opening the door to rational bubbles. While the financial bubble increases asset supply endogenously, it is also prone to crashes. More generally, low world interest rates can fuel search for yield, or inefficient investments (e.g. Rajan (2005)). A number of observers noted the close connection between current account deficits and housing booms (Bernanke (2010), Ferrero (2012)). Lower global interest rates, and in particular mortgage rates, can account for part of the increase in housing prices. As Ferrero (2012) observes, a gradual relaxation of borrowing constraints for household, or a favorable change in

property taxes would lead to a simultaneous current account deficit and housing boom, as observed in the data, but would also lead to an increase in interest rates. In the same vein, Adam et al. (2011) use a small open economy model with endogenous housing and learning. In their model, bullish agents about the housing market respond strongly to a decline in world interest rates, triggering a housing boom and a current account deficit.

### 4.6 Private Flows, Public Flows and Reserve accumulation

A number of papers have pointed out that private and public flows behave quite differently, and that most of the net accumulation of foreign assets by emerging economies is in the form of public flows, especially through official reserve accumulation by central banks (see Aguiar and Amador (2011), Gourinchas and Jeanne (forth.) and Alfaro et al. (2011)). Indeed, a large share of emerging markets gross external asset holdings takes the form of central bank reserves or other official holdings. The distinction between private and public capital flows becomes relevant once we depart from the -admittedly extreme- case of full Ricardian equivalence. In that class of models, any change in public flows is offset one-for-one by a corresponding change in private sector capital flows so the model pins down total net capital flows but not their composition. It is quite reasonable to depart from full Ricardian equivalence and the stringent assumptions it requires (non-distortionary taxation, perfect capital markets, infinitely lived dynasties). But the precise channels by which models depart from Ricardian equivalence matters greatly for the predictions of the model about the *joint fluctuations* in private and public flows. It is not in general a good idea to simply assume private flows behave as if there were *no* public flows. Spelling out the right model of public and private flows is an active area of ongoing research. At one extreme, some models assume that there are no private capital flows and governments provide the only form of intermediation of domestic resources into foreign stores of value (semi-open economy). For instance, one may see governments as financial intermediaries for the domestic private sector, intermediating domestic savings into global uses, as pointed out by Song et al. (2011). Similarly, in Aguiar and Amador (2011) a government that has access to international capital markets faces a commitment problem. It accumulates international reserves as a way to post collateral, and limit the temptation to expropriate investors in the future. In Jeanne and Rancière (2011), the domestic government faces instead the possibility of a sudden loss of access to external credit and accumulates reserves for precautionary reasons.[49]

[49] Bacchetta and Benhima (2012) present a model where the demand for precautionary liquid reserves arises from the corporate sector. In the model, credit constrained firms face liquidity shocks and their demand for liquid assets (foreign bonds) increases with investment. Therefore, a more rapidly growing economy will invest more and demand more foreign bonds.

Bacchetta et al. (2012) present a model where households face borrowing constraints and where the planner may choose to impose capital controls and accumulate reserves. In steady state, when financial constraints don't bind, it is optimal to replicate the open economy, and the central bank is simply a shell for international financial intermediation. Along the transition, binding financial constraints may lead the planner to choose an interest rate different from the world interest rate, through reserve accumulation and capital control policy, as in Jeanne (2012). Many of these models emphasize the strong demand from emerging market economies for liquid and safe global assets. Indeed, as Bernanke (2011) show, surplus emerging market economies concentrated their reserve accumulation on the safest US securities: U.S. Treasuries and agency debt. To understand this pattern, one needs to go beyond models with no aggregate risk and no diversification motive.

# 5 External Balance Sheets Valuation Effects and Adjustment

Many of the models of the previous section, with no aggregate uncertainty or no diversification motive, make predictions about *net* capital flows, that is, about the intertemporal transfer of resources across countries. However, as emphasized in Section 2, one key stylized facts in international economics since the 1990s has been the massive increase in gross capital flows. The properties of the international balance sheet of countries determine how different shocks propagate across countries and how countries adjust to their long run solvency constraint.

## 5.1 International Adjustment

This section highlights the quantitative importance of valuation effects and the financial channel of external adjustment. To do so, we explore the implications of the external solvency constraint. Unlike sections 3 and 4, we present derivations in discrete time for two reasons. First, it allows for an easier mapping between the theoretical objects of analysis and their empirical counterpart. Second, many of the issues discussed in this section have a business cycle dimension, for which a discrete time set-up is better adapted.

### 5.1.1 External solvency constraint

We begin by writing down the external budget constraint of a country and deriving some implications for the process of international adjustment. Define $NA_t = A_t - L_t$ as the net foreign asset position (at market value) of a country at the end of period $t$, where $A_t$ and $L_t$ denote respectively

gross external assets and liabilities.[50] The change in net foreign asset position from one period to the next is given by the following accumulation equation:

$$NA_t = R_t NA_{t-1} + NX_t \tag{39}$$

where $NX_t = X_t - M_t$ renotes the balance on goods, services and net transfers during period $t$, and $R_t$ represents the gross portfolio return on the net foreign portfolio between the end of period $t-1$ and the end of period $t$. Adding and subtracting the net investment income balance $NI_t$, we can write:

$$NA_t - NA_{t-1} = [(R_t - 1)\, NA_{t-1} - NI_t] + CA_t = VA_t + CA_t \tag{40}$$

using the definition of the current account as the sum of the trade balance $NX_t$ and the net factor payment: $CA_t = NX_t + NI_t$. The change in the net foreign position equals the current account, $CA_t$, plus the valuation adjustment $VA_t$. This valuation adjustment equals the *capital gain* on the net foreign asset portfolio i.e. the net return $(R_t - 1)$ minus income, dividends and earnings distributed.[51] Traditionally, this valuation term has been omitted and the net external position of a country has been calculated as the cumulated sum of past current acounts. This is in keeping with the National Income and Product Accounts (NIPA) and the Balance of Payments methodology that focuses on produced transactions and ignores capital gains and losses**.** But cumulated current acounts will give a very approximate and potentially misleading reflection of a country's net foreign asset position –the object of interest in most of our economic models– unless the cumulated valuation gain is correspondingly small. While this assumption may have been reasonably accurate in eras of limited levels of financial integration, it is not one we can maintain in the face of large cross border gross positions, as seen in sylized fact 5. We now turn to the empirical methodology allowing us to value assets and liabilities at market prices.

[50] Note that this definition of the net foreign asset position coincides with the one presented in the previous section since domestic wealth $W$ consists of domestic holdings of domestic assets $V^d$ and gross external claims $A$, while domestic assets $V$ can be held by either by domestic residents $(V^d)$ or by foreigners in the form of gross external liabilities $(V^f = L)$. It follows that $NA = A - L = \left(W - V^d\right) - \left(V - V^d\right) = W - V$.

[51] To be complete, the accumulation equation should also include the capital account $KA_t$, unilateral transfers $UT_t$ and the statistical discrepancy $SD_t$. We abstract from these components in this discussion and will bring them back when necessary. For many countries, especially industrialized ones, capital account transactions and unilateral transfers are typically small. Errors and omissions are also excluded from the financial account in the US Bureau of Economic Analysis estimates of the US international investment position.

### 5.1.2 Valuation effects: empirical methodology

Obtaining precise estimates of these valuation changes is not an easy task. We start with a discussion of the empirical methodological advances that have allowed researchers to focus on valuation changes with a particular attention to the relevant empirical caveats that are involved in any exercise of this nature.

**Stocks and Flows.** The relatively recent availability of periodic surveys of cross border assets and liabilities has it made possible to investigate empirically the channels of adjustments of a country's external balance sheet.[52] Constructing external balance sheets of countries *at market value* involves reconciling data on stocks and balance of payment data on flows.[53]

For each asset class, we can write a general law of motion as follows:

$$PX^i_{t+1} = PX^i_t + FX^i_{t+1} + VX^i_{t+1} + OX^i_{t+1} \tag{41}$$

where $PX^i_t$ represents the position at the *end of period* $t$ for asset class $i$ reported in the disaggregated net international investment position for gross claims ($X = A$) or gross liabilities ($X = L$), $FX^i_t$ denotes the corresponding flow during period $t$ as recorded in the balance of payments, $VX^i_t$ is the valuation gain that can be attributed to currency and asset price movements, while $OX^i_t$ ('other changes') represents an error term due to changes in coverage or mismeasurements of various kinds. Summing across all the series and using a simplified version of the balance of payment identity $FA_t = CA_t + SD_t$, where $SD_t$ denotes the statistical discrepancy of the balance of payment, we obtain the international investment position at the end of period $t+1$ :[54]

$$NA_{t+1} = NA_t + CA_{t+1} + VAL_{t+1} + OC_{t+1} + SD_{t+1} \tag{42}$$

where $VAL_t = \sum_j VA^j_t - \sum_i VL^i_t$, is the sum of the valuation effects across asset classes, and $OC_t = \sum_j OA^j_t - \sum_i OL^i_t$. is the corresponding sum of the 'other changes'.

These simple accounting relations allow in principle researchers to construct time series of

[52] For example, the Coordinated Portfolio Investment Surveys of the IMF, covering external holdings of securities of 73 countries (in 2010) started in 1997 and became annual from 2001. The CPIS surveys are complemented by the surveys on Securities Held as Foreign Exchange Reserves (SEFER), and Securities Held by International Organizations (SSIO). The Coordinated Direct Investment Survey (CDIS) of the IMF covering 97 countries started in 2009. The US Treasury has performed very occasional surveys of external assets or liabilities since at least the second world war but has done so on a more regular (annual) basis only since 2002 for the liability side and 2003 for the claim side.

[53] In the case of the US, data on stocks comes from surveys performed infrequently by the Treasury and reported by the Bureau of Economic Analysis.

[54] As before, we ignore the capital account and unilateral transfers in this derivation.

estimates of cross border positions at market values which are consistent with flow data and with the periodic surveys. In practice, of course, the exercize is rarely straighforward and a number of assumptions are needed to ensure everything "adds up."

Lane and Milesi-Ferretti (2001) and Lane and Milesi-Ferretti (2007a) in pioneering work constructed and updated annual estimates of external assets and liabilities for over 178 countries and the euro area over the period 1970-2007 (data release august 2009). Gourinchas and Rey (2007a) and Gourinchas et al. (2010) focused on the United States and provided quarterly estimates for the period 1952-2010. Bertaut and Tryon (2007), building on Thomas et al. (2004) perform a number of refinements to the data and provide monthly estimates of US cross border securities positions from 1994. Stoffels and Tille (2009) constructed data on the Swiss external investment position. In more conjectural work given the data limitations, Kubelec and Sá (2010) provides estimates of *bilateral* holdings among 18 advanced economies and emerging markets, Milesi-Ferretti et al. (2010) estimated a snapshot of bilateral holdings in a sample of 70 countries at end year 2007 while Gourinchas et al. (2012) extended this sample to 2009. Lane and Shambaugh (2010) presents *currency compositions* of external claims and liabilities for a large panel of countries over 1990-2004. Finally, exploiting a unique Swiss database, Zucman (2013) shows that non recorded assets held in offshore accounts can explain the discrepancy between assets and liabilities at the world level.

### 5.1.3 The case of the United States

**A world's banker balance sheet.** The case of the United States is a particularly interesting. We have already noted the very sizeable gap between the reported U.S. net international position and cumulated current account deficits (stylized fact 5). This suggests possible important roles played by valuation effects in the dynamics of the net foreign asset position of the US. Along the same line, Tille (2008) observed the potential important stabilizing effects of a dollar depreciation on the external balance sheet of the United States due to a large asymmetry in currency composition between liabilities (all in dollars) and assets (mostly in foreign currency): when the dollar depreciates, the value of liabilities in dollar is unchanged while the value of external claims goes up.

As a number of papers noted, the structure of the US external balance sheet is also asymmetric in other ways. Writing in the 1960s while the US was the center country of the Bretton Wood system of fixed exchange rates, Kindleberger (1965) and Despres et al. (1966), observed that the US was the 'Banker of the World', 'lending mostly at long and intermediate terms, and borrowing short' thereby supplying loans and investment funds to foreign enterprises and liquidity to foreign

asset holders. Figure 10 presents the decomposition of the US external accounts by asset classes (FDI, bank -which includes trade credits-, debt, equity). In the wake of the second world war, the United States was a creditor country, with a positive Net International Investment Position (NIIP) of about 12 percent of U.S. output. More importantly, U.S. gross external claims and liabilities were small, reflecting the large direct and indirect costs of cross-border financial transactions. Most of the external claims of the US were direct investment or bank loans, while a sizeable share of its external liabilities were foreign holdings of US government securities. Fast forward to the beginning of the 21st century, after an unprecedented period of deregulation of cross border financial flows. By then, the U.S. has become a sizable debtor country, with a negative NIIP of about 22 percent of output in 2010. More dramatically, gross external claims and liabilities soared,to more than 100% of output in recent years. Figure 9 presents the evolution of net portfolio equity and FDI position of the US (its risky asset position) and its net debt and bank asset position (as a proxy for its safe asset position). The risky position skyrocketed upwards in the run up to the crisis while the US was increasingly short in safe and liquid assets: as noted by Gourinchas and Rey (2007a), the US became an increasingly leveraged global financial intermediary. The pattern of *liquidity and maturity transformation* already noted by observers in the 1960s is still a characteristic of the US balance sheet. This is all the more surprising if one puts this stylized fact in parallel with the evolution of the banking sector in recent years. In a series of thought provoking papers, Shin argues that European global banks have become intermediaries for US savings, financing themselves in the United States, in particular via the wholesale market (money market funds) and channelling the liquidity worldwide including back into the US markets (see for example Shin (2012)). Shin points out that US-dollar denominated assets of banks outside the United States amounted to about $10 trillion prior to the 2007 crisis. This pattern of banking investment flows whereby global banks are liquidity providers to the United States goes against the previously described role of the US as a World Banker. In the aggregate balance sheet of the country though, it is still dominated by the overall pattern of *liquidity and maturity transformation* performed by the United States as a whole.

**Computing returns on the U.S. external asset position.** The particular structure of the external balance sheet of the United States has been shown to generate an "Exorbitant Privilege": the United States is able to earn higher returns on its external assets than on its external liabilities (see Gourinchas and Rey (2007a)).[55] This French claim has been under intense scrutiny in the

[55] Giscard d'Estaing (February 16, 1965), then finance Minister of President Charles De Gaulle coined the term "exorbitant privilege."

literature, igniting a lively debate, which we now briefly summarize.

From equation (42), the formula linking the change in net foreign asset position and the return is:

$$NA_{t+1} = R_{t+1}NA_t + NX_{t+1} + SD_{t+1} + OC_{t+1} \tag{43}$$

When computing the returns on the net foreign asset position of a country, the researcher is immediately faced with a problem: Where should $OC_{t+1}$, the residual term whose raison d'être is to reconcile stock and flow data coming from different sources be allocated?[56] Different authors have taken different (time varying) views on this question and obtained estimates of external returns on samples of different lengths, resulting in a debate which may look confusing for the lay person. But the underlying issue is quite simple and easy to summarize: as a residual item, $OC_{t+1}$ can only represent mismeasured valuations, mismeasured flows, mismeasured initial positions, or some combination of the three. Let's consider each possibility in turn.

- $OC_{t+1}$ represents mismeasured capital gains. This is a plausible assumption for some asset categories, such as direct investment, where capital gains are notoriously hard to measure. This was the assumption adopted in the first wave of papers of the literature. In that case, the total return is given by $(R_{t+1} - 1) NA_t = NI_{t+1} + VAL_{t+1} + OC_{t+1}$. This set of papers tend to find that the US enjoys a strong excess returns on its overall external position. Gourinchas and Rey (2007a) report a real excess return of 2.1% per year on the 1952:2004 period; Lane and Milesi-Ferretti (2007b) reports 3.9% per year for the shorter 1980-2004 period; similarly Obstfeld and Rogoff (2005) finds a 3.1% per year excess return for 1983-2003 and Meissner and Taylor (2008) 3.7% per year on 1981-2003.

- $OC_{t+1}$ represents mismeasured financial flows as pointed out in a second wave of papers (Curcuru et al. (2008b) and Lane and Milesi-Ferretti (2009)).[57] In that case, the dynamics of net assets is given by $NA_{t+1} = NA_t + F\hat{A}_{t+1} + VAL_{t+1}$ with the "corrected" flow term defined as $F\hat{A}_t = FA_t + OC_t$. Such an adjustment must have a counterpart in the Balance of Payments identity $F\hat{A}_t = CA_t + KA_t + SD_t - OC_t = 0$. By definition, if $F\hat{A}$ measures the correct financial flows, then the residual term $SD - OC$ must correspond to mis-measured

[56] $OC_{t+1}$ can also reflect some reclassification. For example when a portfolio investor has a position in a firm and then acquires more equity such that total holdings exceed 10%, his entire holdings are classified as direct investment, including those that were held prior to meeting the 10% threshold. This results in $OC$ for both portfolio and FDI. A similar reclassification occurs when a US firm reincorporates offshore or onshore.

[57] Their argument relies on the difference in revision policies between the stock and the flow data for equity and bond portfolio investment.

current account transactions: $C\hat{A}_t = CA_t + (SD_t - OC_t)$.[58] Hence, if flow adjustments are large, this implies that trade flows are also *de facto* grossly misrecorded for the United States, especially in the recent period (for a discussion on the implications for the balance of payments see Lane and Milesi-Ferretti (2009) and Curcuru et al. (2008a)). Adding residuals to flows, Curcuru et al. (2008b) finds *no* excess returns on the portfolio component nor on the overall net foreign asset position of the US for the 1990-2005 period.[59] Forbes (2010) implements the Curcuru et al. (2008b) methodology and, in contrast, estimates very large excess returns of about 6.9% per year during 2002-2006.[60] Curcuru et al. (2013) finds excess returns of 1.9% on the total net foreign asset position of the US for the 1990-2011 period and show that direct investment yield differentials play an important role in their sample.

- $OC_{t+1}$ represents mismeasured positions as advocated by Lane and Milesi-Ferretti (2009) for non-portfolio positions of banks and non banks. For these categories covering bank loans, deposits, short term paper and trade credits, capital gains are unlikely to be large. However the scope of the surveys has progressively expanded over time and the methodology has improved making it plausible that initial positions were mismeasured.

Lane and Milesi-Ferretti (2009) offer a detailed and careful discussion of these different options, indicating where mismeasurements are likely to be more severe. They end up recommending that for portfolio assets and liabilities, the residual be partly reallocated to financial flows; for FDI that it be reallocated to capital gains; and for non-portfolio positions of banks and non-banks that it be reallocated to mismeasured initial positions.

**How large is the "Exorbitant Privilege"?** We follow an agnostic approach and allocate the residual term in different ways to assess quantitatively whether the result change substantially. As pointed out already by Lane and Milesi-Ferretti (2009) allocating the residual term to valuations increases the excess returns on the net foreign asset position, while allocating it to flows decreases it. Table 3 presents in (a) the most conservative results regarding the excess returns (following Curcuru et al. (2008b) -whose own estimates are presented in row (e) for the shorter period analysed in their paper- we allocate *all* the residuals to flows); in (b) we allocate all the residuals to flows except for

[58] Capital account transactions are well measured if they correspond mostly to official aid and grants. However, we note that the capital account also includes transactions in non-produced, non-financial assets, such as patents and trademarks which should be included in direct investment returns and are unlikely to be measured with great precision.

[59] For the return on the overall position, they use BEA original data releases instead of revised data to compute their estimates, arguing this corrects the problem of disparate revision policies between stocks and flows.

[60] As we show below, the difference in estimates comes from the short sample period and volatility of underlying returns.

FDI where they are allocated to valuations as argued by Lane and Milesi-Ferretti (2009); in (c) we present an upper bound for the excess returns as all the other changes are allocated to valuations. In rows (d) to (h) we present earlier estimates of the literature pertaining to various sample lengths and estimation methods. Estimates (d), (g) and (h) allocate all residuals to valuations; estimates (e) and (f) allocate residuals to flows. In all cases we find evidence of an "exorbitant privilege" ranging on the whole 1952:1-2011:4 period from 1.6% to 2.7% depending on the assumptions. This is far from being negligible.

The key lessons of this robustness exercize are (i) that the sample length is important (see the very different results obtained by Curcuru et al. (2008b) and Forbes (2010) who use the same methodology or the results for the two periods in (a) (b) or (c)). This is to be expected given the large volatility of the excess returns. (ii) that the refinements on construction of positions data (Bertaut and Tryon (2007)) while undoubtedly improving the quality of the data, do not make much of a quantitative difference; (iii) that the allocation of the residuals does not alter the substance of the results if the sample is long enough.

The most natural interpretation of the results is that this positive excess return may come from a composition effect The composition effect is positive if, just like a bank or a venture capitalist, U.S. claims on foreigners are weighted toward riskier asset classes with higher average returns and liabilities are safer and more liquid. In addition, there may be excess returns within asset classes, for example because US government bonds earn a liquidity discount compared to foreign bonds or because of tax asymmetries in the realm of direct investment. More research is doubtlessly needed to understand the underlying determinants of these excess returns.

#### 5.1.4 Intertemporal approach to the current account

We now go back to the external solvency constraint (39), and iterate it forward, imposing a no-Ponzi condition and taking conditional expectations:[61]

$$NA_t = -E_t \left[ \sum_{i=1}^{+\infty} \left[ \prod_{j=1}^{i} R_{t+j} \right]^{-1} NX_{t+i} \right]. \tag{44}$$

This expression states that the net foreign asset position of a country should equal the (opposite of) the expected present discounted value of future trade balances, discounted at the cumulated return on the net foreign asset position. Hence the current value of a country's net foreign asset

[61] The no-Ponzi condition is: $\lim_{k\to\infty} \left( \prod_{j=1}^{k} R_{t+j} \right) NA_{t+k} = 0$.

position reflects both the expected future path of net exports and of returns on the net foreign asset position. Equation (44) is very generic: it has to hold, regardless of the details of the economic model, provided Ponzi schemes are ruled out. To illustrate the economic intuition behind this intertemporal constraint, imagine that some news lead agents to update upwards their estimates of future next exports. That same news would either decrease the value of current net foreign assets (either by movements in the exchange rate or by increasing consumption and current indebtedness for example) or would affect expectations of future returns on the net foreign asset position (or both).

In a world where internationally traded assets consist only in riskless government bonds whose gross rates of returns are $R_t^f$, the rate of return on the net foreign asset positions $R_t$ simplifies to $R^f$. In such a world, which may not be so different from the pre-1980s international capital markets, equation (44) takes the familiar form $NA_t = -E_t \sum_{i=1}^{+\infty} (1+r)^{-i} NX_{t+i}$ where we also assumed that $R_t^f = (1+r)$ is constant. Hence in this "relatively non-financially globalized world", any movements in the net foreign asset position has to be made up in the future by net exports. The international adjustment process of countries relies exclusively on *quantity* adjustments through the classical *trade channel*.[62] Furthermore, since there are no capital gains or losses on net riskless bond positions, it is immediate from (40) that there is no valuation effect either and the change in the net foreign asset position $NA_{t+1} - NA_t$ coincides with the current account $CA_t$. From there, the simplest version of the *intertemporal approach to the current account* assumes an infinite-horizon certainty-equivalent representative consumer, with a rate of time preference equal to interest rate, to obtain:[63]

$$CA_t = Q_t - \hat{Q}_t = \sum_{s=t+1}^{\infty} (1+r)^{-(s-t)} E_t \left(Q_s - Q_{s-1}\right) \tag{45}$$

where $Q_t$ denotes net output, i.e. output minus government expenditures and domestic investment and a 'hat' denotes the permanent value of a variable.[64]

This expression makes particularly transparent some of the main lessons of the intertemporal approach to the current account: movements in the current account in a world where riskless bonds with constant rate of returns $r$ are the only assets traded internationally, are driven by temporary

[62] Whether this adjustment requires movements in the real exchange rate and/or the terms of trade, is a debated issue. Obstfeld and Rogoff (2005) present estimates of the adjustment in relative prices needed to close the U.S. current account. Corsetti et al. (forth.) argue that some of the adjustment can come from adjustments at the extensive margin, i.e. through the export/import of new varieties, without much adjustment in terms of trade. Faruqee et al. (2007) presents a richer simulation based on four regional blocs.

[63] See Obstfeld and Rogoff (1995) in the previous Handbook chapter.

[64] Formally, $\hat{Q}_t = rE_t \left[\sum_{t+1}^{\infty} (1+r)^{-(s-t+1)} Q_s\right]$.

deviations of macroeconomics quantities from their permanent levels. A US deficit reflects a combination of a temporary shortfall in US output or an investment level or government spending temporary above trends. It leads to an accumulation of US riskless debt by foreign countries on which the US pays a constant interest rate $r$.[65] As discussed above, the new international financial landscape characterized by large cross border holdings of a myriad of different assets denominated in different currencies cannot be forced into that mold. The empirical failure of intertemporal approach to the current account underlines this discrepancy between the simple market structure of the models and the real world.We therefore go back to equation (39) to derive a more general characterisation of the dynamics of the net foreign asset position that is the core of the empirical analysis of Gourinchas and Rey (2007b)

### 5.1.5 Trade and valuation channels of international adjustment

Gourinchas and Rey (2007b) start with the external constraint identity (39), with a slightly altered timing (for notational convenience):[66]

$$NA_{t+1} \equiv R_{t+1} \left( NA_t + NX_t \right). \tag{46}$$

As above, $NX_t$ represents net exports during period $t$, defined as the difference between exports $X_t$ and imports $M_t$ of goods and services. $NA_t$ represents net foreign assets, defined as the difference between gross external assets $A_t$ and gross external liabilities $L_t$ measured in the domestic currency, while $R_{t+1}$ denotes the (gross) return on the net foreign asset portfolio. A first step consist in log-linearizing equation (46). But while in most theories the ratios of exports, imports, external assets and liabilities to wealth are all statistically stationary along a balanced-growth path, even a cursory look at the data shows in contrast, that the stock of gross assets and gross liabilities, exports and imports are on a transition path. Looking at international financial integration from a historical perspective (see for example Obstfeld and Taylor (2004)), capital mobility increased between 1880 and 1914; decreased between the First World War and the end of the Second World War; and has been increasing until the advent of the global financial crisis. Many of these long run structural shifts are driven by exogenous forces, chief among them technological innovations in

[65] For a richer model with non traded and traded goods where stochastic movements in real interest rate plays a role, see Bergin and Sheffrin (2000).

[66] In equation (46), net foreign assets are measured at the beginning of the period. This timing assumption is innocuous. One could instead define $NA'_t$ as the stock of net foreign assets at the end of period $t$, i.e. $NA_{t+1} = R_{t+1} NA'_t$. The accumulation equation becomes: $NA'_{t+1} = R_{t+1}\ NA'_t + NX_{t+1}$.which brings us back to the notation of the previous section.

the shipping and communication industries. Hence a natural approach consists in modelling the world economy as a stochastic economy around a slow-moving deterministic trend. The variables of interest are the fluctuations of the net asset and net export variables *in deviation from these trends*.[67] The derivation of the loglinearized solvency constraint requires several steps and some ancillary assumptions, which are relegated to the online Appendix. Denote by $nxa_t$ a linear combination of the stationary components of exports, imports, assets and liabilities (the weights are constant given by the loglinearization). The loglinearized approximation of (46) takes the following form:

$$nxa_{t+1} \approx \frac{1}{\rho} nxa_t + r_{t+1} + \Delta nx_{t+1} \tag{47}$$

where $r_t$ are the loglinearized returns on the net foreign asset position, the variable $nxa_t$ is a measure of *cyclical external imbalances* and $\Delta nx_{t+1}$ measures the cyclical net export growth. Unlike the current account, this expression incorporates information both from the trade balance (the flow) and the foreign asset position (the stock). It increases with assets and exports and decreases with imports and liabilities. Finally, the constant $\rho$ equals the ratio of the long term growth rate of the economy to the long term gross return on the net foreign asset position, assuming the economy eventually settles in a balanced growth path. Assuming a no-Ponzi condition and taking expectations, one obtains:

$$nxa_t \approx -E_t \sum_{j=1}^{+\infty} \rho^j \left[ r_{t+j} + \Delta nx_{t+j} \right] \tag{48}$$

where we assume $\rho < 1$ i.e. that the long-term growth rate of the economy is lower than the steady-state rate of return, a plausible restriction.[68]

Equation (48), which is the loglinearized equivalent of (44), is central to the analysis of external adjustment dynamics in a world of integrated financial markets. It shows that movements in net exports and the net foreign asset position must forecast either future portfolio returns, or future net export growth, or both. Consider the case of a country with a negative value for $nxa$, either because of a deficit in the cyclical component of the trade balance, or a cyclical net debt position, or both. If returns on net foreign assets are expected to be constant: $E_t r_{t+j} = r$. In that case, equation (48) implies that any adjustment *must* come through future increases in net exports: $E_t \Delta nx_{t+j} > 0$.

[67] In that sense the exercise is similar to the one performed in the business cycle literature, which separates trend growth from medium frequency fluctuations and focuses exclusively on the latter. It differs from it though, in that the trends considered here have considerably lower frequency. Evans (2012) proposes a variation that keeps the trend component. It requires that the ratio of gross assets to gross liabilities be stationary.

[68] This also implies that the steady state mean ratio of net exports to net foreign assets $NX/NA$ satisfies $NX/NA = \rho - 1 < 0$. In other words, countries with long run creditor positions ($NA > 0$) should run trade deficits ($NX < 0$) while countries with steady state debtor positions ($NA < 0$) should run trade surpluses ($NX > 0$).

As above, this is the standard implication of the intertemporal approach to the current account, where adjustment is done by quantities. This is the *trade channel of adjustment*.

But instead, the adjustment may also come from high *expected* net foreign portfolio returns: $E_t r_{t+j} > 0$. This is the *valuation channel of adjustment*. Such movements in predictable returns can occur via a depreciation of the domestic currency which induces a predictable wealth transfer from foreigners to domestic residents. The role of the exchange rate can be illustrated by considering the case -relevant for the US, the UK and generally advanced economies- where foreign liabilities are mostly denominated in domestic currency while foreign assets are mostly denominated in foreign currency. Holding local currency returns constant, a currency depreciation helps stabilize the net external asset position as it increases the domestic return on foreign assets, an effect that can be magnified by the degree of leverage of the net foreign asset portfolio. If we consider emerging markets, external liabilities are likely to be at least partly denominated in foreign currency (dollar or euro). A domestic currency depreciation might then lead to sizable losses on the net foreign asset position for these countries and be destabilizing, as in the Asian financial crisis of 1997-1998.[69]

**Quantifying the trade and the valuation channels of adjustment.** It is possible that some of today's fluctuations in the cyclical net foreign asset position come from *unexpected* changes in asset prices or net exports. These unexpected changes would be reflected simultaneously in the left and right hand side of equation (48). If valuation changes were mostly unexpected and had a white noise structure, they would not matter much for the underlying process of external adjustment. If, on the contrary, they had a predictable component they would be potentially an important component of the process of international adjustment, just like the trade channel.

We can decompose the cyclical imbalance $nxa_t$ into a valuation and a net export component $nxa_t = nxa_t^r + nxa_t^{\Delta nx}$ where $nxa_t^r$ is the component of $nxa_t$ that forecasts future returns, while $nxa_t^{\Delta nx}$ is the component that forecasts future net exports growth. We construct empirical estimates of $nxa_t^r$ and $nxa_t^{\Delta nx}$ using a VAR formulation. Specifically consider the VAR($p$) representation for the vector $(r_{t+1}, \Delta nx_{t+1}, nxa_t)'$. Appropriately stacked, this VAR has a first order companion representation: $z_{t+1} = A\ z_t + \epsilon_{t+1}$. We construct $nxa_t^r$ and $nxa_t^{\Delta nx}$ as:

$$nxa_t^r = \beta \mathbf{e}_r' \mathbf{A} \left(\mathbf{I} - \rho \mathbf{A}\right)^{-1} \mathbf{z}_t;\ nxa_t^{\Delta nx} = -\mathbf{e}_{\Delta nx}' \mathbf{A} \left(\mathbf{I} - \rho \mathbf{A}\right)^{-1} \mathbf{z}_t$$

where $e_r'$ ($e_{\Delta nx}'$) defines a vector such that $e_r' z_t = r_t'$ (resp. $e_{\Delta nx}' z_t = \Delta nx_t'$).

[69] Corsetti and Konstantinou (2012) uses a similar approach to show that transitory shocks are important drivers of gross asset and liability positions while variations in aggregate consumption are dominated by permanent shocks.

We can also compute the unconditional decomposition of the variance of $nxa_t$:

$$1 = -\frac{\text{cov}\left(\sum_{j=1}^{+\infty}\rho^j r_{t+j}, nxa_t\right)}{\text{var}\left(nxa_t\right)} - \frac{\text{cov}\left(\sum_{j=1}^{+\infty}\rho^j \Delta nx_{t+j}, nxa_t\right)}{\text{var}\left(nxa_t\right)} \equiv \beta_r + \beta_{nx}$$

The empirical study of the measure of cyclical imbalances of the United States $nxa_t$ uncovers the following stylized facts:

1. The valuation channel has historically accounted for roughly 30% of the process of adjustment of the United States towards its long run solvency constraint. The results are similar for the conditional decomposition and the unconditional variance decomposition ($\beta_r$).

2. The capital gains on the net foreign asset position are positively correlated with net exports for the United States.

3. Current imbalances help predict net exports (especially in the medium to long run), returns in the net foreign asset position (in the short to medium run) and the exchange rate from one quarter onwards, both in and out of sample.

Writing models compatible with these facts has proved to be a challenging task,as discussed in the next section.

## 5.2 Theoretical models and valuation effects

*Expected and unexpected valuation effects*

Valuation effects come in two flavors: unpredictable and predictable. The first variety does not create any particular difficulty for standard models of international finance: while we may argue over what model best characterizes international portfolio holdings, most models from our toolbox would incorporate in one form or another something akin to a parity condition. Conceptually, perhaps the simplest way to understand unpredictable valuation terms is by reference to a standard complete market model. In such a set-up, one can interpret unexpected valuation effects as the record-keeping of future payments on the contingent claims held by domestic and foreign investors, payments that implement full risk sharing. Interpreted in this light, the volatility generated by valuation adjustments could be interpreted as 'good volatility' insofar as it reduces the volatility of marginal utility of consumption and improves welfare.

Consider for example a symmetric two country two good endowment economy in complete markets. Imagine the domestic economy is hit by a positive output shock. As is well known (see

for example Chapter 5 of Obstfeld and Rogoff (1995)), when current realisation of domestic output is high compared to foreign's, the domestic economy is running a trade surplus, while the real exchange rate is depreciating due to the relative abundance of the domestic good. In complete markets, the home country becomes a net debtor as foreigners hold claims on current and future domestic output and domestic asset is worth more relative to foreign's. Hence foreigners realize an (unexpected) capital gain on their net asset position. So when its trade balance is in surplus, the domestic economy experiences a valuation loss on its net external asset position. This is the desired outcome from an efficient risk sharing point of view and these valuation gain and losses tend to stabilize the external debt dynamics. External liabilities will tend to disappear over time so that the relative wealth distribution remains stationary. Hence, in that standard set up, there are potentially strong valuation effects but these are unexpected capital gains and losses on the net foreign asset position. As such, they do not contribute to the adjustment process described in equation (48) which is driven by *expected* gains and losses. This is not to say that it would be impossible to get expected valuation effects in models with complete markets, but for this to happen, one would need, for example, models with time variation in the risk premia, such as external habits models (see Campbell and Cochrane (1999)).

Conversely, models with incomplete markets do not necessarily generate expected valuation effects. Pavlova and Rigobon (2012) present a continuous time two-country pure exchange model with incomplete markets in which stocks and a bond are traded and in which valuation effects are non existent. There are supply shocks in both countries as well as preference shocks for the home country good. By assuming log utility, Pavlova and Rigobon (2012) are able to elegantly obtain closed form solutions and to gain a number of important insights. Interestingly, in their model, preference shifts can introduce enough heterogeneity to generate non-zero bond holdings in equilibrium. They show that in the absence of intertemporal hedging –which comes from the log preference specification, the net foreign asset position is exactly equal to the present value of future trade deficit. This result reflects the absence of time varying risk premia in their incomplete asset market model. In log linearized models with more general utility specifications and incomplete markets such as for example Tille and van Wincoop (2010) or Evans and Hnatkovska (2012) similar results have been obtained as a first order approximation around the deterministic steady state. More generally, as long as the Euler condition of the model implies expected returns are equalized at the first order around the non stochastic steady state, expected valuation effects can only be of second or higher order, a point noted by Devereux and Sutherland (2010). Expected valuation effects will therefore generally not be quantitatively large.in this class of models, as they

can only reflect changes in second or higher order moments. As a result, and despite significant methodological advances made by Devereux and Sutherland (2011) and Tille and van Wincoop (2010), the recent microfounded literature on optimal portfolios in DSGE models of the open economy surveyed in Coeurdacier and Rey (2013) has not, so far, led to frameworks in which expected gains and losses on net foreign asset positions can be substantial.

*Modelling expected valuation effects*

By contrast, the predictable valuation effects that are relevant for the US adjustment along its long run solvency constraint require large deviations from standard arbitrage conditions. Some limited progress has been made toward modeling predictable valuation effects with a revival of the older portfolio-balance literature associated with the work of Dale Henderson, Pentti Kouri, or the late Bill Branson. Blanchard et al. (2005) provides a very elegant presentation of the Kouri portfolio balance model and explores its implications for the joint dynamics of the US current account and the dollar. In this literature, a key assumption is imperfect asset substitutability. A negative shock to the trade balance of the United States, leads to a depreciation of the US dollar. But this immediate unexpected depreciation does not fully offset the shock. If it did, there would be excess demand for US assets since the supply of assets is assumed inelastic and in dollar terms the value of the rest of the world's wealth rises. Instead, there is a less than offsetting drop in the dollar and foreigner's demand for US assets is kept in check by a further *expected* depreciation of the dollar towards its long run steady state value. The US keeps on accumulating more debt along the depreciation path so that the long run level of the dollar will be below that which would have been needed to offset the negative shock at once. If in contrast assets were perfect substitutes then the exchange rate would have immediately jumped to offset the negative shock fully. The imperfect substitutatibility of assets implies a slow adjsutment of the portfolios together with expected exchange rate changes. Very interestingly the model does therefore predict that foreigners will be purchasing US dollar assets while expecting a dollar depreciation. The model however has the drawback of assuming exogenous interest rates and ad hoc demand functions for financial assets. Microfoundations and general equilibrium effects tend to mute portfolio balance effects. For example, Backus and Kehoe (1989) have shown in the context of sterilized interventions on foreign exchange markets that if a general equilibrium setting is adopted, portfolio balance effects are not present any longer. Changes in the relative supplies of bonds do not matter if one takes into account the ensuing changes in monetary and fiscal variables. As Woodford (2012) recently remarked in his Jackson Hole address assessing the effectiveness of open market purchases, in most

of our microfounded general equilibrium models, a Modigliani -Miller irrelevance results holds (see Wallace (1981)). When assets are valued "only for their pecuniary returns" (they may not be perfect substitutes from the standpoint of investors, owing to different risk characteristics, but not for any other reason) and when there are no limits to arbitrage, one of the core predictions of portfolio balance models, which is that changing the relative supply of assets has an effect on prices, goes away. This is because the market price of any asset is taken to be the present value of returns. Since changing the relative supplies of assets should not change the real quantity of resources available for consumption in each state of the world, the representative household's marginal utility of income in different states of the world should not change. Hence the pricing kernel should not change, and the market price of a given asset should not change, either (see Woodford (2012) p61).

The open economy literature has so far not managed to come up with a new generation of portfolio balance models microfounded and embedded in a general equilibrium set up. In the context of closed economies some recent papers have introduced strong frictions on asset markets in order to rationalize the effect of net supply changes on prices. Greenwood and Vayanos (2008) for example build on the idea of "preferred habitat" for bond market investors, a very strong form of non-substitutatility of assets, to study the effect of open market interventions. A similar research agenda could be pursued in the open economy.

# 6 The International Monetary and Financial System

The world banker balance sheet of the US generates excess returns in normal times. But, as explained in Gourinchas et al. (2010), this "exorbitant privilege" has a counterparty in times of financial turmoil. The US as the center country of the international monetary system provides insurance to the rest of the world. During a global crisis, there is a massive wealth transfer from the US to the rest of the world. This insurance transfer occurs at a time where the marginal utility of consumption is high. This is the "exorbitant duty". It is implemented very naturally by a portfolio long in risky assets -whose value goes down dramatically in crisis times- and short on government debt -whose value remains relatively stable in crisis times-. This is precisely the external portfolio of the US, issuer of the safe asset, the reserve currency, which is held in large quantities abroad. Hence Gourinchas et al. (2010) argues that the US plays the role of a *global insurer*. This interpretation of the role of the centre country in the international monetary system is new. Traditional views have focused on the network externality in the use of the centre country's currency as a medium of exchange: the dollar is used in international transactions because the sheer

size of the US economy in the world makes it more likely that other agents use it and therefore dollar transaction costs are low (see for example Krugman (1980)).

The economic intuition of the global insurance role of the US can be simply captured within a CCAPM framework[70]. If we denote the net foreign asset position of of the US as $NA_t = A_t - L_t$, the external solvency constraint (in a world with no government consumption nor investment) is given by $NA_{t+1} = \left(1 + r^a_{t+1}\right) A_t - (1 + r^l_{t+1}) L_t + Y_t - C_t$. where $r^a_{t+1}$ and $r^l_{t+1}$ are the returns on gross external assets and liabilities.

Let us call $r_t$ the risk free rate of interest, we can then use the no arbitrage condition of a representative consumer model to get

$$(1 + r_t) E_t \left( \frac{\beta u'(C_{t+1})}{u'(C_t)} \right) = E_t \left( \frac{\beta u'(C_{t+1})}{u'(C_t)} (1 + r^a_t) \right) = E_t \left( \frac{\beta u'(C_{t+1})}{u'(C_t)} \left(1 + r^l_t\right) \right) = 1$$

Multiplying the external constraint through by the pricing kernel and taking expectation:

$$E_t \left[ \frac{\beta u'(C_{t+1})}{u'(C_t)} NA_{t+1} \right] = A_t - L_t + \frac{Y_t - C_t.}{1 + r_t}$$

which is equivalent to

$$E_t (NA_{t+1}) = (1 + r_t) NA_t + Y_t - C_t - (1 + r_t) cov_t \left[ \frac{\beta u'(C_{t+1})}{u'(C_t)}, NA_{t+1} \right]$$

Hence, by having a net external position which comoves negatively with the stochastic discount factor (i.e .which decreases when the marginal utility of consumption is high), the US is able to increase the expected return on its net foreign asset position (this is the "exorbitant privilege"). As a mirror image, the rest of the world sees its return on its net foreign asset position decreased due to the hedge provided by the centre country. Indeed during the 2007-2009 global financial crisis, the US wealth transfer to the rest of the world amounted to about $2 trillion. Gourinchas et al. (2012) present some empirical evidence on the geographical distribution of gains and losses. Interestingly during that period, some regional insurers such as Switzerland and the euro area also provided wealth transfers to the rest of the world alongside the US, albeit on a much smaller scale.

Gourinchas et al. (2010) provides a theoretical model of the role of the US as the global insurer. The model features both business cycle and global risk. The US portfolio, endogenously determined, is long equity and short in safe assets. This portfolio reflects an assumed asymmetry in risk aversion between the US and the Rest of the World (more risk averse).[71] One way of microfounding this

[70] We are very grateful to Maury Obstfeld for this insight.

[71] Stepanchuk and Tsyrennikov (2011) also model the US as a less risk averse economy and use global solution

asymmetry in risk aversion is provided by Maggiori (2011) who models a world in which financial development is unequal. The country whose financial intermediaries are less constrained will behave in the aggregate as if it were less risk averse. Another possible microfoundation can be found in Mendoza et al. (2009), where it is a better ability to share idiosyncratic risk within the US, which enables the US to be long in risky assets internationally. Focusing on international bond markets, Hassan (forth) emphasizes differences in country sizes to explain differences in real rates of returns. In his model, bonds of larger economies (in particular the US) are better hedges because they insure against shocks that affect a larger fraction of the world economy.

This interpretation of the workings of the International Monetary System, where the US is a global insurer, puts center stage the ability of the US to issue safe assets (government bonds). Those are backed by the *fiscal capacity* of the United States. During times of global crisis, US government bonds are the only assets able to provide insurance on a massive scale (the Swiss bond market can also be considered a safe haven but its sheer size precludes it from being the world insurer). This in turn suggests the emergence of a modern version of the Triffin dilemma. In the 1960s, Robert Triffin identified a fundamental weakness in the Bretton Woods institutions. Under that system, the currencies of member countries could be exchanged at a fixed rate against the dollar while the value of the dollar was fixed against gold at $ 35/oz. Triffin observed that global liquidity demand grows with the global economy. As the rest of the world grew, so did the stock of dollars held abroad. In the meantime, however, the United States' gold stocks (backing the dollars held abroad) remained more or less constant. Maintaining the gold value of the dollar had to become increasingly difficult, and the dollar crisis of the dollar unavoidable. Ten years before the end of the Bretton Woods system, Triffin had thus predicted its collapse.The gold value of the dollar is no longer fixed, but we still live in a Triffin style world. There is a growing asymmetry between the fiscal capacity of the United States (the "backing" of U.S. Treasury bills) and the stock of reserve assets held abroad, in other words, the U.S.'s external debt, thus threatening the ability of the US to act as a world insurer (see Farhi et al. (2011) and Obstfeld (2011)).

## 7 Conclusions

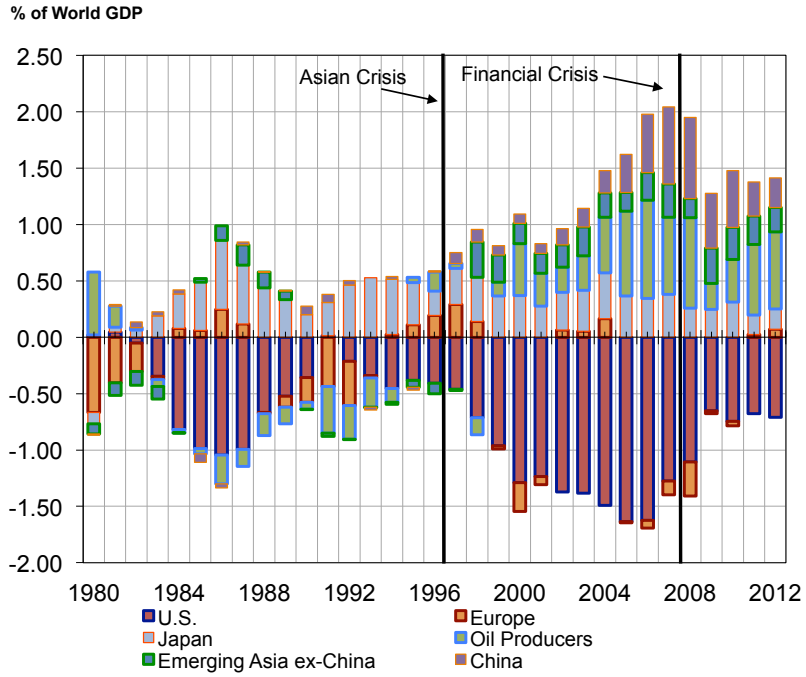
The consequences of these dramatic changes in the landscape of international finance have only started to be investigated recently. A large part of the economics profession, as well as international organizations (see for example Fischer (1997)) often see financial integration as an ideal towards

methods to solve for optimal portfolios under incomplete markets.

which economies should aspire. The belief was that by moving towards a more integrated world, the international economy would reap many of the benefits from better risk sharing. The recent crisis however, having shaken advanced economies financial systems more deeply than emerging markets' has altered this view and put at the forefront the dangers of contagion inherent to large cross-border holdings. It has become more obvious that current accounts deficits or surpluses, linked to net capital flows, miss important dimensions of the process of international adjustment of countries and of their financial fragility in crisis times.[72] After all, the euro area was running a balanced current account vis-a-vis the US and yet it was deeply affected by the US financial crisis of 2007-8. The properties of the international balance sheet of countries determine how different shocks propagate across countries and how countries adjust. There is a clear need for a deeper analysis of the international financial landscape.

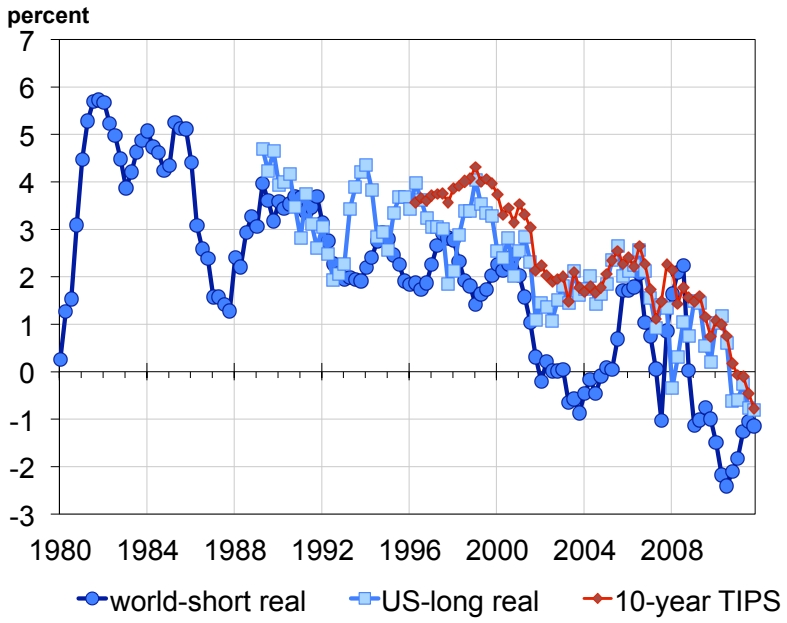
[72] See Obstfeld (2012) for a recent careful and nuanced discussion of the role of current accounts.

Figure 1: Global Imbalances: Current Accounts.



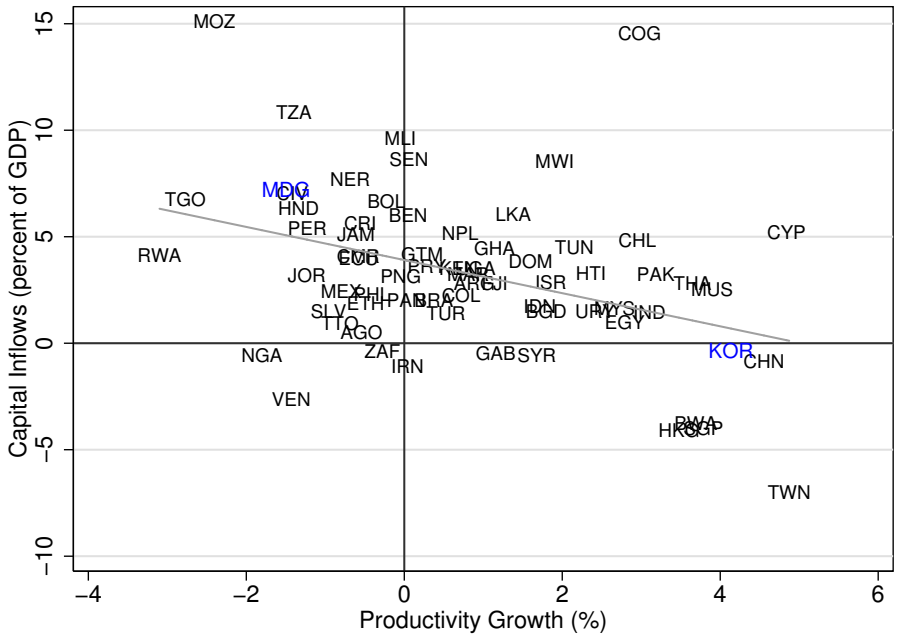

Notes: Oil Producers: Bahrein, Canada, Kuweit, Iran, Lybia, Nigeria, Norway, Mexico, Oman, Russia, Venezuela, Saudi Arabia; Emerging Asia ex-China: Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand. Europe: European Union. Source: IMF World Economic Outlook

Figure 2: Global Imbalances: World Interest Rates.



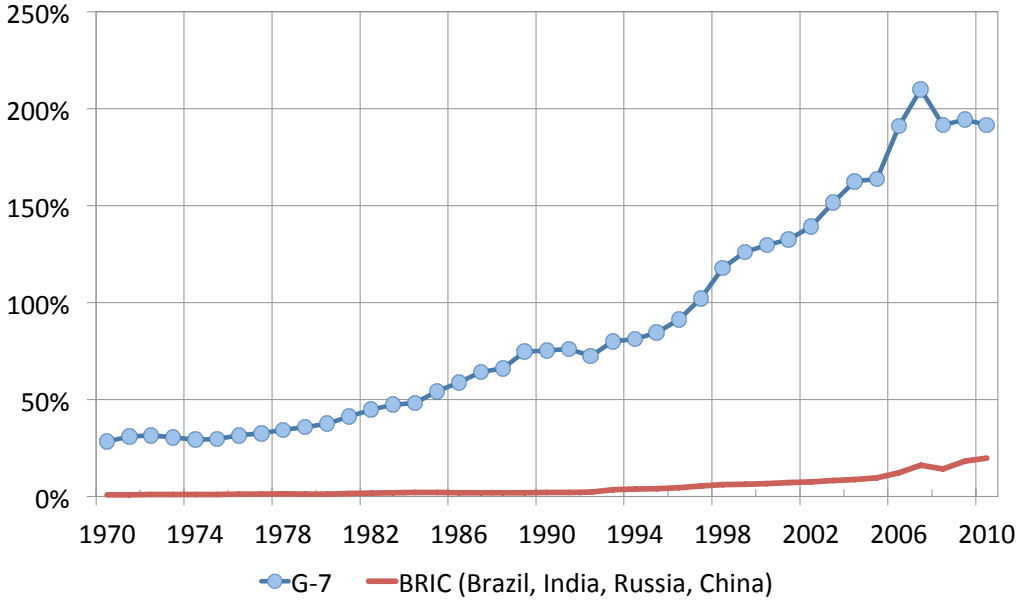

Notes: world-short real: ex-post 3-month real interest rate for the G-7 countries (GDP weighted). US-long real: 10 year yield on U.S. Treasuries minus 10-year expected inflation. 10-year TIPS: yield on inflation indexed 10-year Treasuries. Source: Global Financial Database, IMF International Statistics, OECD Economic Outlook, Survey of Professional Forecasters

Figure 3: Average productivity growth and capital inflows between 1980 and 2000.

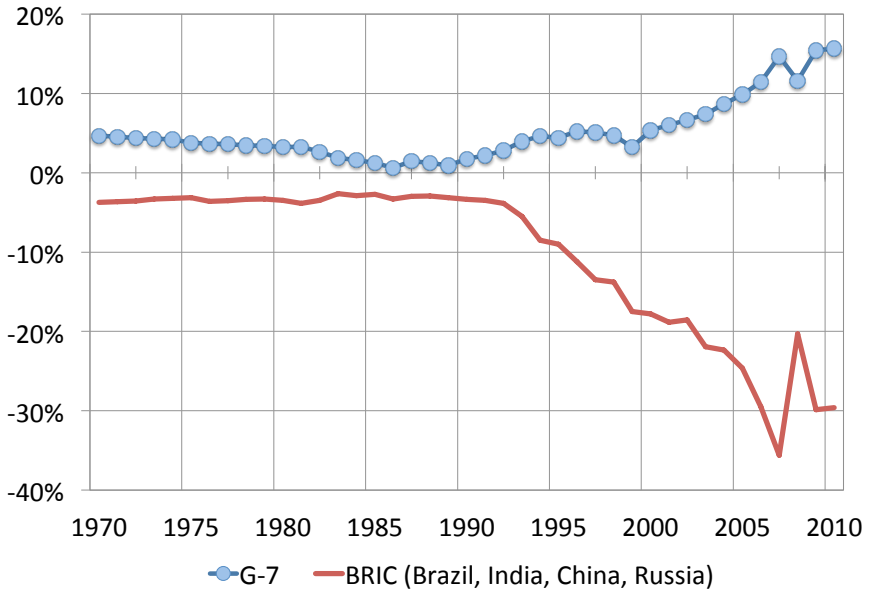



Source: Gourinchas and Jeanne (forth.). Sample of 68 developing economies

Figure 4: G-7 Cross Border Assets and Liabilities (percent of world GDP)

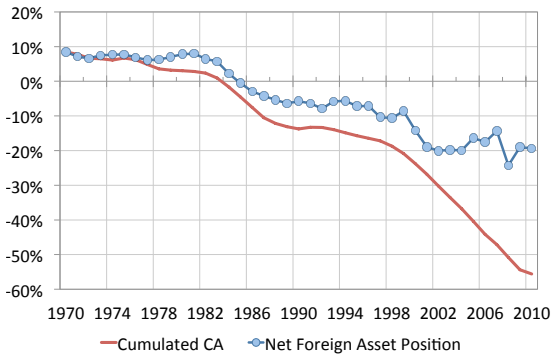



Source: Lane and Milesi-Ferretti (2007a) updated to 2010. Gross external assets and liabilities, scaled by world GDP.

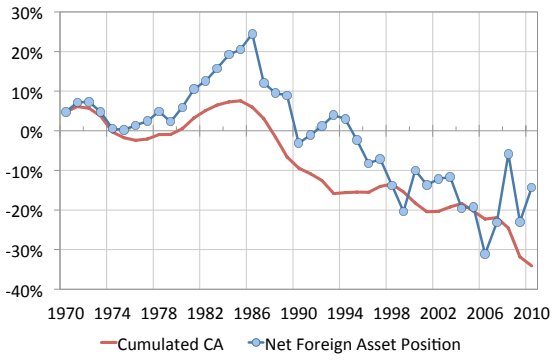



Source: Lane and Milesi-Ferretti (2007a) updated to 2010. Net risky position defined as equity and direct investment assets, minus equity and direct investment liabilities. percent of GDP

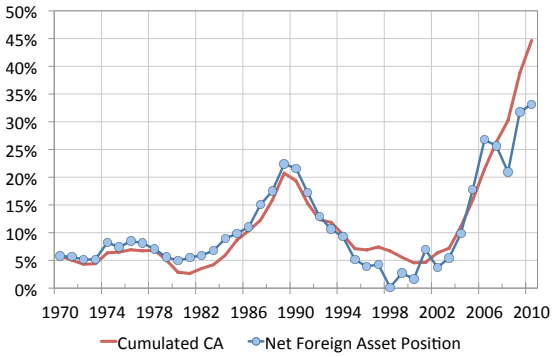
Figure 6: Cumulated Current Account and Net Foreign Asset Position, US, UK, Germany and Japan, 1970-2010. Percent of GDP



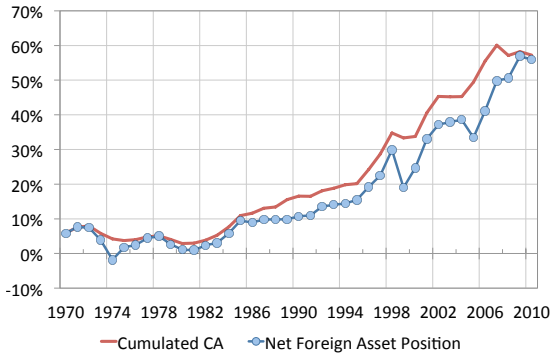

(a) United States




(b) United Kingdom



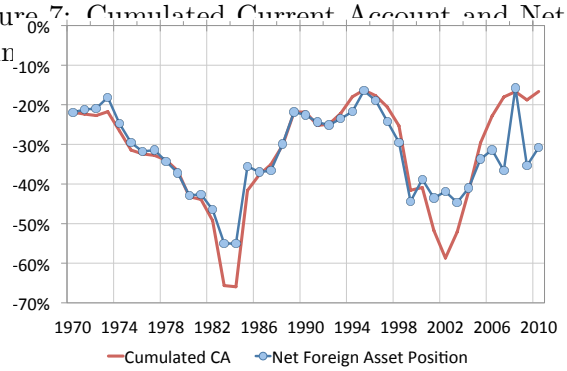

(c) Germany



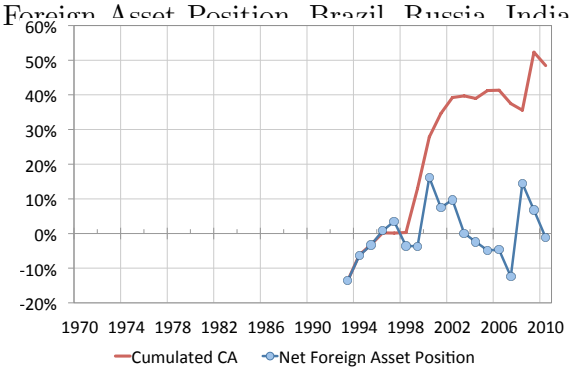

(d) Japan

Source: Lane and Milesi-Ferretti (2007a) updated to 2010.

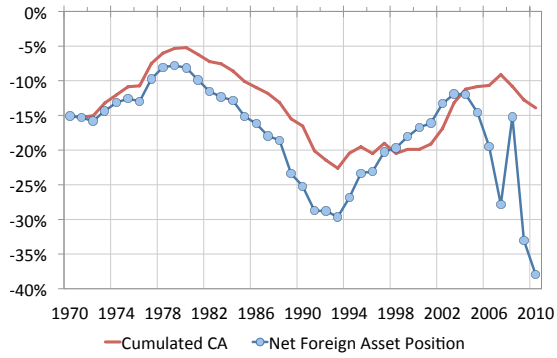
Figure 7: Cumulated Current Account and Net Foreign Asset Position. Brazil, Russia, India and China



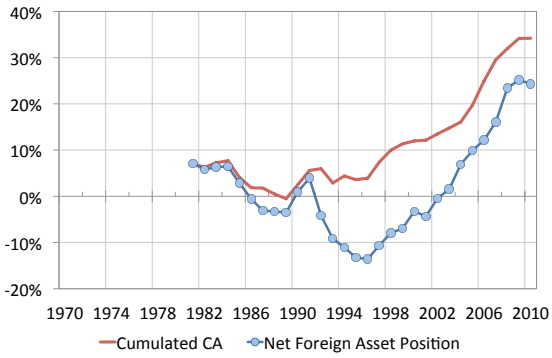

(a) Brazil




(b) Russia




(c) India




(d) China

Source: Lane and Milesi-Ferretti (2007a) updated to 2010.

Figure 8: The Metzler diagram

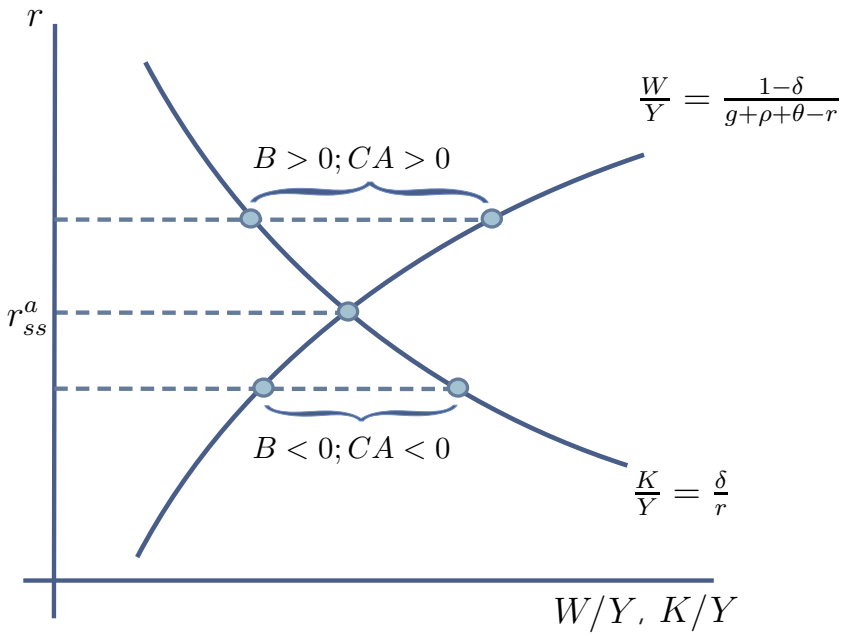
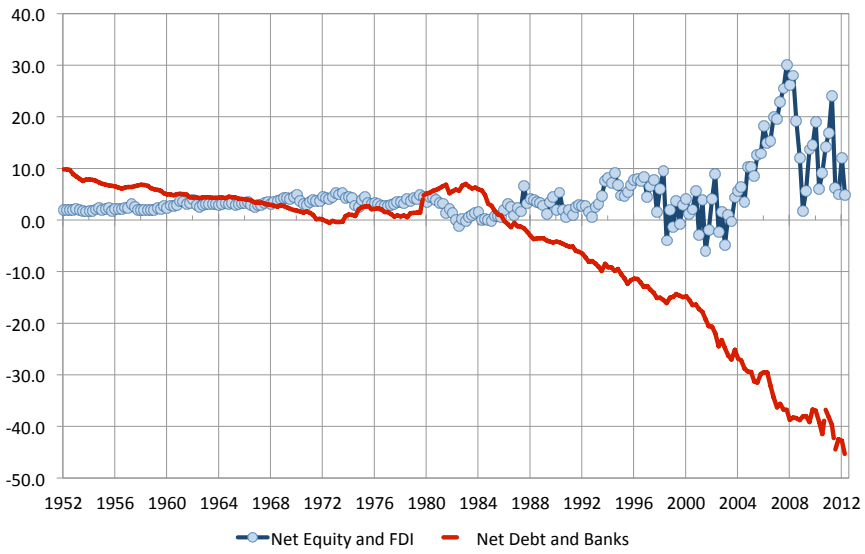
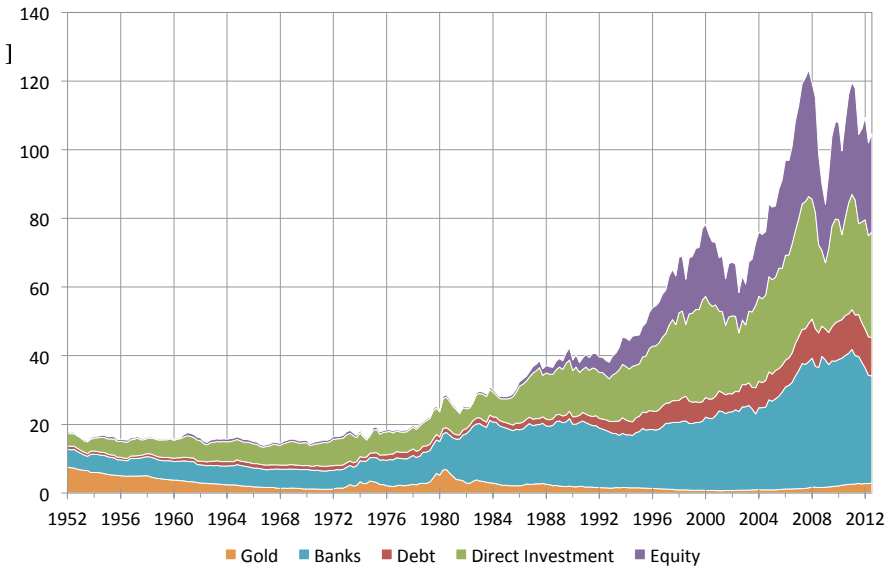


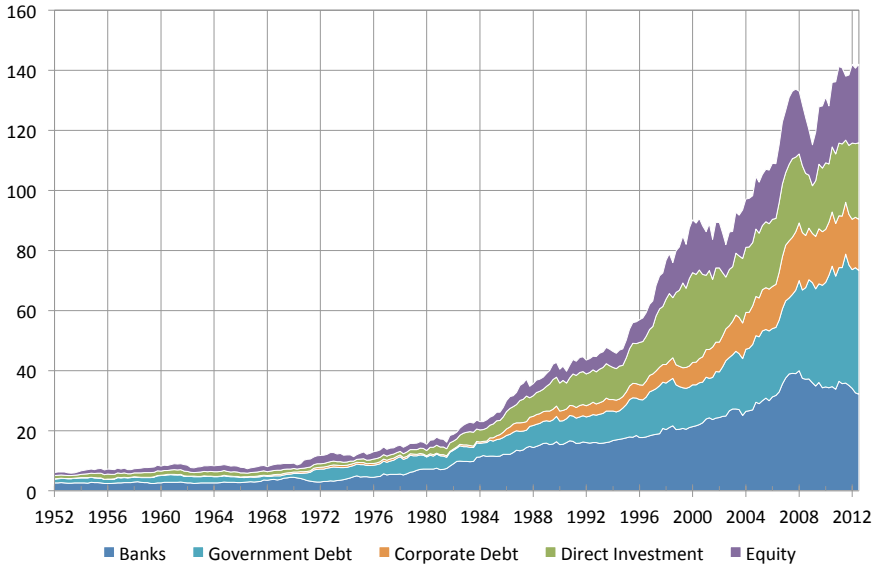
Figure 9: Net portfolio equity and direct investment (percent of GDP) and net portfolio debt and other assets (percent GDP).




Source: Gourinchas et al. (2010).




(a) Gross Assets (percent of GDP)




(b) Gross Liabilities (percent of GDP)

Source: Gourinchas et al. (2010)

| | Period | | |
|---|---|---|---|
| Region | 1980-1996 | 1997-2006 | 2007-2012 |
| United States | -0.44 | -1.17 | -0.86 |
| Japan | 0.32 | 0.36 | 0.26 |
| European Union | -0.10 | 0.04 | -0.07 |
| Oil producers | -0.06 | 0.28 | 0.57 |
| China | 0.01 | 0.15 | 0.49 |
| Emerging Asia ex-China | -0.01 | 0.19 | 0.26 |
| Latin American and Caribbean | -0.13 | -0.10 | -0.07 |
| Rest of the World | -0.08 | -0.02 | -0.14 |

Source: IMF World Economic Outlook, April 2012. Oil producers consists of Canada, Norway, Mexico, Russia, Venezuela, Saudi Arabia, Iran, Kuweit, Libya, Oman and Bahrein. Emerging Asia ex-China consists of Taiwan, Korea, Malaysia, Indonesia, Philippines, Singapore and Thailand.

Table 1: Current Account Balances, fraction of world GDP.

| Period | US | UK | Ireland | Germany | Japan | Brazil | Russia | China | India | Switzerland |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | —valuations— | | | | | |
| 1971-1980 | 0.84% | 1.29% | 3.12% | 0.67% | 1.3% | 0.97% | N/A | 0.00% | 0.44% | 10.74% |
| 1981-1990 | 0.93% | 3.59% | 3.73% | 0.75% | 0.83% | 2.02% | N/A | 1.47% | 0.98% | 9.76% |
| 1991-2000 | 1.79% | 4.71% | 18.67% | 1.42% | 2.03% | 2.11% | 4.26% | 2.95% | 1.16% | 9.39% |
| 2001-2010 | 4.75% | 7.57% | 13.29% | 3.91% | 2.67% | 8.38% | 13.71% | 2.22% | 6.08% | 11.84% |
| | | | | | —current accounts— | | | | | |
| 1971-1980 | 0.40% | 1.16% | 5.75% | 1.00% | 1.15% | 5.74% | N/A | 0.00% | 0.82% | 2.16% |
| 1981-1990 | 1.95% | 2.16% | 4.23% | 2.71% | 2.32% | 2.32% | N/A | 1.52% | 1.68% | 3.72% |
| 1991-2000 | 2.12% | 2.21% | 0.48% | 1.48% | 2.26% | 2.05% | 9.02% | 1.94% | 1.13% | 8.55% |
| 2001-2010 | 4.56% | 2.24% | 2.37% | 4.50% | 3.39% | 1.67% | 7.94% | 5.43% | 1.41% | 10.96% |

The table reports the average valuation and current account components, as a share of GDP, for each sub period, where the average valuation and current account components are defined as $VA = 1/T \sum_t \left| \frac{NA_t - NA_{t-1} - CA_t}{GDP_t} \right|$ and $CA = 1/T \sum_t \left| \frac{CA_t}{GDP_t} \right|$.

Table 2: Valuations and Current Accounts, (average p.a., % GDP)

| | Period | | |
|---|---|---|---|
| | 1952:1-2011:4 | 1952:1-1972:4 | 1973:1-2011:4 |
| Excess returns | $r^a - r^l$ | $r^a - r^l$ | $r^a - r^l$ |
| (a) $OC_{t+1}$ allocated to flows | 1.6% | 0.8% | 2.0% |
| (b) $OC_{t+1}$ allocated to flows (except for FDI) | 2.1% | 0.8% | 2.8% |
| (c) $OC_{t+1}$ allocated to valuations | 2.7% | 0.8% | 3.8% |
| | Previous estimates | | |
| (d) Initial Gourinchas and Rey (2007a) on 1952-2004 | 2.1% | | |
| (e) Curcuru et al. (2008b) on 1994-2005 | 0.72% | | |
| (f) Forbes (2010) on 2002-2008 | 6.9% | | |
| (g) Lane and Milesi-Ferretti (2009) on 1980-2004 | 3.9% | | |
| (h) Obstfeld and Rogoff (2005) on 1983-2003 | 3.1% | | |

Table 3: Various Estimates of the Excess Returns on the U.S. Net Foreign Asset Position

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