Financial Integration, Financial Deepness and Global Imbalances[1]

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Abstract

Large global financial imbalances need not be the harbinger of a world financial crash as many authors believe. Instead, we show that large and persistent global imbalances can be the outcome of financial integration when countries have different financial markets characteristics. In particular, countries with more advanced financial markets accumulate foreign liabilities vis-a-vis countries with less developed financial systems in a gradual, long-lasting process. Moreover, differences in financial development affect the composition of foreign portfolios, so that a country with *negative* net foreign asset positions can receive *positive* factor payments. Three empirical observations support these arguments: (1) financial deepness varies widely even amongst industrial countries, with the United States ranking at the top; (2) the secular decline in the U.S. net foreign assets position started with a gradual process of financial markets liberalization; (3) net exports and current account balances are negatively correlated with indicators of financial markets development.

1 Introduction

The current account deficit of the United States will reach 2 percentage points of the world's GDP by the end of 2006 and the country's net foreign liabilities will reach 8 percent of global output. The IMF (2006) expects the U.S. current account to remain in the red through 2011. By then, U.S. net foreign liabilities will be about 15 percent of the size of the global economy. These are unprecedented global imbalances that are fueling heated debates in academic and policy circles. On the one hand there is the view that, unless major policy actions are taken, these imbalances will lead to global financial turbulence and, most likely, to a world economic crisis (e.g. Summers (2004), Obstfeld & Rogoff (2004), Roubini & Setser (2005), Blanchard, Giavazzi & Sa (2005)). On the other, there is the view that the imbalances are the harmless outcome of various events such as differences in productivity growth, 'global saving glut', or valuation effects (e.g. Backus, Henriksen, Lambert & Telmer (2005), Bernanke (2005), Croke, Kamin and Leduc (2005), Gourinchas and Rey (2005), Hausmann & Sturzenegger (2005), Lane and Milesi-Ferretti (2005), Caballero, Farhi & Gourinchas (2006), Cavallo and Tille (2006)).

This paper proposes an explanation of global imbalances that has not been fully explored in this debate. We argue that an important factor underlying the large and persistent global imbalances is the cross-country heterogeneity in financial markets. These differences started to matter after the far-reaching reforms that liberalized the international capital markets during the 1980s and 1990s. The reforms were predicated on the benefits that financial globalization would have for efficient resource allocation and risk-sharing across countries. But these arguments generally abstracted from the fact that financial systems differ substantially across countries.

The motivation for studying the consequences of capital markets liberalization among countries with different financial characteristics comes from three key empirical observations:

1. Measures of financial development or financial deepness differ sharply across countries, even across industrial countries. Moreover, these differences have changed very little in the past 10 years. (Figure 1).

2. The net foreign asset position of the country with the highest level of financial development—the United States—shows a secular decline that

began at roughly the same time as the major financial liberalization reforms in industrialized and emerging economies (Figures 2 and 3).

3. Net exports and current account balances, as a share of GDP, are negatively correlated with proxies for the degree of financial markets development (Figure 4).

These empirical observations raise three important questions that we seek to answer with our model: First, if countries involved in the process of financial integration are characterized by different financial structures, can we expect to see the type of imbalances observed in the data? Second, are these imbalances temporary or permanent? Third, are policies aiming at reverting the imbalances desirable?

Our analysis shows that financial liberalization amongst countries with different levels of financial development leads to the build up of large global imbalances. This result is derived from the quantitative predictions of a multi-country dynamic general equilibrium model. Countries are inhabited by a continuum of ex-ante identical consumers who face two types of idiosyncratic shocks: endowment and investment shocks. 'Financial development' is captured by the extent to which financial contracts are enforceable. This can range from the case in which contracts are perfectly enforceable, allowing for the full insurability of the idiosyncratic risk (complete markets), to the case in which enforcement is so limited that the only mechanism for consumption smoothing is the accumulation of non-contingent assets.

Analytical characterizations as well as numerical simulations of a two-country version of the model show that, if country U (say the United States) is more financially developed than country E (Europe or emerging economies), financial integration causes U's net foreign asset position to decline to very low values in the long-run. In fact, moderate differences in financial deepness can easily lead to net foreign asset positions larger than domestic production. This is a gradual and long-lasting process that can take more than 30 years.

We also shows that countries with different financial markets characteristics choose different compositions of foreign assets. In particular, countries with deeper financial markets invest in foreign risky assets and finance the investment with debt. Because of the higher return from the risky investment, these countries could receive positive net factor payments even if their net foreign asset position is negative. This is in line with the structure of the U.S. foreign balances as documented by Gourinchas and Rey (2005) and Lane and Milesi-Ferretti (2006).

Studies of the global imbalances based on quantitative predictions of dynamic optimizing models are not common in the literature. Yet, it is critical that assessments of the effects of these imbalances, and the policy recommendations derived from them, be based on models that explain why the imbalances emerged in the first place and whether their normative implications justify policy interventions.

Chapter 1 of IMF (2005) and the studies of Faruqee, Laxton, Muir & Pesenti (2005) and Caballero, Farhi & Gourinchas (2006) are amongst the few that examine global imbalances with quantitative dynamic optimizing models. IMF (2005) and Faruquee et al. (2005) conduct simulations based on a multi-country, multi-sector model with nominal rigidities in line with the New Open Economy Macroeconomics. The focus of these exercises is on examining alternative policy scenarios for the unwinding of the imbalances, rather than explaining the imbalances themselves. Global imbalances emerge as the outcome of a combination of exogenous shocks, such as a permanent increase in U.S. fiscal deficit, a permanent decline in the rate of time preference in the U.S., and a permanent increase in foreign demand for U.S. financial assets. In contrast, the model developed in this paper predicts a reduction in U.S. savings and an increase in the foreign demand for U.S. assets endogenously, after liberalization, as a result of the different characteristics of the U.S. financial system. This occurs even if all countries have identical preferences, resources and production technologies. The result only derives from differences in the characteristics of financial markets across countries.

The model proposed by Caballero et al. (2005) also emphasizes the importance of the financial structure for global imbalances. There are important differences between the two papers. In their model financial imperfections are captured by the country's ability to *supply* assets in a world without uncertainty. In our framework, instead, financial imperfections have a direct impact on savings, and therefore, on the *demand* of assets. The second difference is the explanation for global imbalances. Caballero et al. (2005) propose differential shocks to productivity growth and/or to the financial structure of countries. Our explanation, instead, relies on structural differences in the characteristics of the financial markets. These differences started to matter for global imbalances only after the gradual liberalization of capital markets in the 1980s and 1990s.

2 Empirical motivation

A recent study by the International Monetary Fund (IMF (2006), chapter 4) constructs an index of financial markets development. One of the variables used to construct the index is the volume of financial transactions that take place through direct market instruments (securities) instead of being intermediated by traditional financial institutions such as banks. Countries with higher indices are characterized by a larger volume of transactions taking place through direct market instruments. The study also compares the evolution of the index over time. The main finding, shown in Figure 1, is that the United States has the highest score. Furthermore, the gap with the U.S. has not changed substantially during the last decade even if most of the countries are becoming more market oriented.

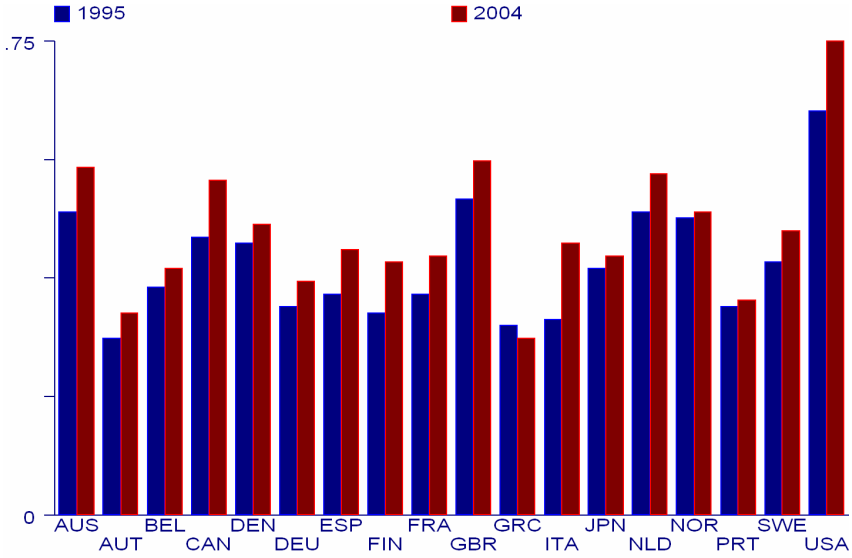


Figure 1: Financial index score for advanced economies. Source: IMF (2006), chapter 4.

The second observation relates to international financial markets liberalization. Chinn and Ito (2005) compile an index of the degree of capital account openness for 163 countries from 1970 to 2004. The index is based on binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the Annual Report on Exchange

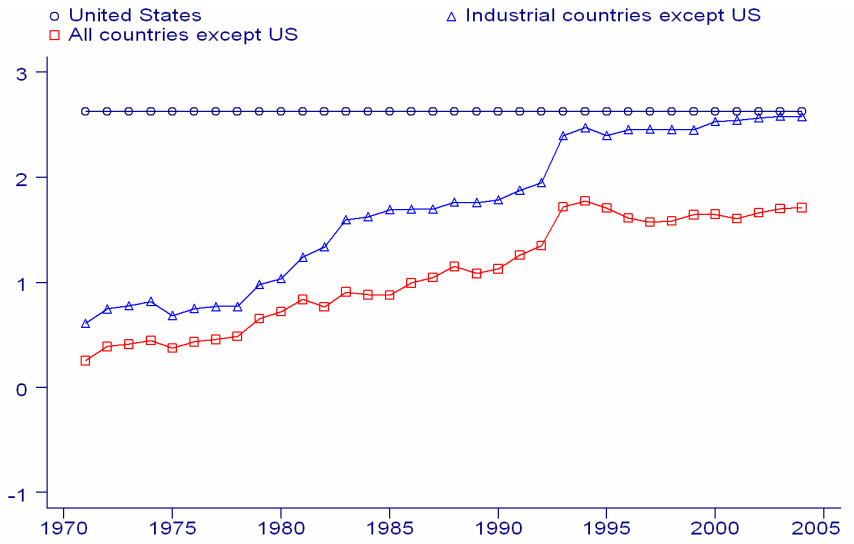


Figure 2: Financial openness index, 1970-2004. Source: Chinn and Ito (2005) and www.ssc.wisc.edu/~mchinn/research.html.

Arrangements and Exchange Restrictions (AREAER) from the IMF. The dummy variables reflect the four major categories on the restrictions on external accounts: presence of multiple exchange rates; restrictions on current account transactions; restrictions on capital account transactions; and requirements for the surrender of export proceeds. The index is the first standardized principal component of these four variables and it takes higher values for countries that are more open to cross-border capital transactions.

Figure 2 reports the value of the openness index for the United States, the group of industrialized countries with the exclusion of the US, and for all countries except the US. The indices are computed as means of individual country indices, weighted by GDP. Although the US has always been open during the last three decades, most of the other countries have been liberalizing gradually since the beginning of the 1980s. What is remarkable is that the timing of the liberalization almost coincides with the deterioration of the US foreign asset position as shown in the next figure.

Figure 3 plots the net foreign asset positions for the United States. The figure also plots the aggregate positions for the group of industrialized countries, excluding the US, and for the emerging economies. The data has been constructed by Lane and Milesi-Ferretti (2006). We can clearly see that he

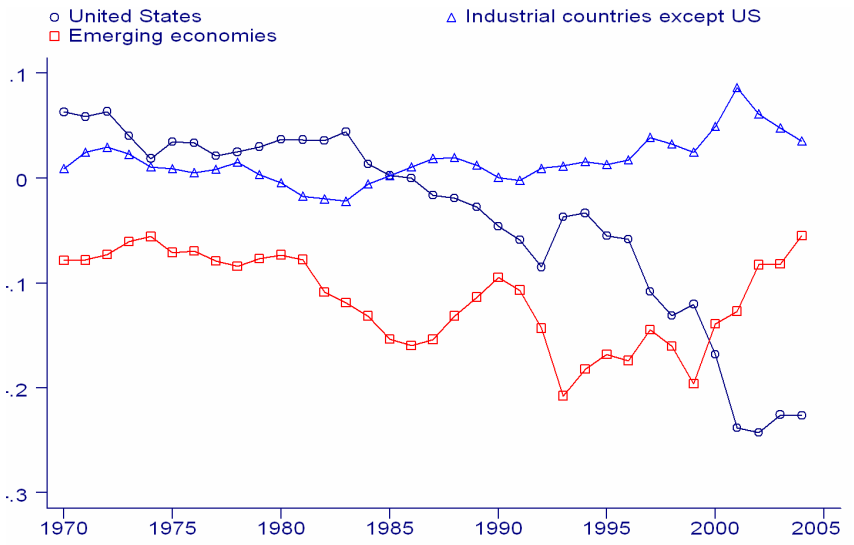


Figure 3: Net foreign asset position relative to GDP, 1970-2004. Source: Lane and Milesi-Ferretti (2006).

deterioration of the US external position is not a recent phenomenon but it has been unraveling almost uninterrupted since the first half of the 1980s. This is right after most of the countries started to liberalize their capital accounts as we have seen in the previous figure.

To further explore the connection between financial development and global imbalances, in the remaining part of this section we will conduct a cross-country analysis using proxies for the degree of financial development. An indicator of financial markets development often used in the finance-development literature is 'Domestic Credit to the Private Sector' (see, for example, Demirguc-Kunt and Levine (2001)). This is defined as the financial resources provided to the private sector, such as loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. This variable is compiled by the World Bank as part of *World Development Indicators*. Our goal is to examine whether private credit is correlated with international flow imbalances, either 'Net Exports of Goods and Services' or the 'Current Account Balances'.

We run the following regression:

$$NEX_{it} = \alpha_0 + \alpha_1 \cdot CREDIT_{it} + \alpha_2 \cdot CGDP_{it} + \varepsilon_{it} \qquad (1)$$

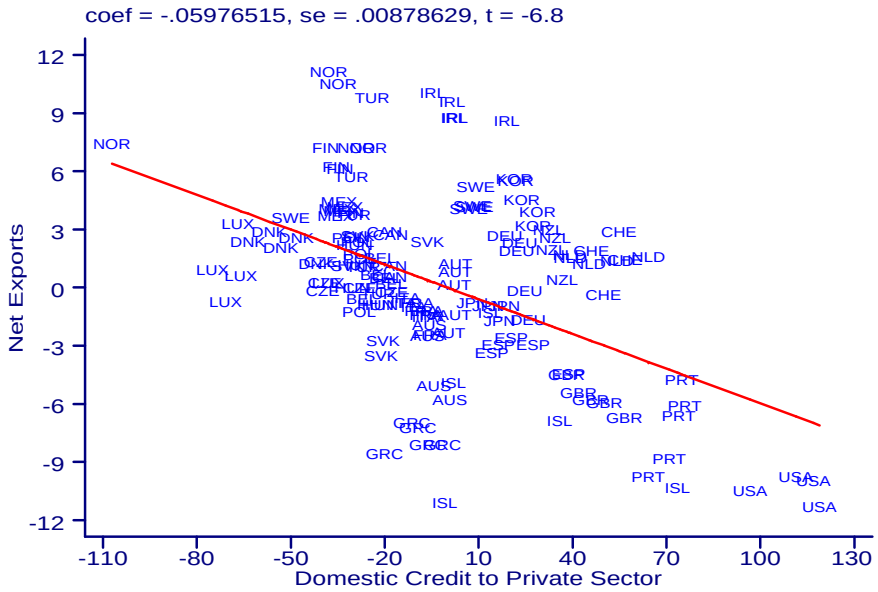


Figure 4: Net exports and domestic credit in OECD countries, 2000-2004.

where NEX is net exports (or current account) in percentage of GDP; $CREDIT$ is domestic credit to the private sector also in percentage of GDP; $CGDP$ is per-capita GDP. The subscripts identify country and year. The inclusion of per-capita GDP controls for the stage of economic development.

We estimate the above relation using yearly data for OECD countries for the period 2000-2004. The results are reported in the first column of Table 1. Figure 4 shows the conditional correlation between domestic credit and net exports, which is negative and statistically significant. This suggests that countries with deeper financial markets tend to experience trade deficits while countries with lower financial deepness tend to experience trade surpluses. Given the resource identity $S = I + NEX$, this can be restated as saying that countries with deeper financial markets save less than their domestic investment while countries with lower financial deepness save more. The variation of net exports captured by domestic credit and per-capita GDP is quite high (R^2 above 60 percent).

The negative correlation of domestic credit with net exports is robust to alternative sample periods. We re-estimate equation 1 for 1995-2004 and 1990-2004 with similar results, although the R^2 tends to decline as we extend the sample to earlier years. The right section of the table also shows that

Table 1: Financial deepness and foreign imbalance in OECD countries

	Net Exports			**Current Account**		
	2000-2004	*1995-2004*	*1990-2004*	*2000-2004*	*1995-2004*	*1990-2004*
Pooled regression						
$CREDIT$	-0.0598	-0.0509	-0.0457	-0.0349	-0.0269	-0.0224
	*(0.0088)**	*(0.0068)**	*(0.0056)**	*(0.0099)**	*(0.0069)**	*(0.0055)**
$CGDP$	0.00063	0.00058	0.00054	0.00041	0.00039	0.00035
	*(0.00004)**	*(0.00003)**	*(0.00003)**	*(0.00005)**	*(0.00004)**	*(0.00003)**
$CONSTANT$	-8.287	-7.589	-6.867	-7.053	-6.713	-6.073
	*(0.950)**	*(0.688)**	*(0.539)*	*(1.121)**	*(0.722)**	*(0.538)**
R^2	0.633	0.525	0.468	0.353	0.318	0.285
Obs.	144	289	432	145	289	428
Fixed effect regression						
$CREDIT$		-0.0406	-0.0448		-0.0370	-0.0505
		*(0.0085)**	*(0.0066)**		*(0.0092)**	*(0.0077)**
$CGDP$		0.00029	0.00043		-0.00003	0.00014
		*(0.00006)**	*(0.00004)**		*(0.00006)*	*(0.00005)**
$CONSTANT$		-1.620	-4.442		3.897	0.913
		(1.191)	*(0.833)**		*(1.304)**	*(1.028)*
R^2 (within)		0.121	0.233		0.079	0.099
R^2 (between)		0.541	0.543		0.100	0.010
R^2 (overall)		0.472	0.461		0.049	0.013
Obs.		289	432		289	428

Notes: Data is from the World Bank, *World Development Indicators*. The countries included in the sample are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherland, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

* Significant at 1 percent level.

the results are robust to the use of the current account balance as a measure of foreign imbalances.

Equation 1 is also estimated with country fixed effects. The results, reported in the bottom section of Table 1, confirm the findings from the pooled regression. The fixed effect results for the first sample period 2000-2004 are not reported because of the limited time series.

The statistics reported in Table 1 are simple correlations, and therefore, they do not establish causation. Nevertheless, they emphasize the existence of a relation between financial markets conditions and global imbalances. The goal of this paper is to investigate theoretically the sources of this correlation.

3 The model

There are I countries, indexes by i, each populated by a continuum of agents with expected lifetime utility $E\sum_{t=0}^{\infty}\beta^t U(c_t)$, where c_t is consumption at time t and β is the intertemporal discount factor. Agents receive an idiosyncratic stochastic endowment, w, that follows a discrete Markov process.

In each country there is one unit supply of a non-reproducible asset, traded at price P_t^i. The asset can be used in production by each individual agent. The production function is $y_{t+1} = z_{t+1}k_t^{\nu}$, where k_t is the quantity of the asset employed at time t, z_{t+1} is an idiosyncratic productivity or investment shock and y_{t+1} is the output generated at time $t+1$. It is important to emphasize that production is individually run and the shock is idiosyncratic. There are no aggregate shocks in the model, and therefore, cross-country risk-sharing is not an issue here. The asset is internationally immobile. This implies that, if an agent decides to buy the foreign asset, he or she has to operate the production technology abroad.

The consideration of investment shocks allows us to distinguish risky from riskless investments so that each agent faces a nontrivial portfolio choice. This allows us to examine not only how financial markets heterogeneity affects net foreign asset positions but also their composition.

Let $s_t \equiv (w_t, z_t)$ be the couple with the endowment and productivity shocks. Agents can buy contingent claims, $b(s_{t+1})$, conditional on the next period realization of these shocks. Because there are no aggregate uncertainty, the price of one unit of consumption goods contingent on the realization of s_{t+1} is $q_t^i(s_t, s_{t+1}) = g(s_t, s_{t+1})/(1 + r_t^i)$, where r_t^i is the equilibrium interest rate and $g(s_t, s_{t+1})$ is the transition probability for the shocks.

Define $a_t = w_t + k_{t-1}P_t^i + z_t k_{t-1}^\nu + b(s_t)$ the agent's net worth before consumption. The budget constraint is

$$a_t = c_t + k_t P_t^i + \sum_{s_{t+1}} b(w_{t+1}) q_t^i(s_t, s_{t+1}) \tag{2}$$

and the net worth evolves according to

$$a(s_{t+1}) = w_{t+1} + k_t P_{t+1}^i + z_{t+1} k_t^\nu + b(s_{t+1}) \tag{3}$$

Without restrictions on the set of feasible claims, agents would be able to perfectly insure against the endowment and investment risks, in which case markets would be complete. Because of market frictions, however, the set of contingent claims is constrained by incentive-compatibility requirements. In particular, we assume that shocks are not verifiable and agents can divert part of the income from both endowment and production. In doing so they loose a fraction ϕ^i of the diverted income. Furthermore, we assume that contracts are not exclusive and there is limited liability. Appendix A shows that, under these conditions, the set of feasible claims must satisfies:

$$a(s_j) - a(s_1) \geq (1 - \phi^i) \cdot \left[w_j - w_1 + (z_j - z_1) k_t^\nu \right] \tag{4}$$

$$a(w_j) \geq 0 \tag{5}$$

for all $j \in \{1, ..., N\}$. Here N denotes the number of possible realizations of the two shocks and s_1 is the lowest (worse) realization.

The first condition requires that the variation in net worth, $a(s_j) - a(s_1)$, cannot be smaller than the variation in income, scaled by $1 - \phi^i$. The parameter ϕ^i, which is country-specific, determines the tightness of the restrictions and it captures the deepness of financial markets. When ϕ^i is very large, agents are able to maintain constant consumption (full insurance). When $\phi^i = 0$—implying that the whole income can be diverted without losses—only non-contingent claims are feasible. The second constraint imposes limited liability.

It is important to emphasize that ϕ^i pertains to the residency of the agent, independently of whether production takes place at home or abroad. For example, the agent could buy foreign productive assets and receive foreign income. Still, the feasible claims are determined by the local, not foreign ϕ.

3.1 Optimization problem and equilibrium

Let $\{P^i_\tau, q^i_\tau(s_\tau, s_{\tau+1})\}^\infty_{\tau=t}$ be a (deterministic) sequence of prices in country i. The agent's problem can be written as:

$$V^i_t(s,a) = \max_{c,k,b(s')} \left\{ U(c) + \beta \sum_{s'} V^i_{t+1}\Big(s', a(s')\Big) g(s,s') \right\} \tag{6}$$

subject to

$$(2), (3), (4) \text{ and } (5)$$

where we have used the convention of denoting current 'individual' variables without subscript and next period 'individual' variables with the prime superscript. Notice that this is the optimization problem for any deterministic sequence of prices, not only steady states, which motivates the time subscript in the value function.

The solution to the agent's problem provides the decision rules for consumption, $c^i_t(s,a)$, productive investment, $k^i_t(s,a)$, and contingent claims $b^i_t(s,a)(s')$. These rules determine the evolution of the distribution of agents over s, k and b, which we denote by $M^i_t(s,k,b)$. The definition of equilibria with and without international mobility of capital follows:

Definition 1 (Autarky) *Given the deepness of the financial markets, ϕ^i, and initial distributions, $M^i_t(s,k,b)$, for $i \in \{1,...,I\}$, a general equilibrium without mobility of capital is defined by sequences of: (i) agents' policies $\{c^i_\tau(s,a), k^i_\tau(s,a), b^i_\tau(s,a)(s')\}^\infty_{\tau=t}$; (ii) value functions $\{V^i_\tau(s,a)\}^\infty_{\tau=t}$; (iii) prices $\{P^i_\tau, r^i_\tau, q^i_\tau(s,s')\}^\infty_{\tau=t}$; (iv) distributions $\{M^i_\tau(s,k,b)\}^\infty_{\tau=t+1}$. Such that: (i) the policy rules solve problem (6) and $\{V^i_\tau(s,k)\}^\infty_{\tau=t}$ are the associated value functions; (ii) prices satisfy $q^i_\tau = g(s,s')/(1+r^i_t)$; (iii) asset markets clear, $\int_{s,k,b} k^i_\tau(s,a) M^i_\tau(s,k,b) = 1$, $\int_{s,k,b,w'} b^i_\tau(s,a)(w') M^i_\tau(s,k,b) g(s,s') = 0$ for all $\tau \geq t$ and in each country $i \in \{1,...,I\}$; (iv) the sequence of distributions is consistent with the initial distribution, the individual policies and the idiosyncratic shocks.*

Definition 2 (Capital mobility) *Given the deepness of the financial markets, ϕ^i, and initial distributions, $M^i_t(s,k,b)$, for $i \in \{1,...,I\}$, a general equilibrium with mobility of capital is defined by sequences of: (i) agents'*

policies $\{c^i_\tau(s,a), k^i_\tau(s,a), b^i_\tau(s,a)(s')\}^\infty_{\tau=t}$*; (ii) value functions* $\{V^i_\tau(s,a)\}^\infty_{\tau=t}$*; (iii) prices* $\{P^i_\tau, r^i_\tau, q^i_\tau(s,s')\}^\infty_{\tau=t}$*; (iv) distributions* $\{M^i_\tau(s,k,b)\}^\infty_{\tau=t+1}$*. Such that: (i) the policy functions solve problem (6) and* $\{V^i_\tau(s,k)\}^\infty_{\tau=t}$ *are the associated value functions; (ii) prices satisfy* $q^i_\tau = g(s,s')/(1+r^i_t)$*,* $P^i_\tau = P_\tau$ *and* $r^i_\tau = r_\tau$*, for all* $i \in \{1,...,I\}$*; (iii) global asset markets clear,* $\sum_i \int_{s,k,b} k^i_\tau(s,a) M^i_\tau(s,k,b) = I$*,* $\sum_i \int_{s,k,b,s'} b^i_\tau(s,a)(s') M^i_\tau(s,k,b) g(s,s') = 0$ *for all* $\tau \geq t$*; (iv) the sequence of distributions is consistent with the initial distribution, the individual policies and the idiosyncratic shocks.*

The only difference between the two definitions is that with mobility there is a global market for assets and the prices are equalized across countries. This also implies that the assets owned by a country is no longer equal to the asset located in the country. Therefore, foreign asset positions are not necessarily zero. Also notice that one country may hold a larger share of the world productive asset than its domestic share. In this case a fraction of this country's agents will be producing abroad.

Next we characterize the properties of the equilibrium with and without mobility of capital. To illustrate these properties, it will be convenient to consider first the special cases with only endowment or investment risks. This will clarify the role played by these two shocks in the general model.

4 Endowment shocks only

Let's consider first the case in which z is not stochastic, that is, $z = \bar{z}$ and the only source of idiosyncratic uncertainty is the endowment w. Denote by $\bar{\phi}$ a sufficiently high value of the enforcement parameter so the incentive compatibility constraint (4) is never binding. We can show that $\bar{\phi} = 1$ when shocks are iid. With persistent shocks, however, $\bar{\phi}$ must be strictly greater than 1. To show the importance of financial deepness, we will compare the limiting cases of $\phi = \bar{\phi}$ and $\phi = 0$. First we look at the autarky regime and then to the regime with capital mobility.

When $\phi = \bar{\phi}$, constraint (4) is not binding by definition. Therefore, the first order conditions with respect to k and $b(w')$ are:

$$U'(c) = \beta(1+r_t)U'(c(w')) + (1+r_t)\lambda(w'), \qquad \forall\, w'$$

$$U'(c) = \beta R_t(k,\bar{z})EU'(c(w')) + R_t(k,\bar{z})E\lambda(w')$$

where $\lambda(w')$ is the Lagrange multiplier associated with the limited liability constraint (5) and $R_t(k,\bar{z}) = (P_{t+1} + \nu \bar{z} k^{\nu-1})/P_t$ is the gross marginal return from the productive asset.

The first condition holds for any realization of w', which implies that next period consumption, $c(w')$, must be the same for all w'. Therefore, individual consumption is not stochastic.[1]

The second condition, together with the first, implies $R_t(k,\bar{z}) = 1 + r_t$, that is, the marginal return from the productive asset is equal to the interest rate. The concavity of the production function then implies that the input of the productive asset is the same for all agents. Because the supply of the productive asset is fixed, total output is also fixed. Then the only possible equilibrium must satisfy $\beta(1+r_t) = 1$.[2] This establishes that with $\phi = \bar{\phi}$ we are essentially in a complete markets economy.

Let's look now at the other limiting case in which $\phi = 0$. The incentive-compatibility constraint (4) imposes that $b(w_1) = ... = b(w_N) = b$, that is, claims cannot be state-contingent. Then the first order conditions can be written as:

$$U'(c) = \beta(1+r_t)\, EU'(c(w')) + (1+r_t) E\lambda(w')$$

$$U'(c) = \beta R(k,\bar{z}) EU'(c(w')) + R(k,\bar{z}) E\lambda(w')$$

Also in this case we have that $R_t(k,\bar{z}) = 1 + r_t$ and the input of the productive asset is the same for all agents. However, consumption is not constant but depends on the realization of the endowment. This is a standard Bewley (1986) economy with uninsurable endowment risks. Even if there is production, all agents use the same input of the productive asset, which is in limited supply. Therefore, they get the same investment income. As it is well known, the uninsurability of the idiosyncratic risk generates precautionary savings and in equilibrium $\beta(1+r_t) < 1$. See Huggett (1993), Ayagari (1994) and Carroll (1997).

Let's consider now the regime with financial integration between two countries with different $\phi's$. Suppose that country 1 has $\phi^1 = \bar{\phi}$ and country

[1] This is obvious when the limited liability constraint is not binding so that $\lambda(w') = 0$. It can be shown that this also holds when $\lambda(w') > 0$.

[2] If this condition is not satisfied, the consumption growth of all agents will not be zero. Because the growth rate is the same for all agents, aggregate consumption will not be constant. This cannot be an equilibrium because aggregate output is constant.

2 has $\phi^2 = 0$. The following proposition characterizes the new steady state equilibrium with capital mobility.

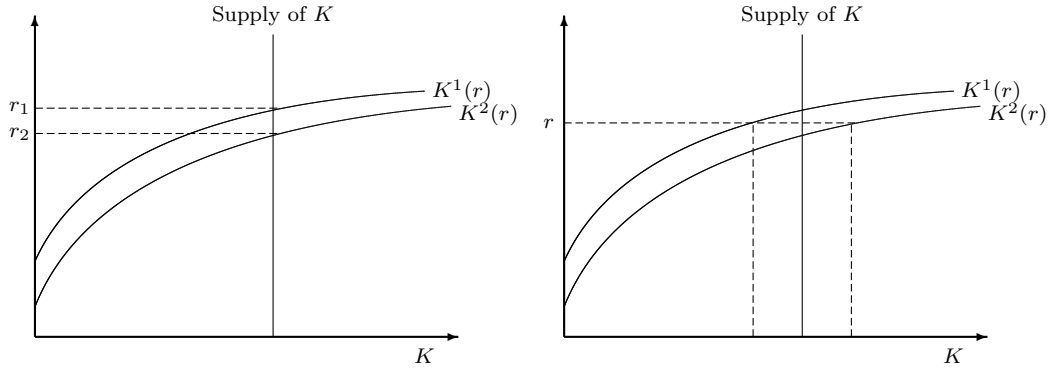
Proposition 1 *Suppose that $\phi^1 = \bar{\phi}$ and $\phi^2 = 0$. In the steady state equilibrium with capital mobility, country 1 has a negative net foreign asset position but a zero position in the foreign productive asset.*

Proof 1 *Because $\phi^1 = \bar{\phi}$, agents in country 1 are able to perfectly insure. Therefore, if the limited liability constraint is not binding, the evolution of consumption satisfies $U'(c_t) = \beta(1+r)U'(c_{t+1})$. This condition implies that consumption stays constant over time if $\beta(1+r) = 1$ and decreases if $\beta(1+r) < 1$ until the limited liability constraint is binding for at least one realization of the shock. But $\beta(1+r) = 1$ cannot be a steady state equilibrium with capital mobility. If this was the case, consumers in country 2 will experience positive consumption growth on average because of precautionary savings and, in the long run, their wealth will be unbounded. Eventually this must drive the interest down. Given that the steady state equilibrium must satisfy $\beta(1+r) < 1$, agents in country 1 will experience decreasing consumption and net worth a. This will continue until the limited liability constraint (5) binds. Then the net worth of all agents will be equal or close to zero and the wealth of country 1 becomes smaller than the wealth of country 2. This implies that the net foreign asset position of country 1 is negative.*

The zero position in the productive asset derives from the fact that the productive investment is not risky. Based on the first order conditions derived above, all agents in both countries equalize the marginal return from the productive asset to the interest rate. Therefore all agents will choose the same k which in equilibrium must be equal to country supply, that is, 1.

So far we have considered only the extreme cases with $\phi = \bar{\phi}$ and $\phi = 0$. This allowed us to establish some results analytically. From these results we can infer the properties of the equilibrium when ϕ is between these two values. In general, lower values of ϕ (lower enforcement) increase precautionary savings, and therefore, reduce the equilibrium interest rate. This point is illustrated in Figure 5. This figure plots the aggregate supply of savings as a function of the interest rate for two countries. Savings are measured in units of the productive asset. The first country has deeper financial markets ($\phi^1 > \phi^2$), and therefore, lower supply of savings for each interest rate. Because the supply of the productive asset is fixed, aggregate net savings

(again in terms of the productive asset) must be zero in both countries. This requires a higher interest rate than in country 2 as shown in the first panel of Figure 5.



a) Autarky *b*) Mobility

Figure 5: Steady state equilibria with heterogeneous financial conditions.

When the two countries liberalize, the prices of the productive asset and the interest rates equalize immediately. Therefore, compared to the autarky equilibrium, country 1 experiences a decline in the interest rate (and an increase in the asset price) while country 2 experiences an increase in the interest rate (and a decline in the price of the asset). As shown in the second panel of Figure 5, the supply of savings (in units of K) declines in country 1 and increases in country 2. Because agents continue to hold the same amount of the productive asset, country 1 borrows from country 2. Therefore, the country with deeper financial markets ends up with a negative foreign asset position. The composition of the current account simply reflects the interest payments made or received on these positions, with country 1 exporting in order to service the foreign debt.

4.1 Quantitative properties

There are two equally sized countries with the same characteristics except in the parameters of the financial structure, ϕ^i. The discount factor is $\beta = 0.94$ and the risk aversion parameter is $\sigma = 2.5$. The stochastic endowment takes two values, that is, $w = \bar{w}(1 \pm \Delta_w)$, with symmetric transition probability matrix. The return to scale parameter is set $\nu = 0.75$. Interpreting w as

labor income and y as net capital income, we set $\bar{w} = 0.85$ and choose $\bar{z}$ so that $y = \bar{z}k^{\nu} = 0.15$. The variation in endowment is set to $\Delta_w = 0.5$ and the persistence probability to 0.75. The parametrization of the endowment process is similar to the one used in Ayagari (1994).

The parameters of the financial structure are set to $\phi^1 = 0.4$ and $\phi^2 = 0$. These values imply that contingent claims are not feasible in country 2 while they are partially feasible in country 1. The equilibrium allocation in country 1 is similar to the allocation that would be achieved if contingent claims were not available but the volatility of the endowment was 40 percent lower. In this sense we can say that the financial structure of country 1 is 40 percent more developed than country 2. This is similar to the difference between the financial index for the US and the average index for all other advanced economies as reported by the IMF (2006).

Table 2 reports the values of some key variables in the steady state equilibrium with and without mobility of capital and Figure 6 plots the transition dynamics induced by capital markets liberalization. Before opening, each country is in the steady state equilibrium and the liberalization is not anticipated. As reported in Table 2, country 1 starts with a lower asset price and a higher interest rate than in country 2. After liberalization, the prices immediately equalize and country 1 experiences an asset price boom while country 2 experiences an asset price fall. Because the two countries continue to differ in their financial conditions, they have different propensity to save. The increase in asset prices (and lower interest rates) in country 1 induces households to save less and the country accumulates negative foreign asset positions. The formation of these positions is gradual until they converge to the new steady state values.

Figure 6 also plots the current account and its composition, that is, net exports and net factor payments from abroad. The first country experiences negative current account balances. This is a consequence of negative trade balances in the first part of the transition and increasing interest payments. In the new steady state the interest payments are compensated by positive exports and the current account balances.

The current account reaches its pick immediately after the liberalization. This, of course, is a consequence of the peculiar exercise we are conducting, where capital markets are fully liberalized overnight. In reality, the process of liberalization has been gradual (see Figure 2). With a gradual liberalization, the current account dynamics would have been more similar to the data.

The numerical exercise conducted in this section outlines three important

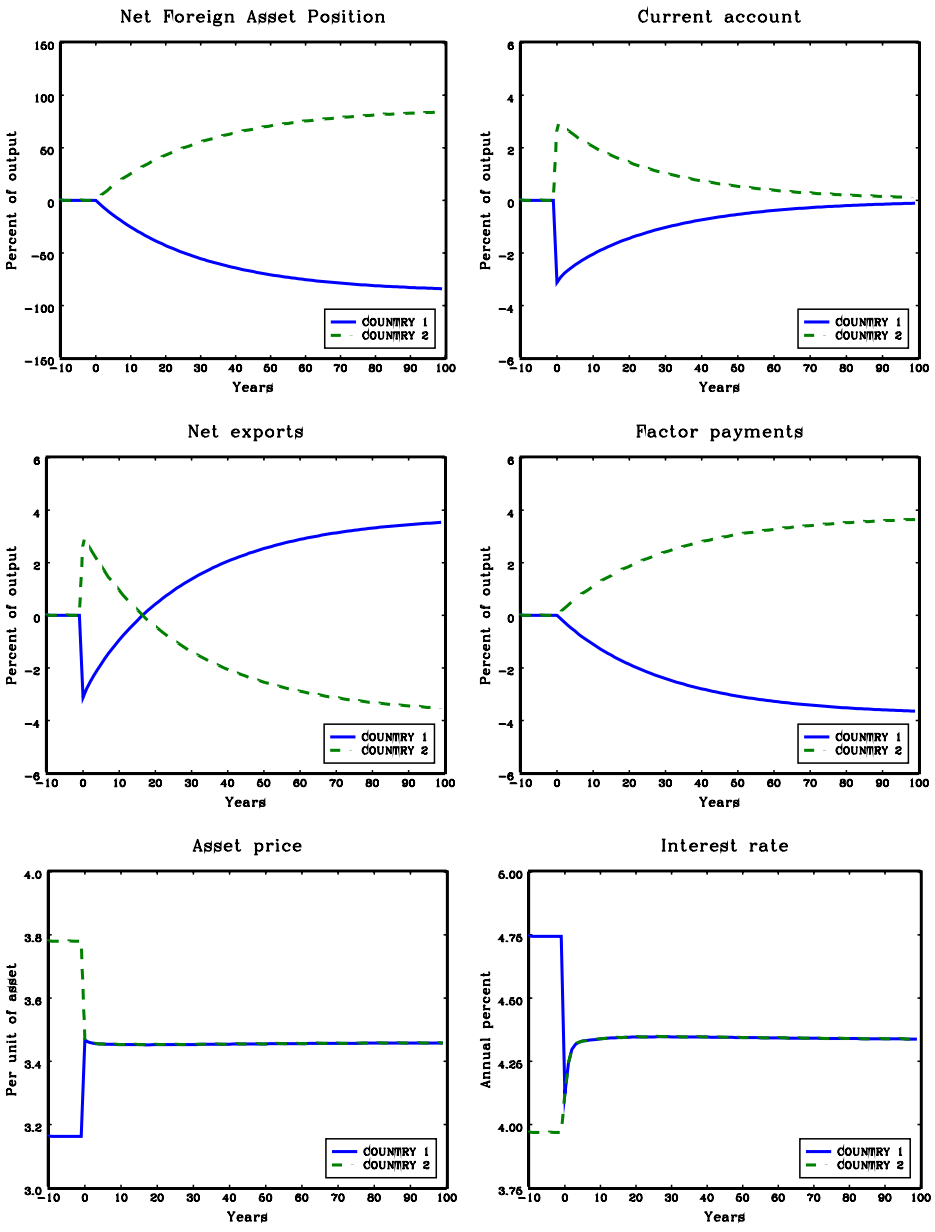


Figure 6: Transition dynamics after capital market liberalization.

Table 2: Steady state with and without capital mobility.

	Autarky		**Capital mobility**	
	Country 1	*Country 2*	*Country 1*	*Country 2*
Asset price	3.16	3.78	3.46	3.46
Interest rate	4.74%	3.97%	4.34%	4.34%
Foreign asset position	-	-	-87.3%	87.3%
Current account	-	-	0.0%	0.0%
Net exports	-	-	3.6%	-3.6%
Net factor payments	-	-	-3.6%	3.6%

Notes: Foreign asset positions, current account, net exports and net factor payments are in percentage of domestic income (endowment plus domestic dividends).

points. First, countries with deeper financial markets accumulate foreign asset liabilities. Second, the magnitude of these liabilities can be large, close to the value of domestic production (GDP). Third, the formation of imbalances is a gradual process that takes a long period of time. For the parametrization used above, only half of the long term imbalances are accumulated during the first 25 years. Although the model with only endowment shocks can generate large imbalances, it cannot capture the fact that some countries receive positive factor payments even if they have negative asset positions. To generate this additional feature we need to introduce investment shocks.

5 Investment shocks only

We now consider the case in which the productivity z is stochastic while the endowment w is constant, that is, $w = \bar{w}$. The assumption that investment income is stochastic allows us to distinguish debt instruments from risky investments such as equity and FDI. Also in this case it will be convenient to compare the limiting cases of $\phi = \bar{\phi}$ and $\phi = 0$, starting with autarky.

When $\phi = \bar{\phi}$ the first order conditions are:

$$U'(c) = \beta(1 + r_t)U'(c(z')) + (1 + r_t)\lambda(z'), \qquad \forall\, w'$$

$$U'(c) = \beta E R_t(k, z')U'(c(z')) + E\lambda(z')R_t(k, z')$$

The first condition holds for any realization of z'. Therefore, the next period consumption, $c(z')$, must be the same for all realizations of z' (full insurance). This implies that individual consumption is deterministic and the only possible equilibrium is such that $\beta(1+r_t)=1$.

Because next period consumption is not stochastic, the two conditions imply that $ER_t(k,z')=1+r_t$. Therefore, there is no marginal premium for investing in the productive asset and k is the same for all agents.

Let's look now at the opposite case with $\phi=0$. The incentive-compatibility constraint (4) imposes that $b(z_1)=...=b(z_N)=b$, that is, claims cannot be state contingent. The first order conditions can be written as:

$$\begin{aligned} U'(c) &= \beta(1+r_t)\,EU'(c(z'))+(1+r_t)E\lambda(z') \\ \\ U'(c) &= \beta EU'(c(z'))R_t(k,z')+E\lambda(z')R_t(k,z') \end{aligned}$$

These two conditions make clear that the expected marginal return from the risky asset is always greater than the return from the risk-free asset, that is, $ER_t(k,z')>1+r_t$. To see this, consider the case in which the borrowing limit is not binding. Then the two conditions can be rewritten as:

$$(1+r_t)EU'(c(z')) = ER_t(k,z')EU'(c(z'))+\mathrm{Cov}\Big(R_t(k,z')\,,\,U'(c(z'))\Big)$$

Because $U'(c(z'))$ is in general negatively correlated with $R_t(k,z')$, the last term on the right-hand-side is negative. Therefore, there is a premium, in the margin, for investing in the risky asset, that is, $ER_t(k,z')>1+r_t$.

Now suppose that liberalization takes place between two countries. The first country has $\phi^1=\bar{\phi}$ and the second $\phi^2=0$. The following proposition characterizes the new steady state equilibrium with capital mobility.

Proposition 2 *Suppose that $\phi^1=\bar{\phi}$ and $\phi^2=0$. In the steady state equilibrium with capital mobility, country 1 has a negative net foreign asset position but a positive position in the foreign productive asset. The average return from the foreign assets of country 1 is bigger than the cost of its liabilities.*

Proof 2 *We show first that the steady state equilibrium with capital mobility satisfies $\beta(1+r)<1$. Because $\phi^1=\bar{\phi}$, agents in country 1 perfectly insure. Therefore, if the limited liability constraint is not binding, the evolution of their consumption satisfies $U'(c_t)=\beta(1+r)U'(c_{t+1})$. This condition implies*

that consumption stays constant if $\beta(1+r) = 1$ and decreases if $\beta(1+r) < 1$. But if $\beta(1+r) = 1$, agents in country 2 experience positive consumption growth on average, due to precautionary savings, and in the long run the country's wealth will be unbounded. Notice that agents in country 2 will face some risk because they will buy at least some of the risky investment (the concavity of the production function implies that the choice of k is interior). Given that the steady state equilibrium satisfies $\beta(1+r) < 1$, agents in country 1 will experience decreasing consumption until the limited liability constraint (5) binds for some realization of the shock. Therefore, the net worth of country 1 is smaller than for country 2, implying that country 1 accumulates a negative net foreign asset position.

Let's consider now the position in the productive asset. Because agents in country 2 cannot insure perfectly, they require a marginal premium over the interest rate for investing in k. Because the production function is concave, this implies that the scale of production of each agent in country 2 is smaller than in country 1. Therefore, country 1 buys some of country 2's assets.

What remains to be shown is that the average return from the foreign productive investment is higher than the cost of the foreign liabilities. First notice that agents in country 1 equalize the expected marginal return from the productive asset to the interest rate. However, because the production function is concave, the average return is greater than the marginal return. Therefore, the average return on the foreign productive assets is greater than the cost of the liabilities, that is, the interest rate.

The proposition shows that, with investment shocks, countries with deeper financial markets invest in foreign (high return) assets and finance the investment with foreign debt. In the particular case in which the most developed country has $\phi^1 = \bar{\phi}$, this country ends up with a negative net foreign asset position. The negativity of the net position, however, cannot be generalized to any value of ϕ. Intuitively, if country 1 has a greater ability to insure than country 2 but the insurance is not perfect, then it will continue to buy some of the foreign risky asset. However, by purchasing more of this asset, the country will take more risk. This in turn may stimulate enough precautionary savings in country 1 up to the point in which the foreign borrowing becomes smaller than the value of the risky assets held abroad. Referring to the previous Figure 5, the supply of savings from country 1 is not necessarily smaller than in country 2. This will be shown in the example below.

Another important point is that, if country 1 cannot insure perfectly against the investment risk, then there will be a marginal risk premium also for country 1. This further increases country 1's return from the foreign investment relative to the cost of its foreign liabilities.

5.1 Quantitative properties

We use the same parametrization used in the previous section. The only change is that w is no longer stochastic, that is, $\Delta_w = 0$, while investment income is now stochastic. For simplicity we assume that z is i.i.d. and takes two values, $z = \bar{z}(1 \pm \Delta_z)$, with $\Delta_z = 4$. This parametrization implies that the losses associated with a negative shock are about 30 percent the value of capital.

Table 3: Steady state with and without capital mobility.

	Autarky		**Capital mobility**	
	Country 1	*Country 2*	*Country 1*	*Country 2*
Asset price	1.79	1.57	1.72	1.72
Interest rate	5.19%	3.40%	4.70%	4.70%
Foreign asset position	-	-	15.5%	-15.4%
Foreign bonds	-	-	-47.7%	46.9%
Foreign risky asset	-	-	63.3%	-62.4%
Current account	-	-	0.0%	0.0%
Net exports	-	-	-2.8%	2.8%
Net factor payments	-	-	2.8%	-2.8%

Notes: Foreign asset positions, current account, net exports and net factor payments are in percentage of domestic income (endowment plus domestic dividends).

Table 3 reports the values of some key variables in the steady state equilibrium. In the autarky equilibrium, country 1 has a higher asset price than country 2 and also a higher interest rate. In the steady state with capital mobility, the prices of the productive asset and the interest rates are equalized and country 1 accumulates positive net foreign asset positions. Country 1 experiences persistent factor payment surpluses and trade deficits. The positive factors payments is in part due to the positive net position and in

part to the portfolio composition. In fact, country 1 takes a long position in the foreign risky asset, which gives higher return, and a short position in the foreign bond.

We conclude this section by observing that the model with only investment shocks generates the right portfolio composition between countries with different financial markets characteristics but it does not necessarily generate the right net foreign asset positions. However, we have seen in the previous section that this feature is unambiguously generated by the model with only endowment shocks. Therefore, the consideration of both shocks has the potential to generate positive factor payments for countries with negative net foreign asset positions.

6 General model with endowment and investment risks

Recent studies such as Lane and Milesi-Ferretti (2005) and Gourinchas and Rey (2005) have pointed out that a large share of US assets owned abroad are in the form of equity and foreign direct investment while a large share of foreign claims toward the US are debt instruments. Given this portfolio composition, the US is similar to a world investment bank: it raises funds with debt and reinvests the funds in riskier and higher return assets. This explains why the US is still receiving positive net factor payments from abroad in spite of the negative foreign asset position. In this section we show that the general model with both endowment and investment risks can generate this type of international portfolio composition.

Table 4 reports some key variables in the steady state equilibrium with and without international mobility of capital. The model uses the same parameters we used earlier but now there are both endowment and productivity shocks. The two shocks are assumed to be independent. We see that country 1 accumulates negative net foreign asset positions as in the model with only endowment shocks. However, there is a difference in the portfolio composition of the two countries. The first country owns part of the productive (risky) asset of country 2 and takes foreign debt (negative value of bonds). Because of the higher return from the risky asset, country 1 receives positive factor payments despite the negative foreign asset position.

Let's look now at the transition from the autarky steady state to the steady state with capital mobility. Figure 7 plots the dynamics of foreign asset positions, current account, asset prices and interest rates. Although prices and interest rates do not respond smoothly, the dynamics of net foreign

Table 4: Steady state with and without capital mobility.

	Autarky		**Capital mobility**	
	Country 1	*Country 2*	*Country 1*	*Country 2*
Asset price	2.60	3.25	2.89	2.89
Interest rate	3.44%	1.71%	2.69%	2.69%
Return on risky asset	5.70%	4.47%	4.75%	5.63%
Foreign asset position	-	-	-43.4%	42.6%
Foreign bonds	-	-	-143.0%	140.6%
Foreign risky asset	-	-	99.6%	-98.0%
Current account	-	-	0.0%	0.0%
Net exports	-	-	-0.9%	0.9%
Net factor payments	-	-	0.9%	-0.9%

Notes: Foreign asset positions, current account, net exports and net factor payments are in percentage of domestic income (endowment plus domestic dividends).

asset position is gradual. The current account remains in deficit for many periods until it balances in the limit.

Figure 8 plots the composition of foreign assets and the current account. Immediately after liberalization, country 1 invests in foreign productive asset and finances it with foreign debt. As the country's wealth declines (due to lower savings), the foreign exposure to the risky investment is partially reduced. Despite the negative foreign asset position, country 1 receives net factor payments from abroad thanks of the higher return from the productive assets. These payments, however, are more than compensated by negative exports and the country experiences current account deficits until it reaches the steady state.

The next question we address if whether capital markets liberalization is welfare enhancing for the participating countries and whether the welfare consequences are equally distributed in the population. We have already solved for the transition dynamics induced by capital markets liberalization, and therefore, answering this questions is simple.

Figure 9 plots the percentage of consumption gains due to liberalization as a function of net worth, a, and for different endowments, w. The gains are computed as the percentage increase in consumption to the autarky allo-

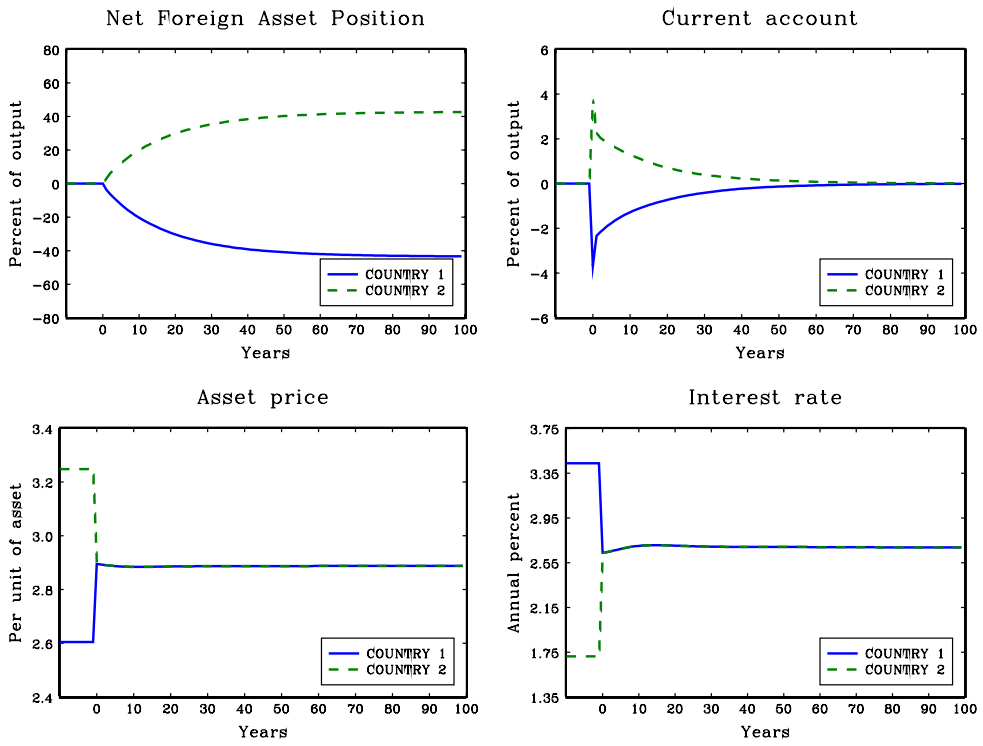


Figure 7: Transition dynamics after capital market liberalization.

cation to make agents indifferent between remaining in autarky and liberalizing. In country 1, liberalization increases welfare for all agents. When we consider a social welfare function with equal weights, capital markets liberalization bring a welfare gain of 3.8 percent of consumption. The opposite arises in country 2 where liberalization has a welfare cost of 3.9 percent.

These welfare consequences can be explained as follows. It is a well-known result that these models tend to generate excessive savings, and therefore, a suboptimal allocation. See, for example, Ayagari (1995). In our closed economy, however, aggregate savings cannot increase because there is not capital accumulation: The interest rate adjusts so that aggregate net savings are zero. With liberalization, however, each country can asses the foreign assets. On the one hand, country 1 can borrow from country 2 at a lower interest rate and it reduces savings. On the other, country 2 can access higher returns by lending to country 1. This will increase the savings of country 2.

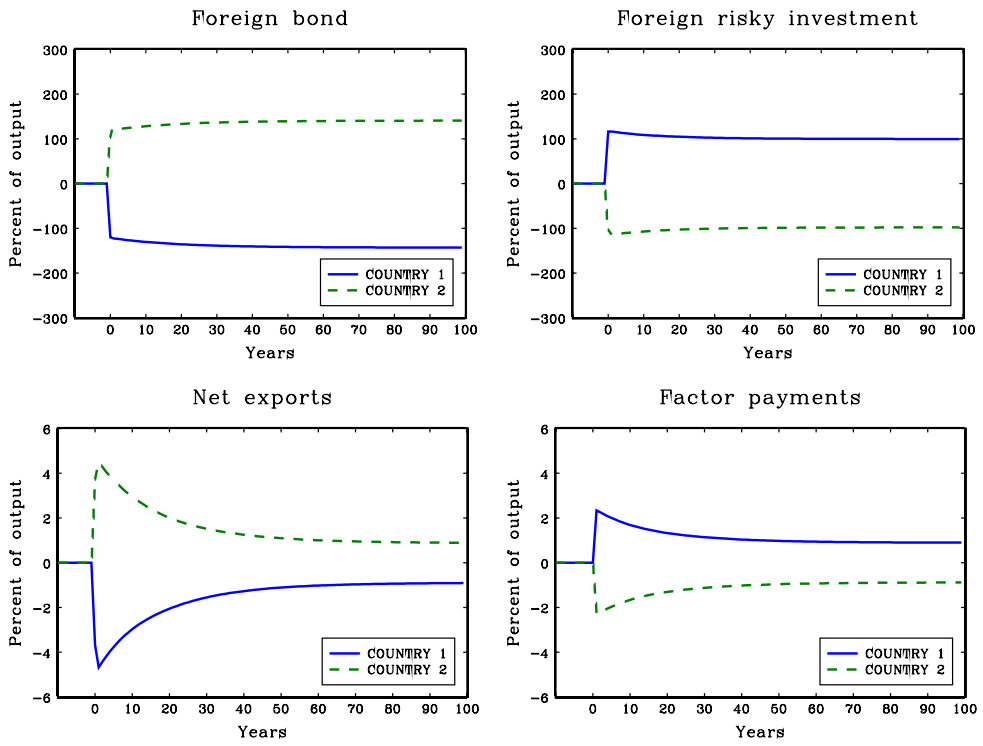


Figure 8: Transition dynamics after capital market liberalization.

The increase in savings, however, is welfare reducing for country 2.[3]

The fact that the welfare losses in country 2 are similar in magnitude to the welfare gains of country 1 derives from the secondary effect that liberalization has on efficiency. Although country 2 can benefit from disinvesting in the risky asset, and therefore, from the lower risk, this is more than compensated by the lower investment income. Therefore, if one country gains, the other must lose. It should be noticed, however, that we are abstracting from possible dynamic gains that may arise with capital markets liberaliza-

[3]This can be easily seen from a simple example. Suppose that there are only two periods and agents in both countries receive the same sequence of non-stochastic endowments. Differential incentives to save are generated by assuming that in each country there is a different saving subsidy from the government, γ^i. In this simple model without uncertainty, the subsidy generates similar effects on savings as income uncertainty. Further assume that $\gamma^2 > \gamma^1 \geq 1$. This model can be solved analytically. It can then be shown that liberalization generates welfare gains for country 1 and welfare losses for country 2.

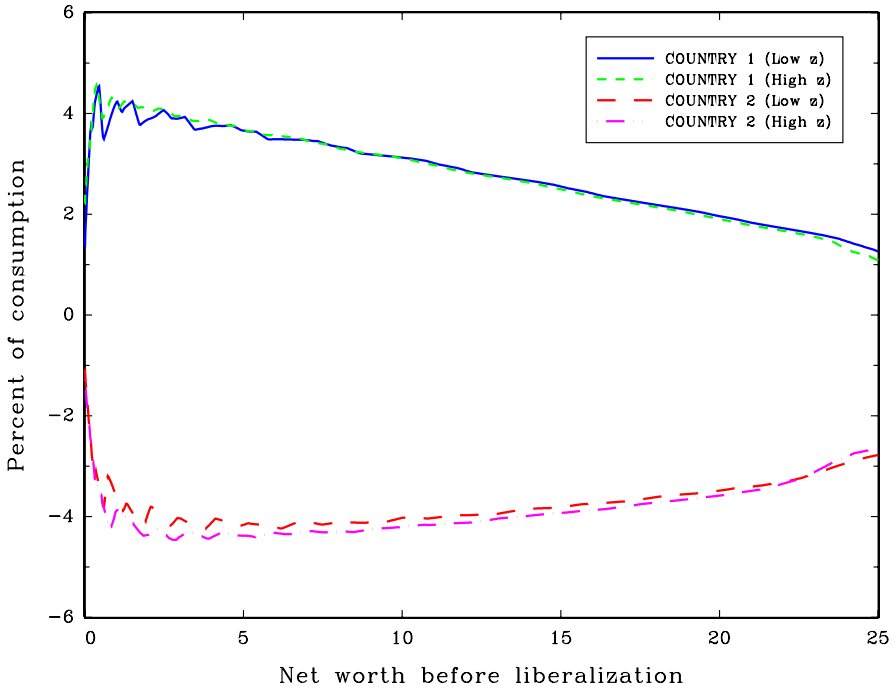


Figure 9: Welfare gains from capital markets liberalization.

tion such as those associated with technological adoption. Therefore, it is premature to conclude that liberalization is detrimental for countries with lower financial markets development. The effects we emphasize in this paper are purely financial.

To summarize, the model with uninsurable endowment and investment risks can generate large global imbalances as a result of different financial markets conditions. Although countries with deeper financial markets accumulate negative net foreign asset positions, they may continue to receive positive factor payments thanks to the composition of the international portfolios. These are also the countries that benefit the most from capital markets liberalization.

7 Conclusion

This paper shows that capital markets liberalization can lead to large and persistent global imbalances when countries are heterogeneous in financial markets conditions. Countries with deeper financial markets have lower savings and accumulate net foreign liabilities. Financial markets differences also affect the composition of the international portfolio. Countries with deeper financial markets invest in high return assets. As a result, they may receive positive factor payments even if the net foreign position is negative. These patterns are consistent with the US imbalance since the beginning of the 1980s.

A Appendix: Set of feasible contingent claims

Suppose that agents have the ability to divert part of the endowment. Diversion is observable but not verifiable in a legal sense. If an agent diverts x, he or she retains $(1-\phi)x$ while the remaining part, ϕx, is lost. We allow ϕ to be greater than. This can be interpreted as a fine or additional punishment.

Contracts are signed with financial intermediaries in a competitive environment. Financial contracts are not exclusive, meaning that agents can always switch to another intermediary from one period to the other. The set of state-contingent claims that an intermediary is willing to offer must be incentive-compatible.

Let $V_t(s,a)$ be the value function for an agent with current realization of endowment and investment shocks s, and current net worth a. The net worth is before consumption. After choosing the contingent claims $b(s_j)$, the next period value is $V_t(s_j, a(s_j))$, where $a(s_j) = w_j + z_j k^\nu + kP_{t+1} + b(s_j)$. In case of diversion, the agent would claim that the realizations of the endowment and productivity were the lowest levels s_1 and divert the difference $w_j - w_1 + (z_j - z_1)k^\nu$. In this process the agent retains $(1-\phi)[w_j - w_1 + (z_j - z_1)k^\nu]$ and receives $b(s_1)$. Therefore, the net worth after diversion is:

$$\begin{aligned} &w_1 + z_1 k^\nu + (1-\phi)\cdot[w_j - w_1 + (z_j - z_1)k^\nu] + kP_{t+1} + b(s_1) \;= \\ &a(s_1) + (1-\phi)\cdot[w_j - w_1 + (z_j - z_1)k^\nu] \end{aligned}$$

and the value of diversion is:

$$V_t\Big(s_j\,,\, a(s_1) + (1-\phi)\cdot[w_j - w_1 + (z_j - z_1)k^\nu]\Big)$$

Incentive-compatibility requires:

$$V_t\Big(s_j\,,\, a(s_j)\Big) \geq V_t\Big(s_j\,,\, a(s_1) + (1-\phi)\cdot[w_j - w_1 + (z_j - z_1)k^\nu]\Big)$$

which must hold for all $j = 1, .., N$.

It is important to emphasize that the financial intermediary can tell whether the agent is diverting but there is no court that can verify this and force the repayment of the diverted funds. Compared to the standard model with information asymmetries, this assumption is convenient because it simplifies the contracting problem when shocks are persistent. Also convenient is the assumption that financial contracts are not exclusive and agents can

switch to other intermediaries without a cost. This further limits the punishments available to the current intermediary. Also notice that, although the new level of wealth after diversion is verifiable when a new contract is signed, this does not allow the verification of diversion because the additional resources could derive from lower consumption in previous periods, which is not observable and verifiable. Again, the intermediary knows that the additional resources come from diversion but it cannot legally prove it.

The last assumption is limited liability for which agents renegotiate negative values of net worth, and therefore, $a(s_j) \geq 0$. The agent's problem can be written as:

$$\begin{aligned} V_t(s,a) &= \max_{c,k,b(s')} \left\{ U(c) + \beta \sum_{s'} V_{t+1}\Big(s', a(s')\Big) g(s,s') \right\} \\ & \quad \text{subject to} \\ a &= c + \sum_{s'} b(s') q(s,s') \\ a(s') &= w' + z' k^{\nu} + k P_{t+1} + b(s') \\ V_t\Big(s_j\,,\, a(s_j)\Big) &\geq V_t\Big(s_j\,,\, a(s_1) + (1-\phi)\cdot [w_j - w_1 + (z_j - z_1)k^{\nu}]\Big) \\ a(s_j) &\geq 0 \end{aligned}$$

Using standard arguments for recursive problems, we can prove that there is a unique solution and the function $V_t(s,a)$ is strictly increasing and concave in a.[4] The strict monotonicity of the value function implies that the incentive-compatibility constraint can be written as:

$$a(s_j) \geq a(s_1) + (1-\phi)\cdot \Big[w_j - w_1 + (z_j - z_1)k^{\nu}\Big]$$

for all $j = 1, .., N$. This is the constraint we imposed on the original problem.

We shall remark that we arrived at this simple formulation of the constraints because of the particular environment. With the alternative assumption of information asymmetries and persistent shocks, the characterization

[4]The proof is facilitated by defining the variable $x = k^{\nu}$. After making the change of variables $k = x^{1/\nu}$, it can be easily proved that this is a standard concave problem.

of the optimal contract becomes more complicated. Because the qualitative properties are similar to the model considered here (see, for example, Fernandes and Phelan (2000)), we have opted for the simpler route.

B Appendix: Computational procedure

We want to show first that the problem with contingent claims is equivalent to an alternative problem where contingent claims are not allowed but agents face a different process for the exogenous shocks. We can then solve this alternative problem which is a standard portfolio choice between a risky and non-risky assets. The computational procedure uses the first order conditions for the choice of these two assets solved on a discrete grid for a.

Let $\bar{b}_t$ be the expected next period value of contingent claims, that is, $\bar{b}_t = \sum_{s_{t+1}} b(s_{t+1})g(s_t, s_{t+1})$. Then a contingent claim can be rewritten as $b(s_{t+1}) = \bar{b}_t + x(s_{t+1})$ where, by definition, $\sum_{s_{t+1}} x(s_{t+1})g(s_t, s_{t+1}) = 0$. The variable $\bar{b}_t$ can be interpreted as a non-contingent bond and the variable $x(s_{t+1})$ is the pure insurance component of contingent claims.

The law of motion for the next period assets becomes:

$$a(s_{t+1}) = w_{t+1} + z_{t+1}k_t^{\nu} + k_t P_{t+1} + \bar{b}_t + x(s_{t+1}) \tag{7}$$

Consider the incentive compatibility constraint. Because agents choose as much insurance as possible, the incentive-compatibility constraint will be satisfied with equality, that is,

$$a(s_j) = a(s_1) + (1-\phi)\cdot\left[w_j - w_1 + (z_j - z_1)k^{\nu}\right]$$

Using the law of motion for a, the constraint can be rewritten as:

$$x(s_j) - x(s_1) = -\phi\cdot\left[w_{t+1} - w_1 + (z_{t+1} - z_1)k_t^{\nu}\right]$$

which must hold for all $j > 1$. The variables $x(s_j)$ must also satisfy the zero-profit condition, that is,

$$\sum_{s_{t+1}} x(s_{t+1})g(s_t, s_{t+1}) = 0$$

Therefore, we have N conditions and N unknowns. We can then solve for all the N values of x. The solution can be written as:

$$x(s_{t+1}) = -\phi\cdot W_j(s_t) + -\phi\cdot Z_j(s_t)\cdot k^{\nu}$$

where $W_j(s_t)$ and $Z_j(s_t)$ are exogenous variables defined as

$$\begin{aligned} W_j(s_t) &= w_j - w_1 - \sum_i g(s_t, s_i)(w_i - w_1) \\ Z_j(s_t) &= z_j - z_1 - \sum_i g(s_t, s_i)(z_i - z_1) \end{aligned}$$

Notice that these variables depend on the current shocks which affect the probability distribution of next period shocks. We made this explicit by writing the variables as functions of s_t.

Define the following variables:

$$\begin{aligned} \tilde{w}_j(s_t) &= w_j - \phi \cdot W_j(s_t) \\ \tilde{z}_j(s_t) &= w_j - \phi \cdot Z_j(s_t) \end{aligned}$$

These are transformations of the shocks. Using these new shocks, the law of motion for next period assets can be written as:

$$a(s_j) = \tilde{w}_j(s_t) + \tilde{z}_j(s_t)k_t^{\nu} + k_t P_{t+1} + \bar{b}_t$$

where now agents no longer choose state contingent assets. Therefore, by redefining the new shocks $\tilde{w}_j(s_t)$ and $\tilde{z}_j(s_t)$, the problem becomes a standard portfolio choice between a risky asset, k_t, and a risk-free asset, $\bar{b}_t$. Differences in financial deepness are now captured by difference in the stochastic properties of the transformed shock. So, for example, if $\phi = 0$, we goes back to the original shock because contingent claims are not feasible. If $\phi = 1$ and shocks are iid, then the transformed shock becomes a constant. We are in the case of full insurance. Any intermediate value allows only for partial insurance.

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