

# Financial Integration, Financial Deepness and Global Imbalances<sup>1</sup>

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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 capital markets liberalization among countries with different financial characteristics comes from three observations:

1. Measures of financial development or financial deepness differ sharply across countries, even across industrialized countries. Moreover, these differences have changed little during 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 leads to the build up of large global imbalances when countries differ in the level of financial development. 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 show 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 Faruquee, 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 vari-

ables 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.

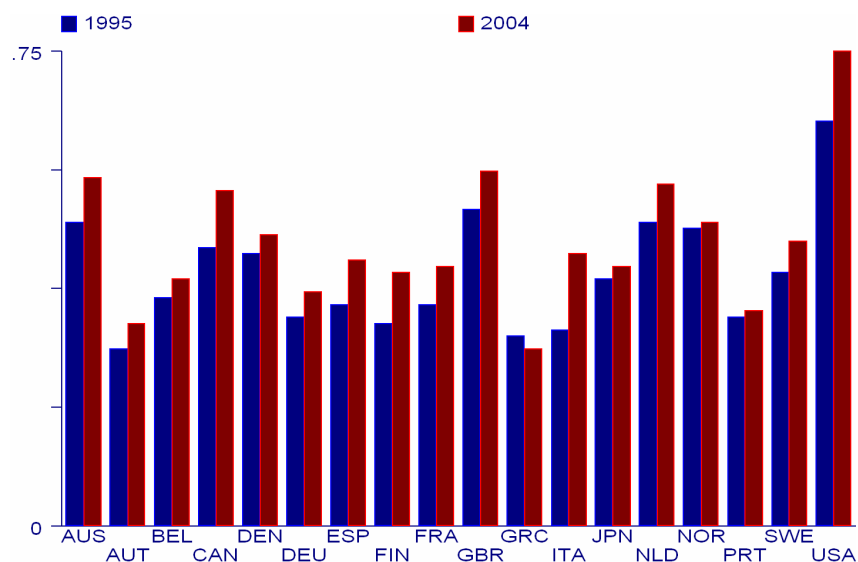


Figure 1: Financial index score for advanced economies. Source: IMF (2006), chapter 4.

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 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

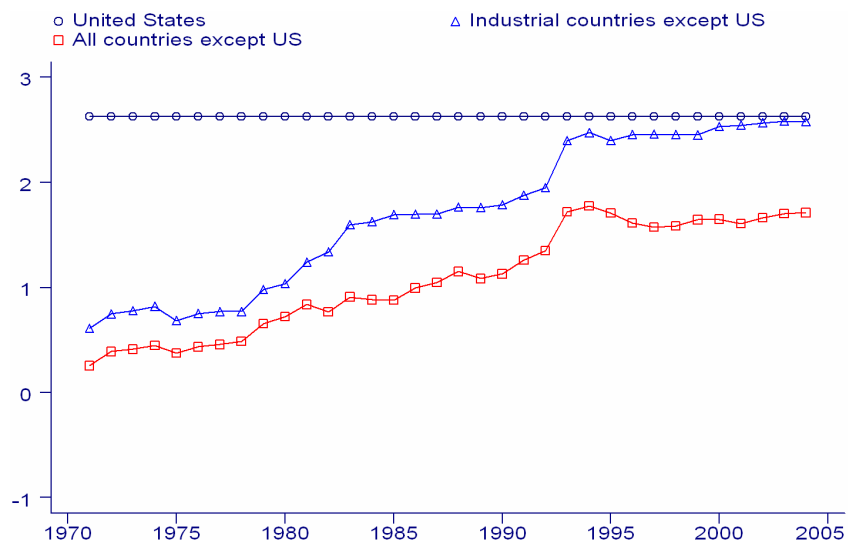


Figure 2: Financial openness index, 1970-2004. Source: Chinn and Ito (2005) and [www.ssc.wisc.edu/~mchinn/research.html](http://www.ssc.wisc.edu/~mchinn/research.html).

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 the 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.

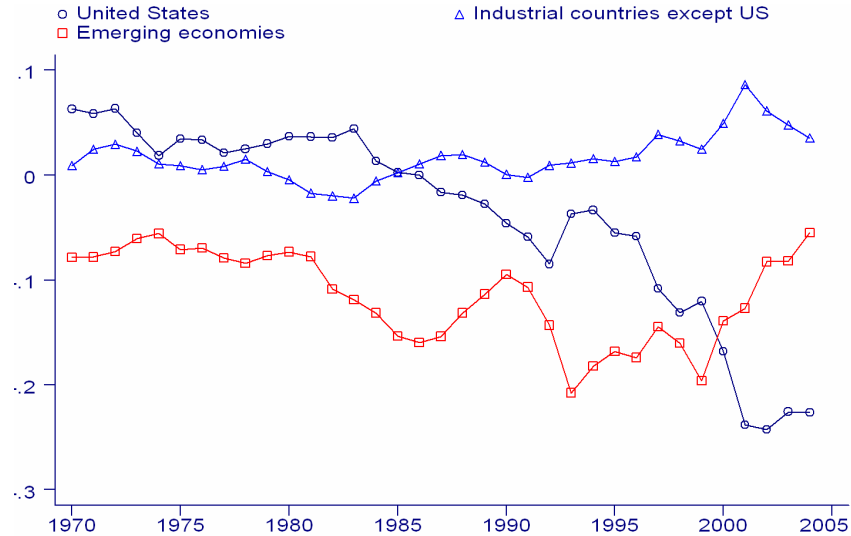


Figure 3: Net foreign asset position relative to GDP, 1970-2004. Source: Lane and Milesi-Ferretti (2006).

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:

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

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.



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
<i>Pooled regression</i>						
<i>CREDIT</i>	-0.0598 (0.0088)*	-0.0509 (0.0068)*	-0.0457 (0.0056)*	-0.0349 (0.0099)*	-0.0269 (0.0069)*	-0.0224 (0.0055)*
<i>CGDP</i>	0.00063 (0.00004)*	0.00058 (0.00003)*	0.00054 (0.00003)*	0.00041 (0.00005)*	0.00039 (0.00004)*	0.00035 (0.00003)*
<i>CONSTANT</i>	-8.287 (0.950)*	-7.589 (0.688)*	-6.867 (0.539)	-7.053 (1.121)*	-6.713 (0.722)*	-6.073 (0.538)*
$R^2$	0.633	0.525	0.468	0.353	0.318	0.285
Obs.	144	289	432	145	289	428
<i>Fixed effect regression</i>						
<i>CREDIT</i>		-0.0406 (0.0085)*	-0.0448 (0.0066)*		-0.0370 (0.0092)*	-0.0505 (0.0077)*
<i>CGDP</i>		0.00029 (0.00006)*	0.00043 (0.00004)*		-0.00003 (0.00006)	0.00014 (0.00005)*
<i>CONSTANT</i>		-1.620 (1.191)	-4.442 (0.833)*		3.897 (1.304)*	0.913 (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.

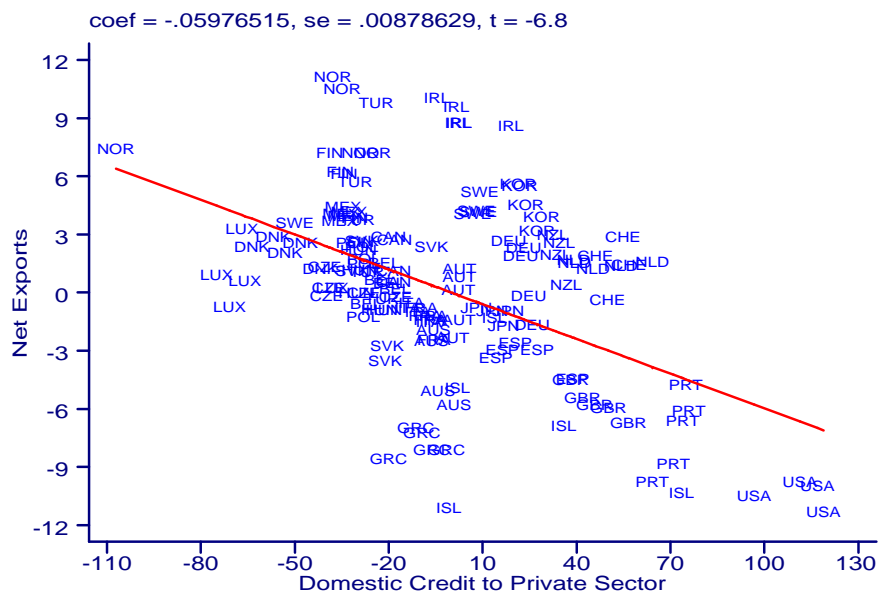


Figure 4: Net exports and domestic credit in OECD countries, 2000-2004.

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 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  $i$ , all having the same characteristics except in financial markets deepness captured by the parameter  $\phi^i$  specified below.

Countries are populated by a continuum of agents of total mass 1 who maximize the expected lifetime utility  $E \sum_{t=0}^{\infty} \beta^t U(c_t)$ , where  $c_t$  is consumption at time  $t$  and  $\beta$  is the intertemporal discount factor.

In each country there is a unit supply of a non-reproducible, internationally immobile 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 used at time  $t$ ,  $z_{t+1}$  is an idiosyncratic productivity or investment shock and  $y_{t+1}$  is the output generated at time  $t + 1$ . Because the productive asset is internationally immobile, when agents buy the foreign asset they will produce abroad.

In addition to the production/investment income, agents receive an idiosyncratic stochastic endowment,  $w$ , that follows a discrete Markov process. Therefore, there are two types of uncertainty or risk: from endowment shocks and from investment shocks. One key difference between these two sources of uncertainty is that the first is beyond the control of the agent while the second can be avoided by choosing not to produce, that is, by choosing not to purchase the productive asset. The consideration of investment shock allows us to distinguish risky from riskless investments so that agents face a non-trivial portfolio choice. We can then study not only how financial markets heterogeneity affects net foreign asset positions but also their composition.

It is important to emphasize that production is individually run and the shocks are idiosyncratic. There are no aggregate shocks in the model. Therefore, cross-country risk-sharing is not an issue here.

Let  $s_t \equiv (w_t, z_t)$  be the couple with the endowment and productivity shocks and  $g(s_t, s_{t+1})$  their conditional probability distribution. 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 end-of-period net worth before consumption. The budget constraint is

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

and the net worth evolves according to

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

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 lose a fraction  $\phi^i$  of the diverted income. We also assume that contracts are not exclusive and there is limited liability. Appendix A shows that, under these conditions, the set of feasible claims must satisfy:

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

$$a(s_j) \geq 0 \quad (5)$$

for all  $j \in \{1, \dots, N\}$ . 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  $\phi^i$ , which is country-specific, determines the tightness of the restrictions and it captures the deepness of financial markets. When  $\phi^i$  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  $\phi^i$  pertains to the residency of the agent, independently of whether production takes place at home or abroad. For example, an agent could buy foreign productive assets and receive foreign income. Still, the feasible claims are determined by the local, not foreign  $\phi$ .

### 3.1 Optimization problem and equilibrium

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

$$V_t^i(s, a) = \max_{c, k, b(s')} \left\{ U(c) + \beta \sum_{s'} V_{t+1}^i(s', a(s')) g(s, s') \right\} \quad (6)$$

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,  $c_t^i(s, a)$ , productive investment,  $k_t^i(s, a)$ , and contingent claims  $b_t^i(s, a)(s')$ . These rules determine the evolution of the distribution of agents over  $s, k$  and  $b$ , which we denote by  $M_t^i(s, k, b)$ . The definition of equilibria with and without international mobility of capital follows:

**Definition 1 (Autarky)** *Given the financial deepness,  $\phi^i$ , and initial distributions,  $M_t^i(s, k, b)$ , for  $i \in \{1, \dots, I\}$ , a general equilibrium without mobility is defined by sequences of: (i) policies  $\{c_\tau^i(s, a), k_\tau^i(s, a), b_\tau^i(s, a)(s')\}_{\tau=t}^\infty$ ; (ii) value functions  $\{V_\tau^i(s, a)\}_{\tau=t}^\infty$ ; (iii) prices  $\{P_\tau^i, r_\tau^i, q_\tau^i(s, s')\}_{\tau=t}^\infty$ ; (iv) distributions  $\{M_\tau^i(s, k, b)\}_{\tau=t+1}^\infty$ . Such that: (i) the policy rules solve problem (6) and  $\{V_\tau^i(s, k)\}_{\tau=t}^\infty$  are the associated value functions; (ii) prices satisfy  $q_\tau^i = g(s, s')/(1 + r_\tau^i)$ ; (iii) asset markets clear,  $\int_{s, k, b} k_\tau^i(s, a) M_\tau^i(s, k, b) = 1$ ,  $\int_{s, k, b, w'} b_\tau^i(s, a)(w') M_\tau^i(s, k, b) g(s, s') = 0$  for all  $\tau \geq t$  and in each country  $i \in \{1, \dots, I\}$ ; (iv) the sequence of distributions is consistent with the initial distribution, the individual policies and the idiosyncratic shocks.*

**Definition 2 (Capital mobility)** *Given the financial deepness,  $\phi^i$ , and initial distributions,  $M_t^i(s, k, b)$ , for  $i \in \{1, \dots, I\}$ , a general equilibrium with mobility is defined by sequences of: (i) policies  $\{c_\tau^i(s, a), k_\tau^i(s, a), b_\tau^i(s, a)(s')\}_{\tau=t}^\infty$ ; (ii) value functions  $\{V_\tau^i(s, a)\}_{\tau=t}^\infty$ ; (iii) prices  $\{P_\tau^i, r_\tau^i, q_\tau^i(s, s')\}_{\tau=t}^\infty$ ; (iv) distributions  $\{M_\tau^i(s, k, b)\}_{\tau=t+1}^\infty$ . Such that: (i) the policy rules solve problem (6)*

and  $\{V_\tau^i(s, k)\}_{\tau=t}^\infty$  are the associated value functions; (ii) prices satisfy  $q_\tau^i = g(s, s')/(1 + r_\tau^i)$ ,  $P_\tau^i = P_\tau$  and  $r_\tau^i = r_\tau$ , for all  $i \in \{1, \dots, I\}$ ; (iii) asset markets clear,  $\sum_i \int_{s,k,b} k_\tau^i(s, a) M_\tau^i(s, k, b) = I$ ,  $\sum_i \int_{s,k,b,s'} b_\tau^i(s, a)(s') M_\tau^i(s, k, b) g(s, s') = 0$  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 of capital there is a global market for assets and the prices are equalized across countries (conditions (ii) and (iii)). 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.

## 4 Characterization of the equilibrium

This section characterizes the properties of the equilibrium with and without international 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.

### 4.1 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 that the incentive compatibility constraint (4) is not binding. When shocks are iid, it is sufficient to set  $\bar{\phi} = 1$ . 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:

$$U'(c) = \beta(1 + r_t)U'(c(w')) + (1 + r_t)\lambda(w'), \quad \forall w' \quad (7)$$

$$U'(c) = \beta R_t(k, \bar{z})EU'(c(w')) + R_t(k, \bar{z})E\lambda(w') \quad (8)$$

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. Notice that  $R_t(k, \bar{z})$  is strictly decreasing in  $k$ .

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.<sup>1</sup>

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. Because  $R_t(k, \bar{z})$  is strictly decreasing in  $k$ , this implies that all agents choose the same input of the productive asset. Because the supply of the productive asset is fixed, total output is also fixed. Then the only possible equilibrium must satisfy  $\beta(1 + r_t) = 1$ .

**Lemma 1** *Consider the autarky regime and assume  $\phi = \bar{\phi}$ . Then the interest rate and the price of the asset are constant and equal to  $r = 1/\beta - 1$  and  $P = \nu \bar{z}/r$ .*

**Proof 1** *If  $\beta(1 + r_t) = 1$  is not satisfied, condition (7) implies that the consumption growth of all agents will be either positive or negative. This cannot be an equilibrium because aggregate output is constant. Therefore,  $r_t = 1/\beta - 1$ . Using this result and the fact that all agents use the same units of the productive asset,  $k = 1$ , conditions (7) and (8) imply  $(P_{t+1} + \nu \bar{z})/P_t = 1 + r_t$ . The only stationary solution for this difference equation is  $P_t = P_{t+1} = \nu \bar{z}/r_t$ . Q.E.D.*

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  $b(w_1) = \dots = b(w_N) = b$ , that is, claims cannot be state-contingent. The first order conditions are:

$$U'(c) = \beta(1 + r_t) EU'(c(w')) + (1 + r_t) E\lambda(w') \quad (9)$$

$$U'(c) = \beta R(k, \bar{z}) EU'(c(w')) + R(k, \bar{z}) E\lambda(w') \quad (10)$$

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

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<sup>1</sup>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  $\lambda(w') > 0$ .

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 known from the savings literature (See Huggett (1993), Ayagari (1994) and Carroll (1997)), the uninsurability of the idiosyncratic risk generates precautionary savings and in the steady state  $\beta(1 + r_t) < 1$ .

**Lemma 2** *Consider the autarky regime and assume  $\phi = 0$ . Then the interest rate satisfies  $r_t < 1/\beta - 1$  and the steady state price is  $P = \nu\bar{z}/r$ .*

**Proof 2** *Suppose that  $\beta(1 + r_t) \geq 1$ . Because  $U'(\cdot)$  is convex, condition (7) implies that the expected next period consumption is bigger than current consumption. This is true for all agents, and therefore, next period aggregate consumption will be greater than today aggregate consumption. This cannot be an equilibrium because aggregate output is constant. Therefore,  $r_t < 1/\beta - 1$ . Using this result and the fact that all agents employ the same productive asset  $k = 1$ , conditions (7) and (8) imply  $(P_{t+1} + \nu\bar{z})/P_t = 1 + r_t$ . In the steady state the price and the interest rate are constant. Therefore,  $P = \nu\bar{z}/r$ . Q.E.D.*

The two lemmas establish that the economy with lower financial deepness ( $\phi = 0$ ) has a lower interest rate and, at least in the steady state, a higher price for the asset.

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 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 equilibrium with capital mobility,  $r_t < 1/\beta - 1$  and country 1 accumulates a negative net foreign asset position but a zero position in the productive asset.*

**Proof 1** *In both economies we have that  $R(k, \bar{z}) = 1 + r_t$ . Because with capital mobility there is a single worldwide interest rate, all agents employ the same input of capital  $k = 1$ . Therefore, the net position in the productive asset is zero. We want to show now that the interest rate is smaller than*



the intertemporal discount rate. Suppose on the contrary that  $\beta(1 + r_t) \geq 1$ . Under this condition agents in country 1 will have non-negative consumption growth (see Lemma 1) and agents in country 2 will have positive consumption growth (see Lemma 2). This implies that worldwide output growth is positive which cannot be an equilibrium because aggregate output is constant. Therefore, the equilibrium must satisfy  $\beta(1 + r_t) < 1$ . Under this condition agents in country 1 will experience negative consumption growth (see again Lemma 1). Therefore, consumption keeps falling until the limited liability constraint (5) binds, that is, the net worth of all agents will be equal or close to zero. This implies that the net foreign asset position of country 1 is negative. Q.E.D.

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  $\phi$  is between these two values. In general, lower values of  $\phi$  (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.

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. This implies that the country with deeper financial markets ends up with a negative foreign asset position. In the long-run, 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.

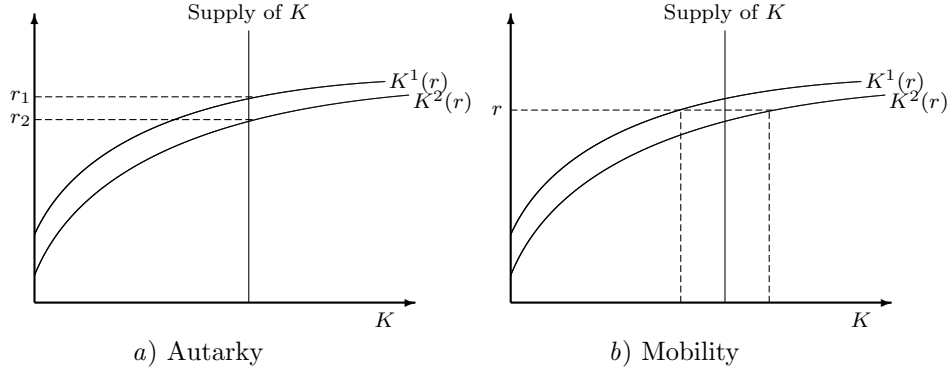


Figure 5: Steady state equilibria with heterogeneous financial conditions.

To summarize, the analysis of this section shows that the economy with only endowment shocks can generate nonzero foreign asset positions but cannot account for differences in the composition of foreign portfolios. We will see in the next section that the consideration of investment shocks allows us to generate portfolio differences.

## 4.2 Investment shocks only

We now consider the case in which the productivity  $z$  is stochastic while the endowment 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:

$$U'(c) = \beta(1 + r_t)U'(c(z')) + (1 + r_t)\lambda(z'), \quad \forall w' \quad (11)$$

$$U'(c) = \beta ER_t(k, z')U'(c(z')) + E\lambda(z')R_t(k, z') \quad (12)$$

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). Because next period consumption is not stochastic, conditions (11) and (12) 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.

Thus, Lemma 1 applies also in this case and the only equilibrium is characterized by  $\beta(1+r_t) = 1$ . Intuitively, because agents can insure perfectly against the idiosyncratic risk, there are no precautionary savings and in equilibrium the interest rate must be equal to the intertemporal discount rate.

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

$$U'(c) = \beta(1+r_t)EU'(c(z')) + (1+r_t)E\lambda(z') \quad (13)$$

$$U'(c) = \beta EU'(c(z'))R_t(k, z') + E\lambda(z')R_t(k, z') \quad (14)$$

Also for the case with only investment shocks Lemma 2 applies, that is, the equilibrium interest rate is smaller than the intertemporal discount rate when  $\phi = 0$ . The main difference with the case of endowment shocks is that now there is a premium over the interest rate for the expected marginal return from the risky asset. To see this, consider the case in which the borrowing limit is not binding. Then conditions (13) and (14) imply:

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

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 with capital mobility,  $r < 1/\beta - 1$  and country 1 has a negative net foreign asset position but a position net 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** *To show that the interest rate is smaller than the intertemporal discount rate, suppose on the contrary that  $\beta(1+r) \geq 1$ . Under this condition agents in country 1 will have non-negative consumption growth and agents in*

country 2 will have strictly positive consumption growth (Lemmas 1 and 2 apply also to the case with only investment shocks). This implies that worldwide output growth is positive which cannot be a steady state equilibrium. Therefore,  $\beta(1+r_t) < 1$ . Under this condition agents in country 1 will experience negative consumption growth (see again Lemma 1). Therefore, consumption keeps falling until the limited liability constraint (5) binds. This implies that the net foreign asset position of country 1 is negative.

To show that country 1 has a positive net position in the productive asset, consider again the first order conditions. Conditions (11)-(12) imply that in country 1  $ER_t(k, z') = 1+r$  while conditions (13)-(14) imply that in country 2  $ER_t(k, z') > 1+r$ . Because the interest rate is the same in both countries, the asset used by agents in country 1 must be greater than the asset used by any individual agent in country 2. Because the supply is the same, country 1 must own part of the productive asset of country 2.

What remains to be shown is that the average return from the foreign productive investment is higher than the cost of the foreign liabilities. Even though the marginal return from the productive asset is equalized to the interest rate, the concavity of the production function implies that the average return is greater than the interest rate. Q.E.D.

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  $\phi$ . 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, agents take more risk. This in turn may generate enough precautionary savings up to the point in which the foreign borrowing of country 1 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. However, the foreign position in productive assets is always positive.

Another important point is that, if country 1 cannot insure perfectly against the investment risk, 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.

### 4.3 Both endowment and investment shocks.

With both endowment and investment shocks, the first order conditions for the cases of  $\phi = \bar{\phi}$  and  $\phi = 0$  are also given by (11)-(14). The only difference is that next period consumption depends on both shocks, that is,  $c(s')$ . Lemmas (1) and (2) also apply to this case with both shocks. The next proposition characterizes some of the properties of the steady state equilibrium with capital mobility.

**Proposition 3** *Suppose that  $\phi^1 = \bar{\phi}$  and  $\phi^2 = 0$ . In the steady state with capital mobility,  $r < 1/\beta - 1$ . Country 1 has a negative net foreign asset position but a position net 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 3** *Same as in Proposition 2.*

This is a restatement of proposition 2. In the extreme case of  $\phi^1 = \bar{\phi}$  and  $\phi^2 = 0$ , the addition of endowment shocks does not change the main properties of the equilibrium. As in the case with only investment shocks, these properties cannot be generalized to any value of  $\phi^1 < \phi^2$ . In particular, while it is always true that the steady state interest rate is smaller than the intertemporal discount rate and country 1 always acquires a positive net position in foreign productive assets, its total net foreign asset position is not necessarily negative. This depends on the relative importance of the two shocks: as long as the endowment shock is sufficiently large, compared to the investment shock, country 1 accumulates negative net foreign asset positions.

## 5 Quantitative analysis

In this section we parameterize the model and show its quantitative properties. The quantitative analysis is limited to two countries: the first is representative of the United States while the second aggregates all other countries.

### 5.1 Calibration

Because the US share of world GDP is about 30 percent, we assume that the relative size of country 1 is 30 percent the economic size of country 2. This

can be accomplished in two ways: by fixing the population size and supply of the productive asset in country 1 to 30 percent the worldwide quantities, or by fixing to the average endowment and productivity of country 1 to 30 percent the worldwide values. Because they all lead to the same results, we take the first approach because of analytical convenience. The relative size will be relevant only for the derivation of the market clearing conditions.<sup>2</sup>

The stochastic endowment takes two values, that is,  $w = \bar{w}(1 \pm \Delta_w)$ , with symmetric transition probability matrix. The investment shocks also takes two values, that is,  $z = \bar{z}(1 \pm \Delta_z)$  but it is assumed to be iid. The return to scale parameter is set  $\nu = 0.75$ .

Interpreting  $w$  as labor income and  $y = zk^\nu$  as net capital income, we set  $\bar{w} = 0.85$  and choose  $\bar{z}$  so that  $y = 0.15$ . For the calibration of the stochastic component of the endowment we follow recent estimates of the earning process and set the persistence probability to 0.95 and  $\Delta_w = 0.6$ . These values imply an autocorrelation coefficient of 0.9 and a standard deviation of log-earnings of 0.30. This is in the ranges of values estimated by Storesletten, Telmer & Yaron (2004). The variation in investment shock is set to  $\Delta_z = 2.5$ . With this parametrization the individual return on assets fluctuates, approximately, between -6% and 15%. We interpret this as an approximation to the volatility of firm-level profits.

Next we choose the parameters of the financial structure. Unfortunately there are not direct observations that allow us to calibrate  $\phi^i$ . Several indicators such as the ones reported in Figure 1 suggest that the financial markets characteristics are significantly different across countries. However, it is difficult to derive a direct map from these indicators to the values of  $\phi^i$ . Given these difficulties, we take a pragmatic approach. We begin by assigning  $\phi^1 = 0.4$  and  $\phi^2 = 0$  but then we conduct a sensitivity analysis. 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 about 40 percent more advanced than country 2.<sup>3</sup>

<sup>2</sup>Let  $\mu^i$  be the share of country  $i$  and define  $B^i$  and  $K^i$  the per-capita financial claims and productive assets owned by agents in country  $i$ . The worldwide market clearing conditions are  $B^1\mu^1 + B^2\mu^2 = 0$  and  $K^1\mu^1 + K^2\mu^2 = 1$ . With productivity differences the per-capita aggregates  $B^i$  and  $K^i$  would be rescaled by the relative productivity.

<sup>3</sup>According to the data shown in Figure 1, the difference between the financial index

The last two parameters to be pinned down are  $\sigma$  and  $\beta$ . We set the risk aversion parameter to  $\sigma = 2.5$  and we choose the discount factor so that in the steady state with capital mobility the worldwide wealth-income ratio is 3.5. Given the parameter values chosen above this requires  $\beta = 0.915$ .

## 5.2 Results

The top section of Table 2 reports some key variables in the steady state equilibrium with and without international mobility of capital. In the steady state with capital mobility, country 1 has a positive foreign position in productive assets but a much larger negative position in riskless bond. As a result, the net foreign asset position is negative. Because of the higher return from the foreign risky assets, country 1 receives positive factor payments despite the negative net foreign asset position.

Let's look now at the transition from the autarky steady state to the steady state with capital mobility. Figure 6 plots the dynamics of several variables for both countries. Before liberalizing countries were in the autarky steady state and the liberalization is not anticipated. As can be seen from the first panel, the dynamics of net foreign asset position is gradual. The current account remains in deficit for many periods until it balances in the limit. The current account deficit picks immediately after 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 gradual liberalization, the current account dynamics would have been more similar to the data.

Figure 6 also plots the composition of foreign assets and the current account. Immediately after liberalization, country 1 purchases a large quantity of foreign productive assets 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. Notice that the portfolio adjustment is very drastic. This would be smoother if there was some adjustment cost.

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for the US and the average index for all other advanced economies is about 40 percent. Therefore, it seems reasonable to start with  $\phi^1 = 0.4$  and  $\phi^2 = 0$ .

Table 2: Steady state with and without capital mobility.

	Autarky		Capital mobility	
	Country 1	Country 2	Country 1	Country 2
<b>A) Both shocks</b>				
Asset price	3.24	3.69	3.54	3.54
Interest rate	3.08%	2.30%	2.56%	2.56%
Return on risky asset	4.57%	3.94%	3.89%	4.28%
Foreign asset position	-	-	-50.31%	21.31%
Foreign bonds	-	-	-167.62%	70.98%
Foreign risky asset	-	-	117.31%	-49.68%
Net exports	-	-	-0.27%	0.11%
Net factor payments	-	-	0.27%	-0.11%
<b>B) Endowment shocks only</b>				
Asset price	3.08	3.44	3.33	3.33
Interest rate	3.66%	3.27%	3.38%	3.38%
Return on risky asset	4.87%	4.36%	4.50%	4.50%
Foreign asset position	-	-	-45.85%	19.65%
Foreign bonds	-	-	-45.85%	19.65%
Foreign risky asset	-	-	0.00%	0.00%
Net exports	-	-	1.55%	-0.66%
Net factor payments	-	-	-1.55%	0.66%
<b>C) Investment shocks only</b>				
Asset price	1.23	1.17	1.20	1.20
Interest rate	8.31%	7.02%	7.58%	7.58%
Return on risky asset	12.18%	12.66%	11.54%	12.99%
Foreign asset position	-	-	-17.78%	7.51%
Foreign bonds	-	-	-62.43%	26.36%
Foreign risky asset	-	-	44.64%	-18.85%
Net exports	-	-	-0.42%	0.18%
Net factor payments	-	-	0.42%	-0.18%

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



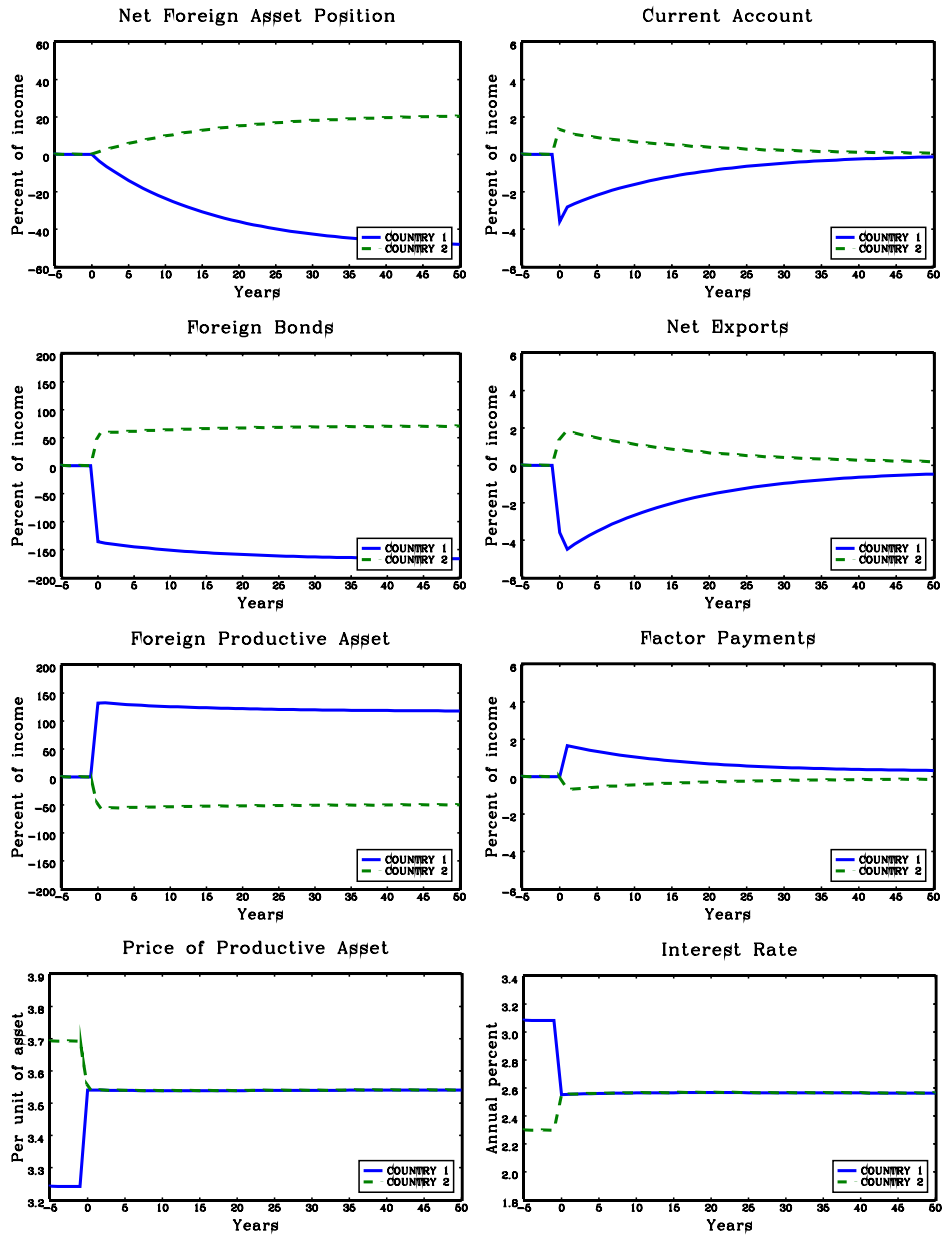


Figure 6: Transition dynamics after capital markets liberalization.

The numerical exercise conducted in this section outlines three important points. First, countries with deeper financial markets take positive positions in foreign risky assets. Because these positions are more than compensated by foreign borrowing, the net foreign asset position is negative. Still, the higher return from the risky assets may allow these countries to receive positive factor incomes from abroad. Second, the magnitude of the 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 2/3 of the long term net foreign position is accumulated in the first 15 years.

To show the importance of investment shocks, Figure 7 plots the transition dynamics for the economies with only endowment or investment shocks. As a reference we also plots the dynamics for the economy with both shocks. Only country 1 variables are reported. Those for country 2 are just the reciprocal rescaled by the relative size of the two countries. The steady state values with and without mobility are reported in Table 2.

As anticipated from the theoretical analysis of Section 4, the economy with only endowment shocks can generate large net foreign asset positions but cannot capture the fact that a large share of US foreign holdings are in high return assets. On the other hand, the economy with only investment shocks accounts for the US foreign ownership of high return assets but it generates a smaller net foreign asset position.<sup>4</sup> By adding the endowment shocks the model can capture both features of the US international position: large net foreign liabilities and a portfolio composition tilted toward high return assets.

### 5.3 Welfare consequences of capital markets liberalization

The next question we address is whether capital markets liberalization is welfare enhancing for the participating countries and whether the welfare consequences are equally distributed in the population.

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<sup>4</sup>For some parameter values, country 1 may accumulate positive assets positions. This seems to contradict Proposition 2. This proposition, however, applies only to the case with  $\phi^1 = \bar{\phi}$ . As remarked in Section 4.2, the country with better financial markets will invest more in the risky asset. However, by doing so, it also takes on more risk which increases the incentive to save. As a result, the country may end up accumulating a positive net foreign asset position.

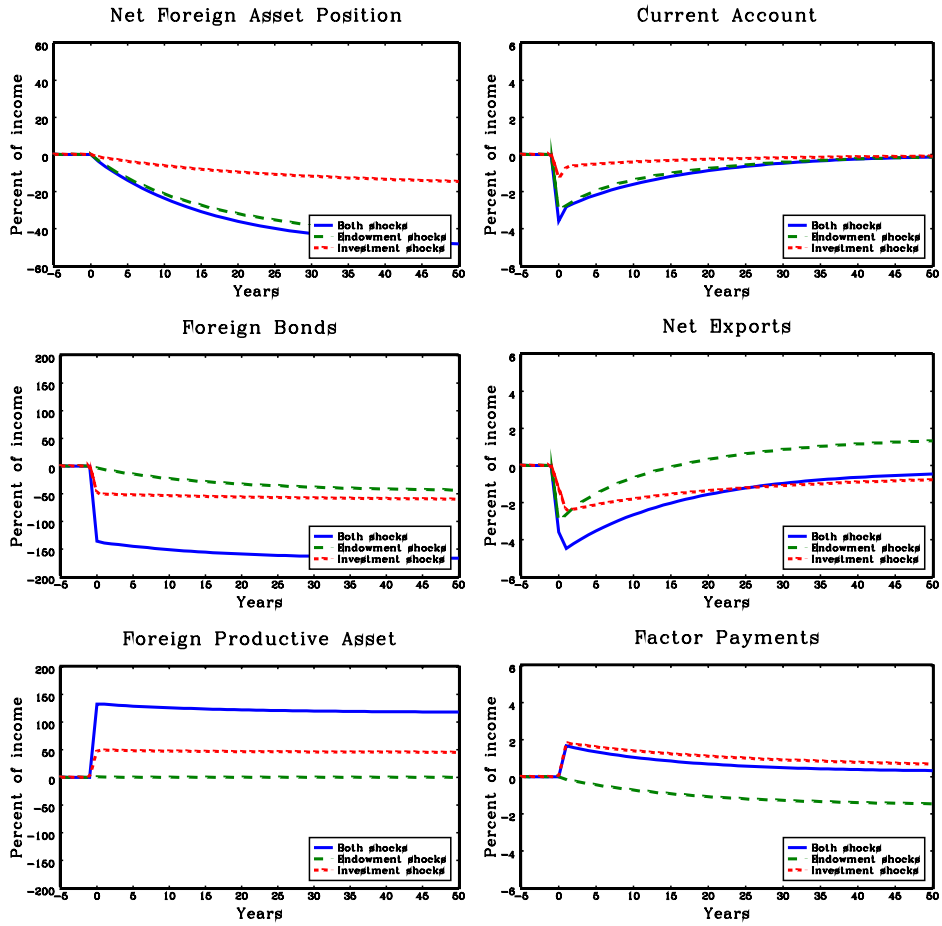


Figure 7: Transition dynamics in country 1 with different shocks.

Figure 8 plots the percentage of consumption gains due to liberalization as a function of net worth,  $a$ , and for different endowments,  $w$ . Three versions of the economy are considered: with both endowment and investment shocks; with only endowment shocks; with only investment shocks. The gains are computed as the percentage increase in consumption in the autarky allocation so that agents are indifferent between remaining in autarky and liberalizing.

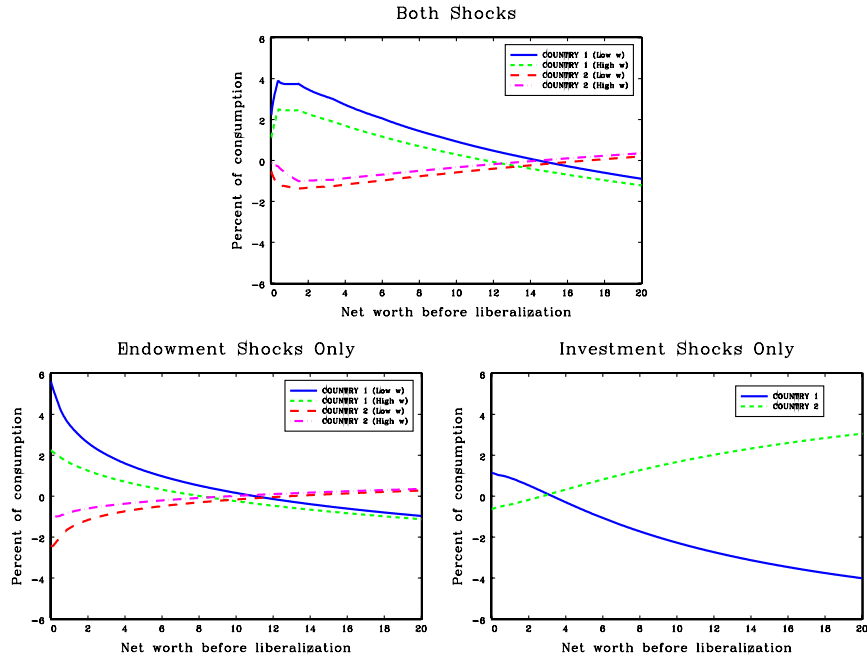


Figure 8: Welfare gains from capital markets liberalization.

As can be seen from the figure, agents with lower initial wealth gain in country 1 while they lose in country 2. This is a consequence of the changes in interest rates after liberalization: the interest rate falls in country 1, which harms wealthy agents, while the interest rate increases in country 2, which is beneficial for wealthy agents. When we consider a social welfare function with equal weights, the aggregate welfare consequences of liberalization depend on the initial distribution. Because most of the agents are concentrated on the left-hand side, the aggregate welfare consequences are dominated by poorer agents. As a result, country 1 gains on average from liberalization while country 2 loses, independently of the types of shocks affecting the economy. These equally weighted welfare consequences are reported in Table 3. For

the economy with both shocks, country 1 gains 2.7 percent of consumption while country 2 loses 1.0 percent.

Table 3: Equally weighted welfare gains (percent of consumption).

	Country 1	Country 2
Economy with both risks	2.71	-1.00
Economy with endowment risks	2.86	-1.33
Economy with investment risks	0.47	-0.18

The fact that country 1 gains and country 2 loses on average 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 assess 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. The increase in savings, however, is welfare reducing for country 2.<sup>5</sup>

The fact that the welfare consequences are not positive for both countries 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 liberalization such as those associated with technological adoption. Therefore, it is premature to conclude that liberalization is detrimental for countries with lower financial markets

<sup>5</sup>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,  $\gamma^i$ . 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.

development. The effects we emphasize in this paper are purely financial.

#### 5.4 Sensitivity for the financial deepness

Here we conduct a sensitivity analysis with respect to parameters of financial deepness. Table 4 reports steady state values for different parametrization of  $\phi^1$  and  $\phi^2$ . In the top section of the table we reduce  $\phi^1$  from 0.4 to 0.2, keeping  $\phi^2$  at the original value of zero. In the second panel we increase  $\phi^1$  to 0.8 but we still keep  $\phi^2$  at the original value of zero. In the third panel, instead, we increase  $\phi^2$  to 0.2.

The impact of these changes on the equilibrium outcomes is as expected. More heterogeneity in financial deepness leads to larger imbalances. More specifically, the country with more advanced financial markets accumulates larger positions in the productive asset and borrows more internationally. The welfare consequences also become bigger.

## 6 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.

Table 4: Steady state with and without capital mobility. Sensitivity analysis.

	<u>Autarky</u>		<u>Capital mobility</u>	
	<i>Country 1</i>	<i>Country 2</i>	<i>Country 1</i>	<i>Country 2</i>
<b>A) <math>\phi^1 = 0.2, \phi^2 = 0.0</math></b>				
Asset price	3.46	3.69	3.62	3.62
Interest rate	2.68%	2.30%	2.42%	2.42%
Return on risky asset	4.25%	3.94%	3.90%	4.10%
Foreign asset position	-	-	-22.74%	9.68%
Foreign bonds	-	-	-81.89%	34.86%
Foreign risky asset	-	-	59.16%	-25.18%
Welfare gains	-	-	1.23%	-0.48%
<b>B) <math>\phi^1 = 0.8, \phi^2 = 0.0</math></b>				
Asset price	2.81	3.69	3.37	3.37
Interest rate	3.92%	2.30%	2.88%	2.88%
Return on risky asset	5.33%	3.94%	3.95%	4.69%
Foreign asset position	-	-	-121.54%	51.13%
Foreign bonds	-	-	-330.47%	139.03%
Foreign risky asset	-	-	208.94%	-87.90%
Welfare gains	-	-	6.72%	-2.09%
<b>A) <math>\phi^1 = 0.4, \phi^2 = 0.2</math></b>				
Asset price	3.24	3.46	3.39	3.39
Interest rate	3.08%	2.68%	2.81%	2.81%
Return on risky asset	4.57%	4.25%	4.22%	4.41%
Foreign asset position	-	-	-26.84%	11.43%
Foreign bonds	-	-	-78.03%	33.24%
Foreign risky asset	-	-	51.19%	-21.80%
Welfare gains	-	-	1.34%	-0.53%
<i>Notes: Foreign asset positions, current account, net exports and net factor payments are in percentage of domestic income (endowment plus domestic dividends).</i>				

## 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,  $\phi x$ , is lost. We allow  $\phi$  to be greater than 1. 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:

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

and the value of diversion is:

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

Incentive-compatibility requires:

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

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

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:

$$V_t(s, a) = \max_{c, k, b(s')} \left\{ U(c) + \beta \sum_{s'} V_{t+1}(s', a(s')) g(s, s') \right\}$$

subject to

$$a = c + \sum_{s'} b(s') q(s, s')$$

$$a(s') = w' + z' k^\nu + k P_{t+1} + b(s')$$

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

$$a(s_j) \geq 0$$

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  $a$ .<sup>6</sup> The strict monotonicity of the value function implies that the incentive-compatibility constraint can be written as:

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

for all  $j = 1, \dots, N$ . 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

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<sup>6</sup>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:

$$a(s_{t+1}) = w_{t+1} + z_{t+1}k_t^\nu + k_t P_{t+1} + \bar{b}_t + x(s_{t+1}) \quad (15)$$

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

$$a(s_j) = a(s_1) + (1 - \phi) \cdot [w_j - w_1 + (z_j - z_1)k_1^\nu]$$

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

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

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:

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

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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