Financial Integration, Financial Development and Global Imbalances[1]

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September 13, 2008

[1]We would like to thank Manuel Amador, David Backus, Luca Dedola, Linda Goldberg, Pierre-Olivier Gourinchas, Gita Gopinath, Ayse Imrohoroglu, Kyungsoo Kim, Alessandro Rebucci for insightful comments, and Gian Maria Milesi-Ferretti and Philip Lane for sharing their cross-country data on foreign asset positions. We also thank participants at several universities and conferences. Financial support from the National Science Foundation is gratefully acknowledged.

Abstract

Global financial imbalances can be the outcome of financial integration when countries differ in financial markets development. Countries with more advanced financial markets accumulate foreign liabilities in a gradual, long-lasting process. Differences in financial development also affect the composition of foreign portfolios: countries with *negative* net foreign asset positions maintain *positive* net holdings of non-diversifiable equity and FDI. Three empirical observations motivate our analysis: (1) financial development varies widely even amongst industrial countries, with the United States ranking at the top; (2) the secular decline in the U.S. net foreign asset position started in the early 1980s, together with a gradual process of international financial integration; (3) the portfolio composition of U.S. net foreign assets features increased holdings of risky assets and a large raise in debt.

1 Introduction

At the end 2007 the United States reported the largest current account deficit and the lowest net foreign asset (NFA) position in its history. The NFA position reached -4.5 percent of the world's output following a trend that started in the early 1980s. Throughout this period, the U.S. foreign asset portfolio also showed marked trends: net equity and FDI climbed to 1/10 of U.S. GDP, while debt obligations increased to about 1/3 of U.S. GDP.

These unprecedented global imbalances are the subject of heated debates in academic and policy circles. On the one hand there is the view that, unless major policy actions are taken, the imbalances will generate global financial turbulence and, possibly, a world economic crisis.[1] On the other, there is the view that the imbalances are the relatively harmless outcome of various events such as differences in productivity growth, business cycle volatility, demographic dynamics, a 'global saving glut', or valuation effects. This view is summarized in Backus, Henriksen, Lambert, & Telmer (2005).[2]

In this paper we argue that both the large imbalances as well as the composition of the imbalances could be the result of financial integration among countries with heterogenous domestic financial markets. The far-reaching reforms that integrated capital markets during the 1980s and 1990s 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 differed substantially across countries, and those differences have remained largely unaltered despite the globalization of capital markets. In short, financial integration was a global phenomenon, but financial development was not.

The motivation for studying global imbalances from this perspective derives from three key observations:

1. *There is a high degree of heterogeneity in domestic financial markets across countries, and these differences persist despite financial global-*

[1]See, for example, Summers (2004), Obstefeld & Rogoff (2004), Roubini & Setser (2005), Blanchard, Giavazzi, & Sa (2005), Krugman (2006).

[2]See also Attanasio, Kitao, & Violante (2006),Bernanke (2005), Croke, Kamin, & Leduc (2005), Gourinchas & Rey (2007), Hausmann & Sturzenegger (2006), Henriksen (2005), Lane & Milesi-Ferretti (2007), Caballero, Farhi, & Gourinchas (2008), Cavallo & Tille (2006), Engel & Rogers (2006), Fogli & Perri (2006), Ghironi, Lee, & Rebucci (2007), Chakraborty & Deckle (2007), Deckle, Eaton, & Kortum (2007), McGrattan & Prescott (2007), Prades & Rabitsch (2007).

ization and financial development. The top panel of Figure 1 plots the financial development index constructed by the International Monetary Fund's for industrial countries (see IMF (2006)). The index shows that there are large differences even among advanced economies, with the United States ranked first. In addition, the gaps of other industrial countries relative to the U.S. did not change significantly between 1995 and 2004. Similar features are evident from another index of financial development constructed by Abiad, Detragiache, & Tressel (2007) for industrial and emerging economies for the 1973-2002 period. As shown in the bottom panel of Figure 1, while financial liberalization progressed in both OECD and emerging economies over the last 30 years, the gap between the two groups of countries has not changed.

2. *The NFA position of the most financially developed country—the United States—began a secular decline in the early 1980s, roughly at the same time as the financial globalization process started.* The top panel of Figure 2 shows the Chinn-Ito financial openness index for the United States, the industrial countries excluding the U.S., and all countries except the U.S. The Figure shows that U.S. capital markets have been relatively open to the rest of the world throughout the last three decades. Most of the other countries started opening their capital accounts gradually since the beginning of the 1980s. The bottom panel of Figure 2 shows that an outcome of the financial globalization has been a worldwide surge in gross stocks of foreign assets and liabilities. This period has also registered the secular decline in the U.S. NFA position as can be observed from Figure 3. This figure plots the two broad components that add up to the total NFA position: The net position in debt instruments and international reserves, and the net position in portfolio equity and foreign direct investment.

3. *The decline in the U.S. NFA position was accompanied by a marked change in the portfolio composition of foreign assets.* Figure 3 shows that the United States increased the net holdings of risky assets (portfolio equity and FDI), and reduced the net holdings of riskless assets into a large negative position. Other industrial countries changed their net holdings of risky assets in a similar way, but hardly changed their holdings of riskless assets. The emerging economies reduced the net holdings of risky assets and increased the holdings of riskless assets.

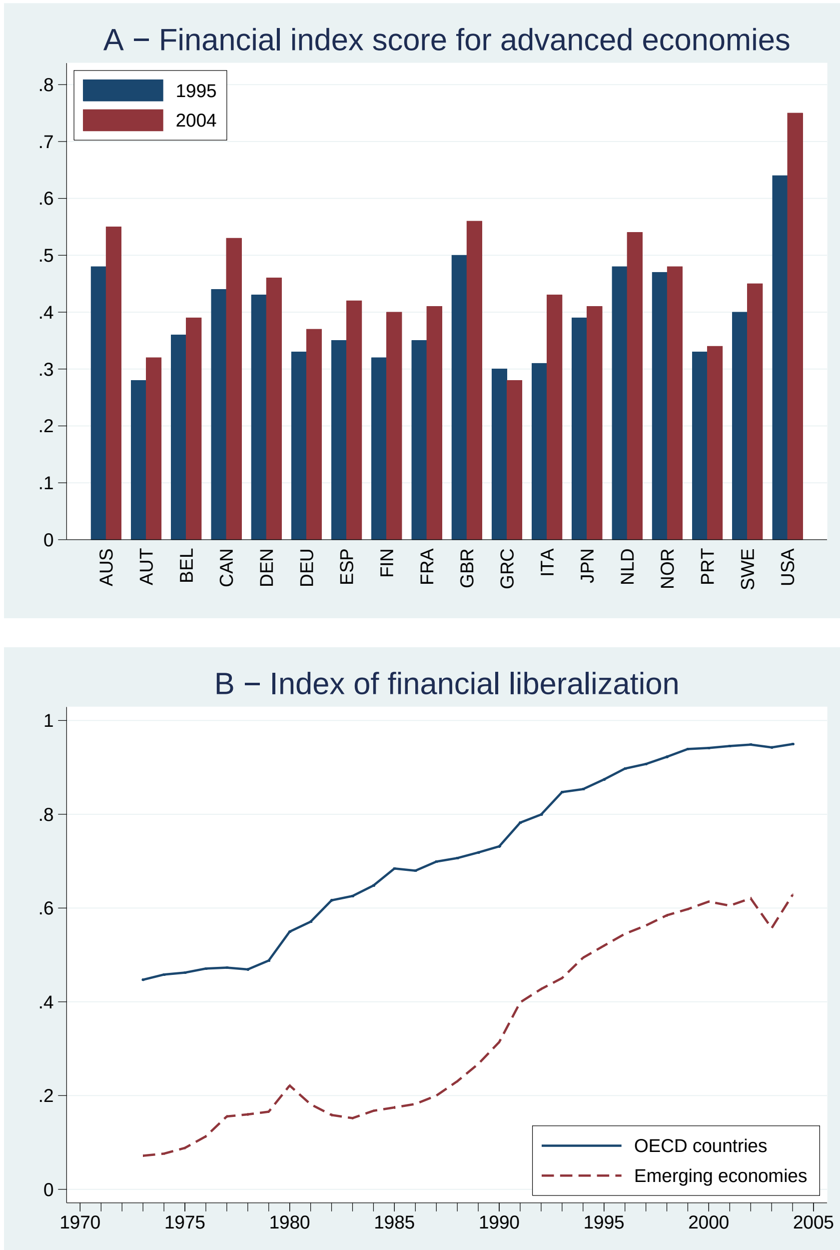

Figure 1: Indices of financial markets heterogeneity. The index in panel A is from IMF (2006). The index in panel B is from Abiad, Detragiache and Tressel (2007). See appendix A for the definition of variables.

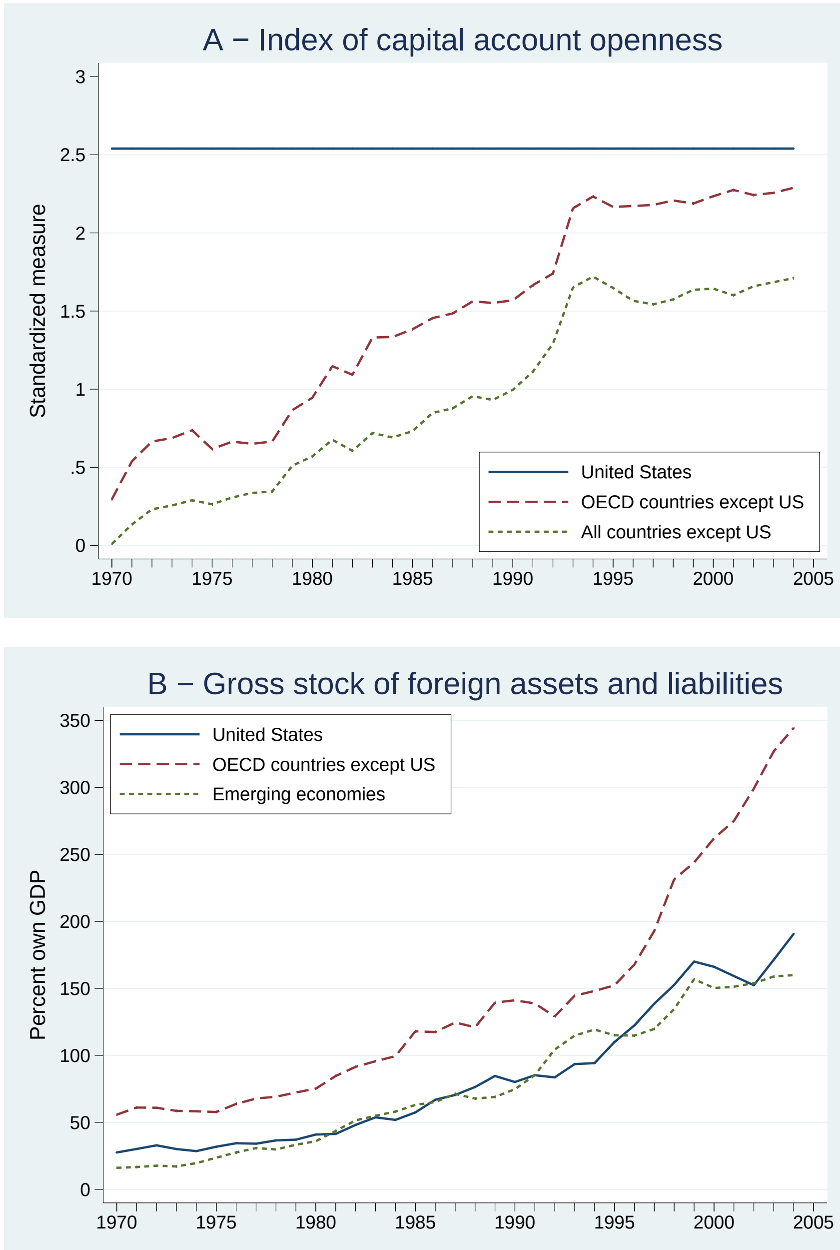

Figure 2: Indices of financial openness. The index in panel A is from Chinn and Ito (2005). The index in panel B is constructed using data from Lane and Milesi-Ferretti (2006). See appendix A for the definition of variables.

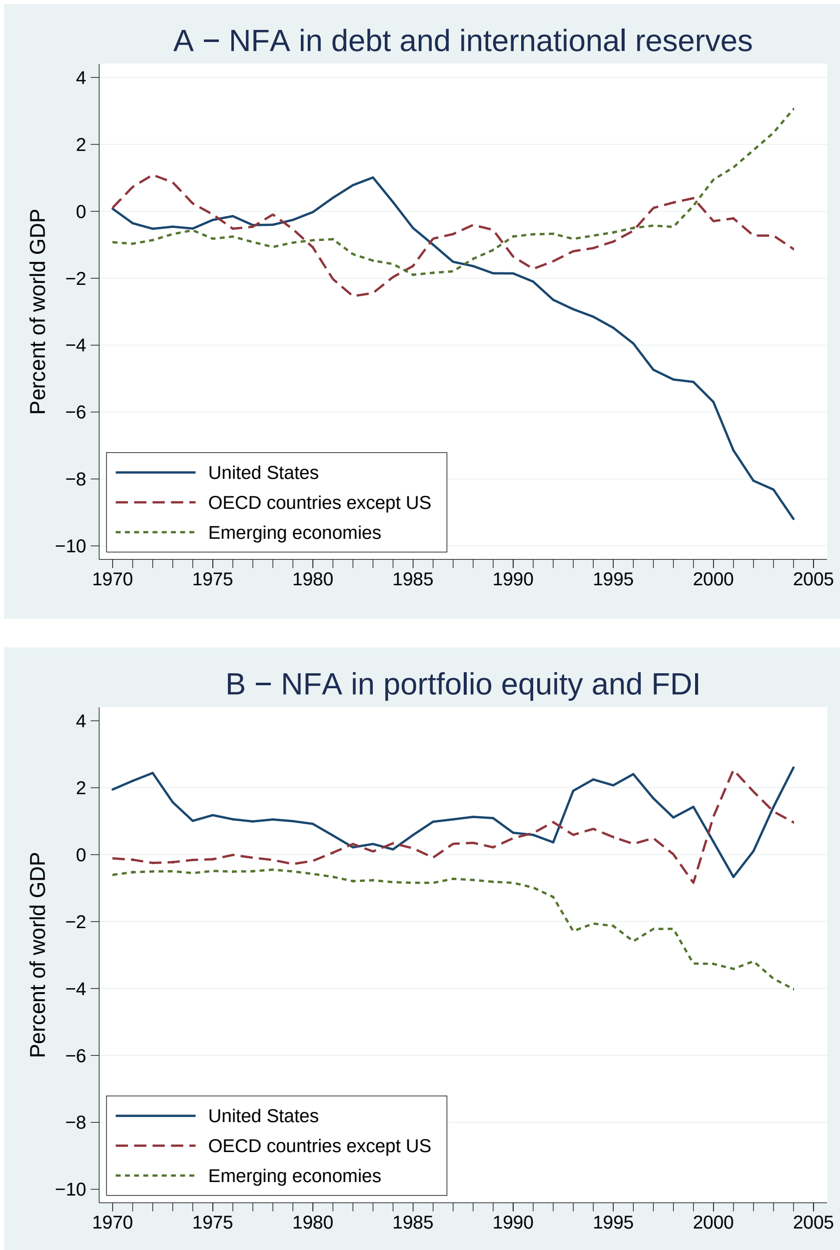

Figure 3: Net foreign asset positions in debt instruments and risky assets. The graphs are constructed using data from Lane and Milesi-Ferretti (2006). See appendix A.

We propose a multi-country dynamic stochastic general equilibrium model with incomplete asset markets that can explain these facts. 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 defined by the extent to which individuals are able to use financial contracts to insure against idiosyncratic risks. This is determined by two types of frictions: the agents' ability to divert a fraction of their income and the ability to claim limited liability. The first limits the feasibility of state contingent contracts. The second restricts the capacity to borrow.

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 sharply in the long-run. In fact, moderate differences in financial development can easily lead to NFA positions larger than half of the domestic production. Moreover, this is a gradual and long-lasting process that can take more than 30 years.

The model also predicts that countries with different financial markets characteristics choose different compositions of foreign portfolios, in a pattern that broadly resembles the portfolio compositions observed in the data. In particular, country U invests in foreign risky assets and finances this investment with debt, so its net foreign asset position features a large negative position in riskless bonds and a positive position in risky assets. Moreover, a three-country extension of the model with two types of financial heterogeneity, can account for both the large negative NFA position of the United States and the differences in portfolio structures of the United States, other industrial countries and emerging economies.

The premise that differences in domestic financial markets can produce external imbalances has precedent in the literature. Willen (2004) studied the qualitative predictions of a two-period endowment-economy model with exponential utility and normal-i.i.d. shocks. He showed that, under incomplete markets, trade imbalances emerge due to reduced savings by the agents residing in countries with 'more complete' asset markets. Our model embodies this mechanism but also differs in two key respects. First, we allow for endogenous production with 'production risks,' which is necessary for explaining the composition of asset portfolios in addition to total NFA positions. Second, we study an infinite horizon model with standard constant relative risk aversion preferences, exploring both the qualitative and quantitative predictions of the model.

Caballero et al. (2008) also emphasize the role of heterogeneous domestic financial systems in explaining global imbalances, but using a model in which financial imperfections are captured by a country's ability to *supply* assets and in a world without uncertainty. In our framework, instead, financial imperfections have a direct impact on savings, and therefore, on the *demand* for assets. Uncertainty is crucial in our framework: without risk there are no imbalances even if financial markets are heterogeneous. The two papers also differ in the main driving forces of global imbalances. In Caballero et al. the imbalances are generated by differential shocks to productivity growth and/or to the financial structure of countries. Our explanation, instead, relies on the international liberalization of capital markets, given the differences in the characteristics of domestic financial markets.

Our work is also related to studies that investigate global imbalances with quantitative dynamic general equilibrium models (see IMF (2005), Hunt & Rebucci (2005) and Faruqee, Laxton, D., & Pesenti (2007)). In these studies, global imbalances emerge as the outcome of a combination of exogenous shocks, such as a permanent increase in the 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, our model predicts a reduction in U.S. savings and an increase in the foreign demand for U.S. assets endogenously, after financial integration, because of the different characteristics of the U.S. financial system. This occurs even if all countries have identical preferences, resources and production technologies.

The rest of the paper is organized as follows: Section 2 describes a basic two-country framework that we use to characterize analytically the key theoretical results. Section 3 extends the basic model along several dimensions and Section 4 conducts the quantitative analysis. Sections 5 and 6 study the robustness of the results to alternative assumptions about the financial differences across countries. Section 7 concludes.

2 A model of financial globalization with financial heterogeneity.

In this section we describe a simple version of the model that allows us to illustrate the key properties analytically. These properties are preserved in the general setup we will use in the quantitative analysis.

Consider an economy composed of two countries, indexed by $i \in \{1, 2\}$. Each country is inhabited by a continuum of agents of total mass 1. Agents maximize the 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. The utility function is strictly increasing and concave with $U(0)=-\infty$ and $U'''(c)>0$.

Each country is endowed with a unit supply of a non-reproducible, internationally immobile asset, traded at price P_t^i. This asset can be used by each agent in the production of a homogeneous good, with a one-period gestation lag. Thus, the individual 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* shock and y_{t+1} is the output produced at time $t+1$. We refer to z_{t+1} as an *investment* shock because it determines the ex-post return on the investment k_t.

We assume that $\nu<1$, *i.e.* individual production displays decreasing returns to scale. This property derives from the assumption that production also requires the input of managerial or organizational capital, of which agents have limited supply. Managerial capital cannot be divided among multiple projects but it is internationally mobile. Therefore, with capital mobility agents can choose to operate at home, buying the domestic productive asset, or abroad, buying the foreign productive asset. Without capital mobility, agents can buy only the productive asset located at home.[3]

Agents also receive incomes in the form of an *idiosyncratic* stochastic endowment, w_t, that follows a discrete Markov process. Therefore, there are two types of uncertainty or risk: endowment and investment shocks. We can interpret w_t as labor income and y_t as capital income.

A key difference between endowment and investment risks is that the first is beyond the control of individual agents while the second can be avoided by choosing not to purchase the productive asset. With this difference at play, we can distinguish risky from riskless investments so that agents face a nontrivial 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 shocks are idiosyncratic. There are no aggregate shocks. Therefore, cross-country sharing of aggregate risks is not an issue here. Also notice that there is no aggregate accumulation of capital. For an extension with capital

[3]The limited supply of the productive asset is similar to the Lucas' tree model with two important differences. First, the tree or the fruits of the tree are combined with another input of production, the managerial capital. This introduces decreasing returns to scale. Second, shocks to production, which can also be interpreted as shocks to the fruits of the tree, are idiosyncratic. In the typical Lucas' tree model, the realizations of the shock are the same for all agents operating in the same country.

accumulation see Mendoza, Quadrini, & Ríos-Rull (2007).

Let $s_t \equiv (w_t, z_t)$ be the pair of endowment and investment shocks and $g(s_t, s_{t+1})$ their conditional probability distribution. Agents can buy contingent claims, $b(s_{t+1})$, that depend on the next period's realizations of these shocks. Because there is 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.

Define a_t as the end-of-period net worth before consumption. The budget constraint for an individual agent is

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

and the net worth evolves according to

$$a(s_{t+1}) = w_{t+1} + k_t P_{t+1}^i + z_{t+1} k_t^{\nu} + b(s_{t+1}). \tag{2}$$

If asset markets were complete, *i.e.* there are no restrictions on the set of feasible claims, agents would be able to perfectly insure against the endowment and investment risks. Because of market frictions, however, the set of feasible claims is constrained in each country. In particular, we assume that contracts are not perfectly enforceable due to the limited (legal) verifiability of shocks. Because of the limited verifiability, agents can divert part of their incomes from endowment and production, but they lose a fraction ϕ^i of the diverted income. The parameter ϕ^i characterizes the degree of enforcement of financial contracts in country i. This is the only feature that differentiates the two countries.

We also assume that there is limited liability and agents cannot be excluded from the market after defaulting. Under these assumptions, Appendix B shows that enforceability imposes the following two constraints:

$$a(s_j) - a(s_1) \geq (1 - \phi^i) \cdot \Big[(w_j + z_j k_t^{\nu}) - (w_1 + z_1 k_t^{\nu}) \Big] \tag{3}$$

$$a(s_j) \geq 0 \tag{4}$$

for all $j \in \{1, ..., J\}$. Here J denotes the number of all 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 $1 - \phi^i$. When ϕ^i is sufficiently large, agents are able to maintain constant net worth, and therefore, constant consumption (full insurance). When $\phi^i = 0$—implying that income can be diverted without losses—only non-state-contingent claims are feasible. The second constraint imposes that net worth cannot be negative. This follows from the assumption of limited liability.

A key assumption is that ϕ^i pertains to the country of residency of the agents, regardless of the geographic location of their assets. In particular, if asset markets are globally integrated, domestic agents can buy foreign productive assets and receive foreign income, but still their feasible claims are determined by the domestic, not the foreign ϕ. This implies that the ability of an agent to divert investment incomes generated abroad depends on the institutional, legal and contractual environment of the residence country.

This assumption is based on the idea that the verification of diversion requires the verification of individual consumption. Because individual consumption takes place in the residence country, the institutional features of the residence country are the ones that matter for enforcement.[4] However, in Section 5 we will show that our results are robust to alternative assumptions about the residence or source nature of ϕ^i.

2.1 Optimization problem and equilibrium

Let $\{P^i_\tau, q^i_\tau(s_\tau, s_{\tau+1})\}_{\tau=t}^{\infty}$ be a (deterministic) sequence of prices in country i. With capital mobility these prices are equalized internationally, and therefore, an individual agent is indifferent about the domestic v. foreign location of the productive investment. We can then write the optimization problem of an individual agent as if he or she only buys domestic k. Independently of the international capital regime, this can be written as:

$$V^i_t(s,a) = \max_{c,k,b(s')} \left\{ U(c) + \beta \sum_{s'} V^i_{t+1}\Big(s', a(s')\Big) g(s,s') \right\} \tag{5}$$

subject to

$$(1), (2), (3) \text{ and } (4)$$

[4]One way to think about this assumption is that agents have the ability to repatriate the incomes earned abroad. Once the incomes are transferred back to the home country, the verifiability of these incomes is determined by the institutions at home.

where we denote 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. This motivates the time subscript in the value function.

The solution to the agent's problem yields decision rules for consumption, $c_t^i(s,a)$, productive assets, $k_t^i(s,a)$, and contingent claims $b_t^i(s,a,s')$. Since in the equilibrium with capital mobility agents are indifferent about the location of the productive investment, we do not have to specify whether the holding of productive capital, $k_t^i(s,a)$, is domestic or foreign. The decision rules determine the evolution of the distribution of agents over s, k and b, which we denote by $M_t^i(s,k,b)$.

Definition 1 (Financial autarky) *Given the financial development, ϕ^i, and initial distributions, $M_t^i(s,k,b)$, for $i \in \{1,2\}$, a general equilibrium without international mobility of capital is defined by sequences of: (i) agents' 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 (5) and $\{V_\tau^i(s,k)\}_{\tau=t}^\infty$ are the associated value functions; (ii) prices satisfy $q_\tau^i = g(s,s')/(1+r_t^i)$; (iii) asset markets clear, $\int_{s,k,b} k_\tau^i(s,a)M_\tau^i(s,k,b) = 1$, $\int_{s,k,b,s'} b_\tau^i(s,a,s')M_\tau^i(s,k,b)g(s,s') = 0$ for each $i \in \{1,2\}$ and all $\tau \geq t$; (iv) the sequence of distributions is consistent with the initial distributions, the individual policies and the stochastic processes for the idiosyncratic shocks.*

The definition of the equilibrium with globally integrated capital markets is similar, except for the prices and market clearing conditions (ii) and (iii). With financial integration there is a global market for assets and asset prices are equalized across countries. Therefore, condition (ii) becomes $q_\tau^1 = g(s,s')/(1+r_t^1) = g(s,s')/(1+r_t^2) = q_\tau^2$ and $P_\tau^1 = P_\tau^2$. Furthermore, asset markets clear globally instead of country by country. Therefore, the market clearing condition for the productive assets becomes $\sum_{i=1}^2 \int_{s,k,b} k_\tau^i(s,a)M_\tau^i(s,k,b) = 2$ and the market clearing condition for the contingent claims becomes $\sum_{i=1}^2 \int_{s,k,b,s'} b_\tau^i(s,a,s')M_\tau^i(s,k,b)g(s,s') = 0$.

With capital mobility, the assets owned by a country are no longer equal to the assets located in the country, and hence NFA positions are generally different from zero. As a result, one country may hold a share of the world productive asset larger than its domestic share. It is important to notice that, since in equilibrium agents are indifferent about the location of the productive investment, only the 'net' share of the foreign productive asset is determined. More specifically, only the 'net' mass of agents operating abroad is determined in equilibrium. The same holds for the contingent claims. Therefore, the net foreign asset position of country i is given by:

$$\text{NFA}^i_\tau = \int_{s,k,b,s'} b^i_\tau(s,a,s')g(s,s')M^i_\tau(s,k,b) + \int_{s,k,b} \Big[k^i_\tau(s,a) - 1\Big] P_\tau M^i_\tau(s,k,b)$$

The first term in the right-hand-side is the net position in 'contingent claims.' The second is the net position in 'productive assets.' We refer to the first term as bond position or international lending, when positive, and debt position or borrowing when negative.

2.2 Equilibria with and without capital mobility

This section characterizes the properties of the equilibrium with and without financial integration. To clarify the different roles played by endowment and investment shocks, we consider separately the cases with only endowment risk and with only investment risk.

2.2.1 Endowment shocks only

Assume z is not stochastic ($z = \bar{z}$), so that the are only endowment shocks. Denote by $\bar{\phi}$ a sufficiently high value of the enforcement parameter so that (3) is not binding. Essentially, this is an economy with complete markets. When shocks are i.i.d., this is obtained by setting $\bar{\phi} = 1$. With persistent shocks, $\bar{\phi}$ must be strictly greater than 1. To show the importance of domestic financial development, we compare the limiting cases of complete markets ($\phi = \bar{\phi}$) with the environment without state-contingent assets ($\phi = 0$). First we look at the autarky regime and then to the regime with financial integration.

When $\phi = \bar{\phi}$, constraint (3) is not binding by assumption. Therefore, the first-order conditions of problem (5) with respect to k and $b(w')$ are:

$$U'(c) = \beta(1+r_t)U'(c(w')) + (1+r_t)\lambda(w'), \qquad \forall\, w' \tag{6}$$

$$U'(c) = \beta R_{t+1}(k,\bar{z})EU'(c(w')) + R_{t+1}(k,\bar{z})E\lambda(w') \tag{7}$$

where $\lambda(w')$ is the Lagrange multiplier associated with the limited liability constraint (4) and $R_{t+1}(k,\bar{z}) = (P_{t+1} + \nu\bar{z}k^{\nu-1})/P_t$ is the gross marginal return from the productive asset. Notice that $R_{t+1}(k,\bar{z})$ is decreasing in k.

Since in this case agents have complete insurance, condition (6) holds for any realization of w', which implies that next period consumption $c(w')$ is the same for all w'. Moreover, conditions (6) and (7) imply $R_{t+1}(k, \bar{z}) = 1 + r_t$, so the marginal return on the productive asset is equal to the interest rate. Because $R_{t+1}(k, \bar{z})$ is strictly decreasing in k, this implies that all agents choose the same input of the productive asset, that is, $k = 1$. Given that the supply of the productive asset is fixed, total output is also fixed.

The following lemma establishes that the autarky equilibrium with full insurance must satisfy $\beta(1 + r_t) = 1$.

Lemma 1 *Consider the financial 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 $P = \nu\bar{z}/r$ respectively.*

Proof 1 *By way of contradiction, if $\beta(1 + r_t) = 1$ is not satisfied, condition (6) implies that consumption growth of all agents is either positive or negative. This cannot be an equilibrium because aggregate output remains constant. Therefore, $r_t = 1/\beta - 1 = r$. Using the fact that all agents use the same units of the productive asset, $k = 1$, conditions (6) and (7) imply $(P_{t+1} + \nu\bar{z})/P_t = 1 + r$. The only stationary solution for this difference equation is $P_t = P_{t+1} = \nu\bar{z}/r$.* *Q.E.D.*

Consider next the case of an economy in financial autarky but with $\phi = 0$. The enforceability constraint (3) imposes that $b(w_1) = ... = b(w_N) = b$, that is, assets cannot be state-contingent. The first-order conditions are:

$$U'(c) = \beta(1 + r_t)\, EU'(c(w')) + (1 + r_t)E\lambda(w') \tag{8}$$

$$U'(c) = \beta R_{t+1}(k, \bar{z})EU'(c(w')) + R_{t+1}(k, \bar{z})E\lambda(w') \tag{9}$$

These conditions still imply that $R_{t+1}(k, \bar{z}) = 1 + r_t$ and the input of the productive asset is the same for all agents. Thus, all agents receive the same investment income. However, the absence of state-contingent assets implies that the endowment risk cannot be insured and individual consumption is not constant. It varies with the realization of the endowment as in the standard Bewley (1986) economy. As it is known from the savings literature, the uninsurability of the idiosyncratic risk generates precautionary savings and in the steady state $\beta(1 + r) < 1$. See Huggett (1993), Aiyagari (1994) and Carroll (1997). The following lemma establishes this property.

Lemma 2 *Consider the financial 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 *By way of contradiction, suppose that* $\beta(1 + r_t) \geq 1$*. Because* $U'(.)$ *is convex, condition (8) implies that, for all agents, the expected next period consumption is bigger than current consumption. Therefore, next period aggregate consumption is also greater than today's consumption. This cannot be an equilibrium because aggregate income is constant. Therefore,* $r_t < 1/\beta - 1$*. Using the fact that all agents employ the same productive asset,* $k = 1$*, conditions (8) and (9) 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.*

Using Lemmas 1 and 2 we can compare countries in financial autarky at different stages of financial development: The country with a lower degree of financial development ($\phi = 0$) has a lower interest rate and, at least in the steady state, a higher asset price than a more financially developed country.

Consider now the steady state equilibrium of an economy where there is perfect mobility of capital between country 1, characterized by $\phi^1 = \bar{\phi}$, and country 2 characterized by $\phi^2 = 0$. We have the following proposition.

Proposition 1 *Suppose that* $\phi^1 = \bar{\phi}$ *and* $\phi^2 = 0$*. In the equilibrium with financial integration,* $r_t < 1/\beta - 1$ *and country 1 accumulates a negative NFA position but holds a zero net position in the productive asset.*

Proof 1 *Appendix C.*

This proposition holds only for the limiting cases of $\phi^1 = \bar{\phi}$ and $\phi^2 = 0$. However, we can infer the properties of the equilibrium for intermediate values of ϕ (*i.e.* for any case $0 \leq \phi^2 < \phi^1 \leq \bar{\phi}$). In general, lower values of ϕ increase precautionary savings and reduce the equilibrium interest rate. Therefore, once the capital markets are liberalized, the country with a lower value of ϕ accumulates a positive NFA position.

This point is illustrated in Figure 4. The figure plots the aggregate demand for assets (savings) in each country as an increasing function of r.[5]

[5] The asset demand curves in Figure 4 correspond to the well-known average asset demand curve from the closed-economy heterogenous agents literature (e.g. Aiyagari (1994)). Average asset demand approaches infinity as the interest rate converges to the rate of time preference from below. This is because agents need an infinite amount of precautionary savings to attain non-stochastic consumption.

Country 1 has deeper financial markets ($\phi^1 > \phi^2$), and hence lower asset demand for each interest rate. Because the supply of the productive asset is fixed, aggregate net savings (in units of K) must be zero under autarky in each country. This requires a higher interest rate in country 1 ($r^1 > r^2$).

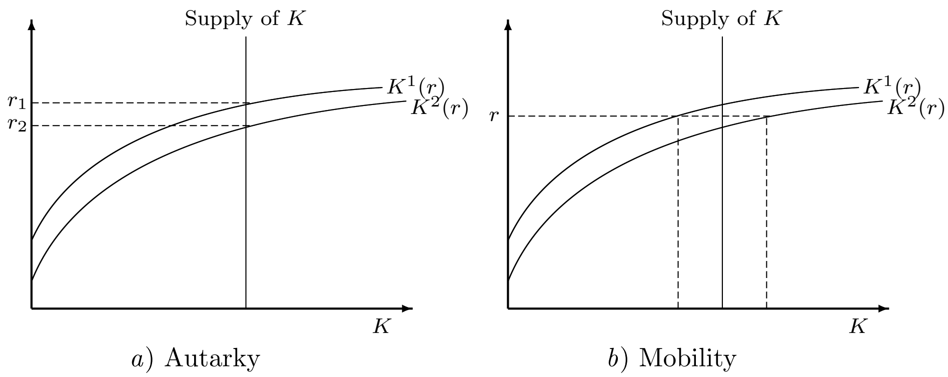

Figure 4: Steady state equilibria with heterogeneous financial conditions.

When the countries become financially integrated, the prices of the productive asset and the interest rates are equalized. Compared to the autarky equilibrium, the interest rate and the demand for assets fall in country 1 and rise in country 2, and hence the country with deeper financial markets ends up with a negative NFA position.

2.2.2 Investment shocks only

We now consider the case in which the productivity z is stochastic while the endowment is constant at $w = \bar{w}$. The assumption that investment income is stochastic allows us to distinguish debt instruments from risky investments such as FDI. As before, we compare equilibria under autarky and under financial integration for the limiting cases of $\phi = \bar{\phi}$ and $\phi = 0$.

The first-order conditions in autarky for an economy with $\phi = \bar{\phi}$ are:

$$U'(c) = \beta(1 + r_t)U'(c(z')) + (1 + r_t)\lambda(z'), \qquad \forall z' \tag{10}$$

$$U'(c) = \beta E R_{t+1}(k, z')U'(c(z')) + E\lambda(z')R_{t+1}(k, z') \tag{11}$$

The first condition holds for any realization of z'. Therefore, the next period's consumption, $c(z')$, must be the same for all realizations of z' (full insurance). Because next period's consumption is not stochastic, conditions (10) and (11) imply that $ER_{t+1}(k, z') = 1+r_t$. Therefore, there is no marginal premium for investing in the productive asset and k is the same for all agents. Thus, Lemma 1 also applies here 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.

Moving on to an economy with $\phi = 0$, the incentive-compatibility constraint (3) imposes that $b(z_1) = ... = b(z_N) = b$, that is, claims cannot be state contingent. The first-order conditions are:

$$U'(c) = \beta(1 + r_t) \, E\left[U'(c(z'))\right] + (1 + r_t)E\left[\lambda(z')\right] \tag{12}$$

$$U'(c) = \beta E\left[U'(c(z'))R_{t+1}(k, z')\right] + E\left[\lambda(z')R_{t+1}(k, z')\right] \tag{13}$$

Lemma 2 also applies here. Hence, the equilibrium interest rate is smaller than the intertemporal discount rate. This can be proved by following the same steps of the proof of Lemma 2. The main difference with the case of endowment shocks is that now there is a marginal risk premium for the risky asset. In particular, assuming that the borrowing limit is not binding, conditions (12) and (13) yield the standard equation for the risk premium:

$$ER_{t+1}(k, z') - (1 + r_t) = -\frac{\text{Cov}\Big(R_{t+1}(k, z') \, , \, U'(c(z'))\Big)}{EU'(c(z'))}$$

which is positive as long as $U'(c(z'))$ is negatively correlated with $R_{t+1}(k, z')$.

Now suppose that the two countries become financially integrated. The first country has $\phi^1 = \bar{\phi}$ and the second $\phi^2 = 0$. The following proposition characterizes the steady state equilibrium.

Proposition 2 *Suppose that $\phi^1 = \bar{\phi}$ and $\phi^2 = 0$. In the steady state with financial integration, $r < 1/\beta - 1$. Country 1 has a negative NFA position but a positive position in the productive asset. The average return of country 1's foreign assets is larger than the cost of its liabilities.*

Proof 2 *Appendix C.*

The proposition shows that, with investment shocks, countries with deeper financial markets invest in foreign (high return) assets and finance this investment with foreign debt. In the particular case in which the most developed country has $\phi^1 = \bar{\phi}$, Proposition 1 guarantees that this country ends up with a negative NFA position. The higher return derives from the decreasing return property of the production function. This generates a surplus that compensates the agent's managerial capital.

The accumulation of a negative NFA position in country 1 cannot be generalized to the case with $0 \leq \phi^2 < \phi^1 < \bar{\phi}$. Intuitively, if country 1 has a greater ability to insure than country 2 but the insurance is not perfect, then country 1 will still buy some of the foreign risky asset. By doing so, its residents take more risk and this may generate enough precautionary savings so that foreign borrowing by country 1 becomes smaller than the value of the risky assets it holds abroad. However, the result that country 1's foreign position in productive assets is positive does hold in the general case.[6] Moreover, since agents in country 1 cannot insure perfectly against the investment risk, there will be a *marginal* risk premium even for country 1. This further increases country 1's return from the foreign investment relative to the cost of the foreign liabilities.

2.2.3 Endowment and investment shocks

With both endowment and investment shocks, the first-order conditions are also given by (10)-(13). The only difference is that next period's consumption depends on both shocks, that is, $c(s')$. The autarky equilibria are also characterized by Lemmas (1) and (2). The following proposition characterizes the equilibrium under global financial integration.

Proposition 3 *Suppose that $\phi^1 = \bar{\phi}$ and $\phi^2 = 0$. In the steady state with perfect capital mobility, $r < 1/\beta - 1$. Country 1 has a negative NFA position but a positive position in the foreign productive asset. The average return of country 1 foreign ownership is bigger than the cost of its liabilities.*

Proof 3 *Same as in Proposition 2.*

[6] The concavity of the production function is crucial here. With a linear technology, as in Angeletos (2007), the most developed country would own all of the world's risky assets. As a result, the less developed country would have less incentives to save.

This is a restatement of proposition 2 describing the equilibrium with financial integration in the setup with investment shocks only. In the extreme case with $\phi^1 = \bar{\phi}$ and $\phi^2 = 0$, the addition of endowment shocks does not change the main properties of the equilibrium. As before, some features of the equilibrium cannot be generalized to the case with $0 \leq \phi^2 < \phi^1 < \bar{\phi}$. In the general case, the interest rate is smaller than the intertemporal discount rate and country 1 acquires a positive net position in foreign productive assets, but its NFA position is not necessarily negative. This depends on the relative importance of the two shocks. As long as the endowment shock is sufficiently large, country 1 will hold a negative NFA position.

3 The general model

In this section we extend the basic setup presented in the previous section along three dimensions. We allow for: (1) cross-country diversification of the investment risk; (2) a second source of financial heterogeneity in addition to ϕ; (3) differences in the economic size of countries. We also generalize the model to include any finite number of countries $N \geq 2$.

We introduce international risk diversification by assuming that production requires managerial capital, which is now divisible across countries. Each agent is endowed with one unit of this capital. Denoting by $A_{\ell,t} \in [0,1]$ the allocation in country ℓ, the total (worldwide) production of an individual agent at time $t+1$ is equal to:

$$y_{t+1} = \sum_{\ell=1}^{N} z_{\ell,t+1} A_{\ell,t}^{1-\nu} k_{\ell,t}^{\nu}, \qquad \text{with} \qquad \sum_{\ell=1}^{N} A_{\ell,t} = 1$$

The variables $z_{\ell,t+1}$ and $k_{\ell,t}$ are, respectively, the idiosyncratic shock and the input of the productive asset in country ℓ.

The divisibility of the managerial capital is the most important extension of the model. In the basic model, each agent had to choose between allocating all the managerial capital in country 1 ($A_{1,t} = 1$ and $A_{2,t} = 0$) or in country 2 ($A_{1,t} = 0$ and $A_{2,t} = 1$). In contrast, now agents can allocate any fraction $A_{\ell,t} \in [0,1]$ in each of the N countries. This has two important implications. First, as long as the shocks $z_{\ell,t+1}$ are imperfectly correlated, financial integration allows for a cross-country diversification of the investment risk.[7] Second, while in the basic model only the net foreign position in

[7]We are implicitly assuming that agents do not benefit from allocating their managerial

the productive asset was determined in equilibrium, now the gross positions are also determined.

Let $s_t \equiv (w_t, z_{1,t}, .., z_{N,t})$ be the endowment and investment shocks and $g(s_t, s_{t+1})$ their conditional probability distribution. As in the basic model, agents can buy contingent claims, $b(s_{t+1})$, that depend on the next period's realizations of these shocks. The price of one unit of consumption goods contingent on the realization of s_{t+1} is $q^i_t(s_t, s_{t+1}) = g(s_t, s_{t+1})/(1+r^i_t)$, where r^i_t is the equilibrium interest rate in country i.

Given the end-of-period net worth before consumption, a_t, the budget constraint for an agent in country i is

$$a_t = c_t + \sum_{\ell=1}^{N} k_{\ell,t} P_{j,t} + \sum_{s_{t+1}} b(s_{t+1}) q^i_t(s_t, s_{t+1}), \tag{14}$$

and the net worth evolves according to

$$a(s_{t+1}) = w_{t+1} + \sum_{\ell=1}^{N} \Big[k_{\ell,t} P_{\ell,t+1} + z_{\ell,t+1} A^{1-\nu}_{\ell,t} k^{\nu}_{\ell,t} \Big] + b(s_{t+1}). \tag{15}$$

The features of the financial environment are the same as in the basic model: We continue to assume that shocks are not verifiable and agents can divert part of the incomes from endowment and production, both domestic and abroad, but in the process they lose a fraction ϕ^i of the diverted income. For the moment we continue to assume that ϕ^i pertains to the 'residence' of agents as opposed to the 'source' of the income.

The second extension to the basic model is the assumption that the minimum value of net worth imposed by limited liability, denote by $\underline{a}^i$, can differ across countries. Hence, financial development is now captured by differences in ϕ^i and $\underline{a}^i$. As we will see, these two dimension of heterogeneity allow us to capture important features of the external imbalances of the United States vis-a-vis other developed countries and vis-a-vis emerging economies.

Following the same steps of Appendix B, the enforcement of financial contracts imposes the following constraints:

$$a(s_j) - a(s_1) \geq (1 - \phi^i) \cdot \Big[w^j - w^1 + \textstyle\sum_{\ell=1}^{N} (z^j_{\ell,t+1} - z^1_{\ell,t+1}) A^{1-\nu}_{\ell,t} k^{\nu}_{\ell,t} \Big] \tag{16}$$

capital to multiple operations within each country. The only diversification gains arise from cross-country diversification. Without loss of generality, we can interpret $z_{\ell,t+1}$ as the residual risk after exploiting all the diversification margins available within each country.

$$a(s_j) \geq \underline{a}^i \tag{17}$$

for all $j \in \{1, ..., J\}$, where J is the number of all possible realizations of endowment and investment shocks and s_1 is the lowest (worse) realization.

The only difference with the previous constraint (3) is that individual agents have both domestic and foreign incomes from productive investments. Before they had only one of the two.

The last extension relates to the economic size of countries participating in world capital markets. This is important for the quantitative properties of the model. Obviously, large imbalances for country 1 can arise only if the economy of country 2 is relatively large. In our model, differences in economic size could derive from differences in population and/or in productivity, that is, the average value of the endowment w and the per-capita supply of the productive asset k. However, for the properties we are interested in, all it matters is the aggregate size of a country independently of the sources of the economic size. Therefore, to simplify the analysis, we assume that differences in the economic size of countries derive only from differences in population.

We denote by μ^i the population share of country i and continue to assume that the per-capita endowment w and the per-capita domestic supply of the productive asset are the same in all countries. This extension does not alter the analytical results of Section 2.

3.1 Optimization problem and equilibrium

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

$$V_t^i(s,a) \quad = \quad \max_{A_\ell, k_\ell, b(s')} \left\{ U(c) + \beta \sum_{s'} V_{t+1}^i\Big(s', a(s')\Big) g(s,s') \right\} \tag{18}$$

subject to

(14), (15), (16), (17)

$$A_\ell \in [0,1], \ \sum_{\ell=1}^{N} A_\ell = 1$$

The definition of the autarky equilibrium is equivalent to the definition provided for the basic model. This is because all the extensions introduced in this section matter only for the regime with capital mobility. The definition of the equilibrium with capital mobility is as follows.

Definition 2 (Financial integration equilibrium) *Given the degree financial development, ϕ^i and $\underline{a}^i$, and initial distributions, $M_t^i(s,A,k,b)$, a general equilibrium with international capital mobility is defined by sequences of: (i) individual policies $\{c_\tau^i(s,a), b_\tau^i(s,a,s'), \{A_{\ell,\tau}^i(s,a), k_{\ell,\tau}^i(s,a)\}_{\ell=1}^N\}_{\tau=t}^\infty$; (ii) value functions $\{V_\tau^i(s,a)\}_{\tau=t}^\infty$; (iii) prices $\{P_{\ell,\tau}, r_{\ell,\tau}, q_{\ell,\tau}(s,s')\}_{\tau=t}^\infty$; (iv) distributions $\{M_\tau^i(s,A,k,b)\}_{\tau=t+1}^\infty$, such that: (i) the policy rules solve problem (18) with $\{V_\tau^i(s,a)\}_{\tau=t}^\infty$ as associated value functions; (ii) prices satisfy $q_{\ell,\tau} = g(s,s')/(1+r_{\ell,t})$; (iii) the global markets for the productive assets of each country clear,*

$$\sum_{i=1}^N \int_{s,A,k,b} k_{\ell,\tau}^i(s,a) M_\tau^i(s,A,k,b) = \mu^\ell$$

for $\ell = 1,..,N$; (iv) the worldwide market for contingent claims clears,

$$\sum_{i=1}^N \int_{s,A,k,b,s'} b_\tau^i(s,a,s') M_\tau^i(s,A,k,b) g(s,s') = 0;$$

(v) the sequence of distributions is consistent with the initial distributions, the individual policies and the idiosyncratic shocks.

It is important to emphasize that, in general, the market-clearing conditions for productive assets do not lead to the equalization of their prices, that is, $P_{i,t}$ is not equal to $P_{\ell,t}$ for $i \neq \ell$. This is because, unless the shocks are perfectly correlated across countries, agents are not indifferent about the composition of their portfolios of productive assets. This is in contrast to the equalization of the interest rates: all that matters for the choice of the contingent claims is their returns which are determined by the interest rate.

It is possible to derive some analytical results for this general model that are similar to those of the basic model. The optimality conditions are analogous, except that now we also have the conditions characterizing the optimal cross-country allocation of managerial capital. These conditions are $\frac{k_i}{A_i} = \frac{k_\ell}{A_\ell}$ for all $\ell = 1,..,N$. If we consider the case in which $N = 2$, $\phi^1 = \bar{\phi}$, $\phi^2 = 0$

and both countries have the same $\underline{a}^i$, we can prove that the same properties shown in Section 2.2 apply to the general model. This is obvious because, with $\phi^1 = \bar{\phi}$, agents in country 1 do not require a marginal premium on the productive investments. Hence, they are indifferent about the domestic and foreign allocation of the managerial capital.

What about the heterogeneity in $\underline{a}^i$? We can show that with endowment shocks only, the equilibria under autarky and financial integration with heterogeneous $\underline{a}^i$ have the same properties as their counterparts with heterogeneous ϕ^i. With investment shocks, however, the properties of the equilibria can only be characterized numerically.

4 Quantitative analysis

In this section, we study the quantitative implications of the model. The goal is to compare stationary equilibria under financial autarky and perfect capital mobility and to study the transitional dynamics after liberalization. Financial globalization is introduced as a once-and-for-all unanticipated regime change. We use a baseline scenario with $N = 2$. The first country (C1) is representative of the United States. The second country (C2) aggregates all remaining countries. Later on we add a third country to separate emerging economies from industrial countries other than the United States.

4.1 Calibration

We set the population size of country 1 to $\mu^1 = 0.3$ so as to match the U.S. share of world GDP, which is about 30 percent. The stochastic endowment takes two values given by $w = \bar{w}(1 \pm \Delta_w)$, with symmetric transition probability matrix. The investment shock also takes two values, $z = \bar{z}(1 \pm \Delta_z)$ but it is assumed to be *iid*. Interpreting w as labor income and y as *net* capital income, we set $\bar{w} = 0.85$ and then we parameterize the production function so that $y = \bar{z}k^{\nu} = 0.15$. Because per-capita assets are $k = 1$, this requires $\bar{z} = 0.15$.[8] The return to scale parameter is set to $\nu = 0.75$.

For the calibration of the stochastic process of the endowment we follow recent estimates of the U.S. earnings process and set the persistence probability to 0.95 and $\Delta_w = 0.6$. These values imply that log earnings have an

[8] The share of labor is higher than the typical value of 2/3 because it is in terms of *net* income, that is, income net of depreciation.

autocorrelation coefficient of 0.9 and a standard deviation of 0.30, which are in the ranges of values estimated by Storesletten, Telmer, & Yaron (2004). The variation in the investment shock is set to $\Delta_z = 2.5$. This implies that the return on productive assets fluctuates between -6% and 14%. We take this as an approximation to the volatility of firm-level returns. The cross-country correlation in productivity shocks is set to zero. Therefore, there is wide scope for international diversification of investment risks.

Next we choose the parameters of the financial structure. Several indicators, such as those reported in Figure 1, suggest that financial markets are significantly different across countries. However, it is difficult to derive a direct mapping from these indicators to the actual values of ϕ^i and $\underline{a}^i$. Given these difficulties, we take a pragmatic approach. We begin by assigning some values and then we conduct a sensitivity analysis. We start by assuming that $\phi^1 = 0.35$, $\phi^2 = 0$ and $\underline{a}^1 = \underline{a}^2 = 0$. Thus, contingent claims are partially available in country 1 and unavailable in country 2. The limited liability constraint, instead, is assumed to be the same in the two countries. It is also worth observing that there is a certain degree of equivalence between cross country differences in $\phi's$ and differences in the volatility of idiosyncratic shocks. The assumption that $\phi^1 = 0.35$ implies that the equilibrium allocation in country 1 is similar to the one that would prevail if contingent claims were not available (*i.e.* $\phi^1 = 0$) but the volatilities of all shocks were 35 percent lower than in country 2.

The utility function is CRRA with the coefficient of risk aversion set to $\sigma = 2$. The intertemporal discount factor is $\beta = 0.925$. With this discount factor, the wealth-to-income ratios in the steady state with capital mobility are 2.86 in country 1 and 3.45 country 2. The worldwide wealth-to-income ratio is about 3.3. This is higher than the typical number of 3 because our income is net of depreciation. The description of the computational procedure is provided in Appendix B.

4.2 Results

Individual policies. Figure 5 plots the individual decision rules as a function of the net worth a, for each value of the endowment w, in the steady state with capital mobility.[9] Three variables are plotted: the value of the contingent claims, $\sum_{s'} b(s')q(s,s')$, the value of productive assets purchased

[9] The current realization of the endowment is a state variable because endowment shocks are persistent. The investment shock z can be ignored because it is *iid*.

in the first country, $k_1 P_1$, and the value of productive assets purchased in the second country, $k_2 P_2$.

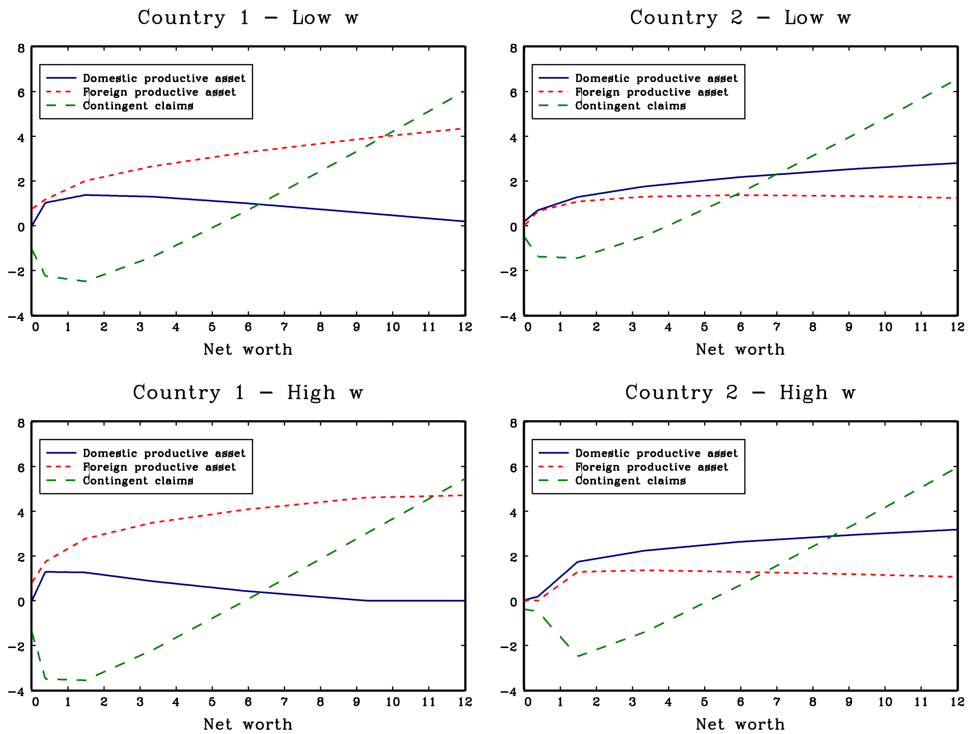

Figure 5: Policy rules as functions of net worth.

The net position in contingent claims increases with net worth: it is negative for poorer agents and positive for richer agents. The total position in risky investments also increases with a. For the range of a plotted in the figure, all agents choose to buy productive assets in both countries. However, as agents become wealthier, they allocate a larger proportion in C2.

The intuition for this pattern is simple. In equilibrium, the price of the productive asset in C2 is smaller than in C1. This implies that the expected return from investing in C2 is higher than in C1. Even if the expected return is higher, however, agents will not reallocate all the investments to C2 because shocks are uncorrelated, which allows for the diversification of risk. As agents become wealthier, with CRRA utility they assign greater weight on returns and less weight on risk. Therefore, they invest more in C2.

Aggregate variables. The first panel of Table 1 reports the equilibrium prices and positions that prevail in the steady state equilibria under autarky and perfect capital mobility. Under capital mobility C1 accumulates a net positive position in productive assets but a much larger negative position in contingent claims.

C1's debt and foreign risky asset positions are -89 and 37 percent of its domestic income respectively. As a result, the NFA position is negative and quite large, -51 percent of income. Hence, the model is consistent with the data in predicting, for the most financially developed country, a substantial decline in NFA, the choice of a riskier portfolio and a reduction in the risk-free rate relative to autarky. Note that the changes in asset prices and interest rates that support these large changes in asset holdings are small. The model also predicts that financial globalization leads to an increase in the *gross* holdings of foreign risky assets for *all* countries, which is also a salient feature of the financial globalization era (see bottom panel of Figure 2).

A feature of the equilibrium is that the *average* return from the productive assets is greater than the interest rate. This derives from two mechanisms. First, because of decreasing returns, there is a surplus that compensates managerial capital. Therefore, even if the marginal return on the productive asset is equalized to the interest rate, total production is bigger than the opportunity cost of the investment. The second mechanism relates to the investment risk. Because of this risk, investors require a marginal premium over the interest rate which further increases the average return.

Consider now the special versions of the model with only endowment or investment shocks. The second and third panels of Table 1 report the steady states values of some key variables in these cases. With endowment shocks only (Panel B), the model can produce a large negative NFA position in C1 (of roughly -38 percent of domestic income). However, with only endowment shocks, the model cannot explain the observed shift in the composition of the portfolios of foreign assets. By contrast, the setup with only investment shocks (Panel C) does produce a portfolio for C1 characterized by a negative debt position and a positive position in risky assets. The total NFA position, however, is not very large. This is because, as C1 takes a greater position in risky assets, it faces greater risk inducing higher savings.

In summary, these results show that by combining endowment and investment shocks, we can capture both features of the U.S. international asset position: large net foreign liabilities and a portfolio composition tilted toward high-return assets.

Table 1: Steady state with and without capital mobility.

	Autarky		**Capital mobility**	
	C1	*C2*	*C1*	*C2*
A) Both shocks				
Prices of productive assets	3.08	3.40	3.38	3.22
Returns on productive assets	4.80	4.30	4.41	4.58
Interest rate	3.25	2.60	3.05	3.05
Net foreign asset positions	-	-	-51.39	22.12
Productive assets	-	-	37.41	-16.10
Bonds	-	-	-88.80	38.22
Gross holdings of productive assets				
Domestic	1.00	1.00	0.24	0.61
Foreign	-	-	0.91	0.33
Welfare gains from liberalization			2.63	-0.27
B) Endowment shocks only				
Prices of productive assets	2.95	3.22	3.14	3.14
Returns on productive assets	5.08	4.66	4.78	4.78
Interest rate	3.81	3.49	3.58	3.58
Net foreign asset positions	-	-	-38.69	16.58
Productive assets	-	-	0.00	0.00
Bonds	-	-	-38.69	16.58
Gross holdings of productive assets				
Domestic	1.00	1.00	1.00	1.00
Foreign	-	-	0.00	0.00
Welfare gains from liberalization			1.66	-0.77
C) Investment shocks only				
Prices of productive assets	1.41	1.37	1.45	1.38
Returns on productive assets	10.63	10.90	10.41	10.83
Interest rate	7.35	6.58	7.33	7.33
Net foreign asset positions	-	-	-5.38	2.31
Productive assets	-	-	14.08	-6.04
Bonds	-	-	-19.46	8.35
Gross holdings of productive assets				
Domestic	1.00	1.00	0.23	0.61
Foreign	-	-	0.91	0.33
Welfare gains from liberalization			0.60	0.20

Notes: Foreign asset positions are in percentage of domestic income (endowment plus domestic investment income). Gross positions of productive assets are units of k per-capita. Welfare gains are in percentage of consumption.

Transition after liberalization. Figure 6 plots the transitional dynamics from autarky to full financial integration of several aggregate variables. The top left panel shows that the decline in net foreign assets in C1 is a slow, gradual process that takes about 30 years. The current account drops to a deficit of almost 4 percent of domestic income on impact and remains in deficit for many periods until it balances in the limit.

The deterioration of the current account in C1 is not as gradual as in the U.S. data. In our results, however, the pattern of a large initial deficit followed by gradual recovery is a consequence of two features of the particular exercise we are conducting. First, we assume that capital markets are fully integrated overnight. In reality, financial integration has been a gradual process (see Figure 2). Second, we abstract from shocks such as the surge in oil prices, that also contributed to the more recent dynamics of the U.S. current account deficit.[10] With a gradual process of financial integration, the current account dynamics would be more in line with U.S. data.

Figure 6 also plots the dynamics for the components of NFA and the current account. Immediately after financial integration, C1 purchases a large quantity of foreign productive assets financed with foreign debt. Despite the negative NFA position, C1 receives initially positive net factor payments from abroad due to the higher return on the productive assets. These payments, however, are more than compensated by negative net exports and thus the country experiences current account deficits until it reaches the new steady state. Notice that the portfolio adjustment is very drastic. It would be smoother if there were adjustment costs and/or the international liberalization of capital was gradual.

Normative implications. We examine next the normative implications of the model. We are interested in answering two questions. First, is financial integration welfare enhancing for the participating countries? Second, how are the welfare effects distributed amongst the population of each country?

Figure 7 plots the welfare gains (or losses if negative) from financial integration as a function of individual net worth, a, and endowment, w, when the reform is introduced. These welfare gains are computed as the percent-

[10] In addition to oil prices, there are other well-known shocks driving U.S. current account deficits, such as the collapse of investment rates in Asia after the 1997-98 Sudden Stops. However, the goal of our analysis is not to track the cyclical pattern of the U.S. current account but to capture the secular decline in its net foreign assets since the mid 1980s.

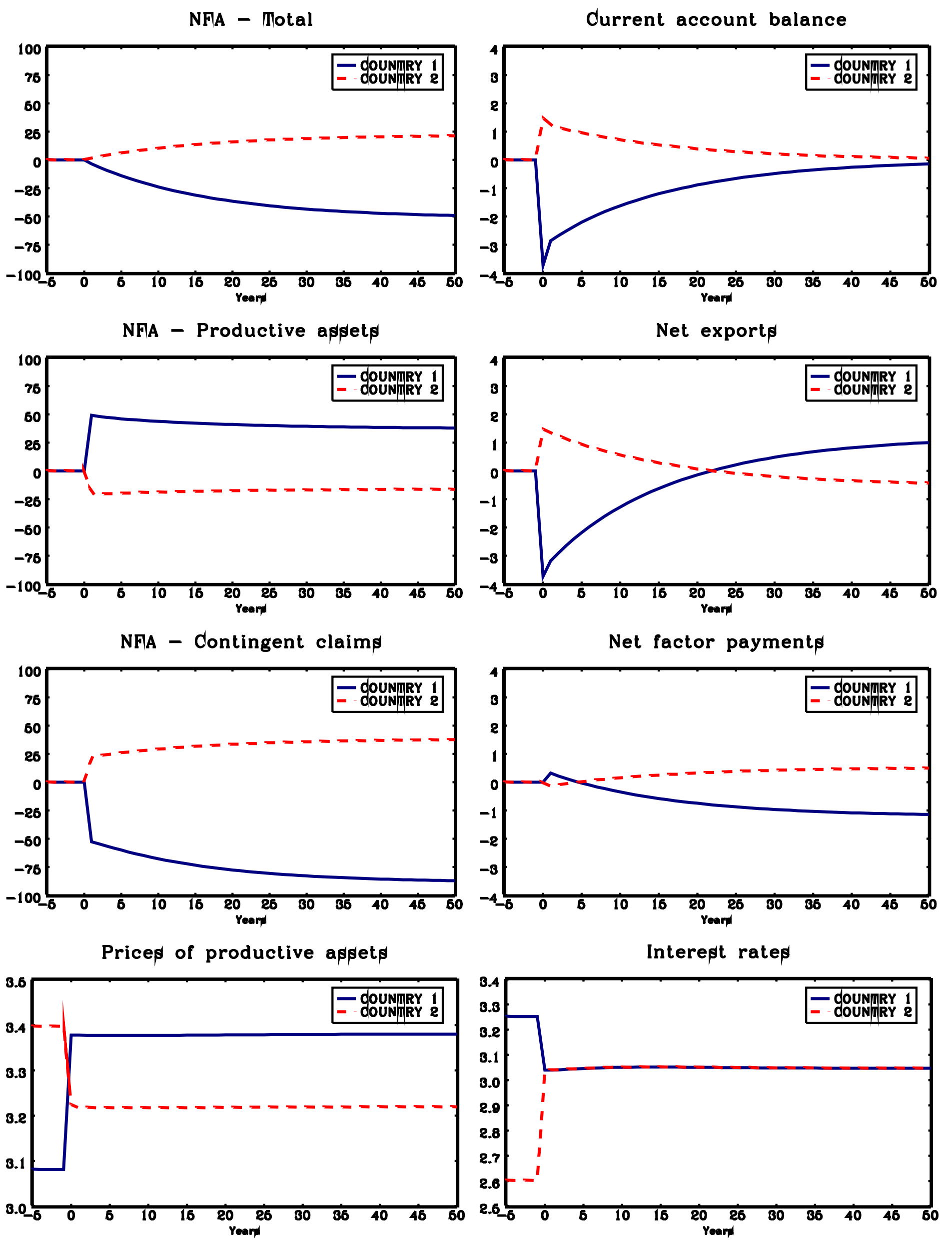

Figure 6: Transition dynamics after capital markets liberalization.

age increase in consumption in the autarky steady state that makes each individual agent indifferent between remaining in autarky and shifting to the regime with financial integration. The figure also shows, for each country, the distribution of agents over net worth in the autarky steady state. This is the initial distribution when the international capital markets are liberalized.

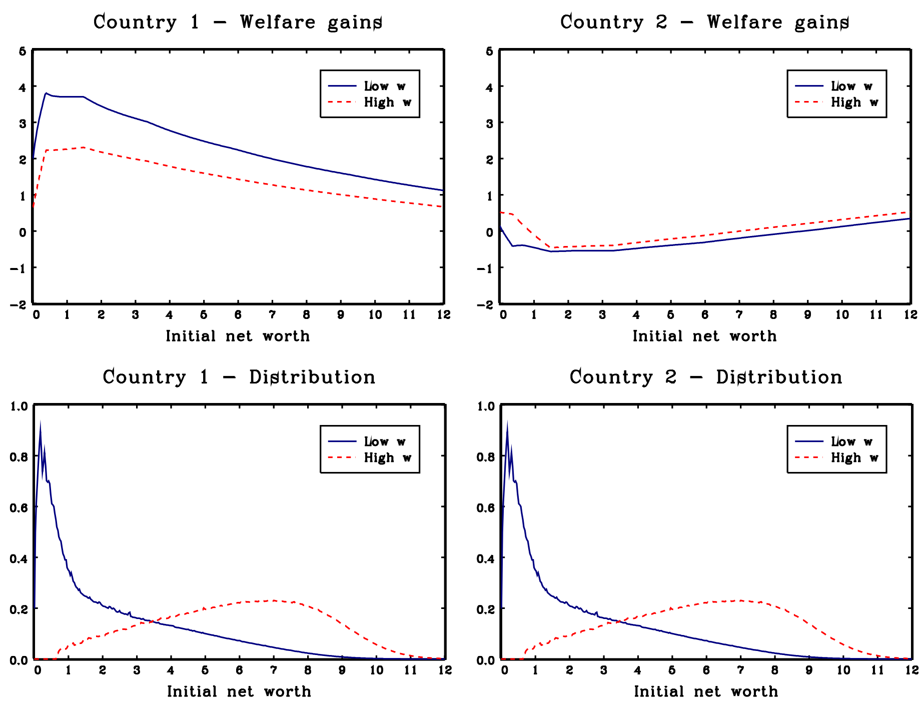

Figure 7: Welfare effects of financial integration.

In C1 all agents gain from liberalization and the gains are especially high for agents with lower initial wealth. For these agents the gains derive from two sources. The first is the diversification of the investment risk allowed by the fact that investment shocks are uncorrelated across countries. The second source of the welfare gains for poorer agents derives from the reduction in the interest rate. As shown in Figure 5, poorer agents are initially net borrowers, and therefore, they benefit from a reduction in the interest rate. Richer agents, instead, are net lenders and they loose when the interest rate drops. This explains why the welfare gains falls with the initial level of wealth.

Looking now at the welfare consequences in C2, we also have that agents benefit from the cross-country diversification of the investment risk. However, the increase in the interest rate relative to autarky in C2 damages the welfare of the poorer residents because, as in C1, they are net borrowers. For these agents, the negative welfare consequences following the increase in the interest rate are larger than the gains from the international diversification of the investment risk. As a result, financial globalization is welfare reducing for these agents. The opposite is true for wealthier agents.

We aggregate the individual welfare effects using an equally-weighted social welfare function that weights each agent's utility equally. The aggregate welfare effects are measured by the same percentage increase in the consumption of all agents in the autarky steady state that makes the value of the aggregate welfare equal to the value in the regime with financial integration when the reform is introduced. We find that C1 gains about 2.6 percent of aggregate consumption while C2 loses 0.27 percent.

These aggregate welfare consequences are not surprising given the individual welfare numbers. As shown by the bottom panels of Figure 7, a large mass of agents is concentrated on the left side of the distribution. Therefore, the aggregate welfare consequences are dominated by the effects of financial integration on poorer agents: in C1 they gain while in C2 they lose.

4.3 Sensitivity to the cross-country correlation of shocks

Table 2 reports the steady state statistics under autarky and financial integration for two different values of the cross-country correlation of investment shocks, 0.5 in Panel A and 0.9 in Panel B. Because of the higher cross-country correlation, agents have lower opportunity to diversify the investment risk compared with the baseline calibration where the correlation was zero.

Higher correlation in investment shocks reduces the NFA position of C1, but even with a correlation of 0.9, C1 still builds a large negative NFA position (about 44 percent of domestic output). The increase in the correlation of shocks also increases the two components of the NFA position in absolute value. Essentially, the main predictions of the model remain valid regardless of whether globalization allows for international risk sharing.

The ability to diversify the investment risk is important for welfare. As we increase the cross-country correlation of shocks, and hence reduce the ability to diversify the investment risk, the welfare gains from international capital markets integration become smaller. As a result, C1's gain falls and C2's loss rises. As observed earlier, in C2 the higher interest rate hurts poorer agents because they are net borrowers. Because the aggregate welfare

Table 2: Sensitivity to the cross-country correlation of shocks.

	Autarky		Capital mobility	
	C1	*C2*	*C1*	*C2*
A) Shocks are partially correlated (correlation=0.5)				
Prices of productive assets	3.08	3.40	3.34	3.26
Returns on productive assets	4.81	4.30	4.32	4.57
Interest rate	3.25	2.60	2.92	2.92
Net foreign asset positions	-	-	-47.69	20.54
Productive assets	-	-	60.29	-25.97
Bonds	-	-	-107.98	46.50
Gross holdings of productive assets				
Domestic	1.00	1.00	0.26	0.59
Foreign	-	-	0.95	0.32
Welfare gains from liberalization			2.18	-0.49
B) Shocks are perfectly correlated (correlation=0.9)				
Prices of productive assets	3.08	3.40	3.30	3.29
Returns on productive assets	4.81	4.30	4.26	4.57
Interest rate	3.25	2.48	2.83	2.83
Net foreign asset positions	-	-	-43.61	18.79
Productive assets	-	-	77.90	-33.56
Bonds	-	-	-121.51	52.35
Gross holdings of productive assets				
Domestic	1.00	1.00	0.27	0.58
Foreign	-	-	0.97	0.31
Welfare gains from liberalization			1.81	-0.63

Notes: See Table 1.

consequences are dominated by the contribution of poorer agents (who are more numerous), the decline in the interest rate generates aggregate welfare losses. These losses are compensated, in part, by the gains from diversifying the investment risk. However, when shocks are correlated, the potential for diversification is reduced. Therefore, the welfare losses for C2 become larger.

5 Residence v. source based enforcement

The analysis conducted so far was based on the assumption that the enforcement parameter ϕ is 'residence based', *i.e.* it depends on the country of residence of the agents, independently of whether their incomes are generated at home or abroad. This assumption is based on the view that the ability to *verify* diversion requires the verification of individual consumption which takes place in the residence country. This assumption is quite plausible for all forms of domestic incomes but it is less so for incomes earned abroad. For example, under a 'source based' approach to model enforcement, if agents residing in C2 invest in C1, their incomes on these investments would be subject to the enforcement ϕ^1 instead of ϕ^2. As a result, residents in C2 would be able to get better insurance on the investment income earned in C1 than in their own country.

In this subsection we study the sensitivity of our results to alternative assumptions about the residence or source based nature of ϕ for the enforcement of contracts. We consider four alternative scenarios with results reported in Table 3. In all the experiments, we use the same values of ϕ as in the baseline calibration, that is, $\phi^1 = 0.35$ and $\phi^2 = 0$.

A) The enforcement of contracts for residents of C1 remains as in the baseline model, that is, ϕ^1 applies to both foreign and domestic incomes. The enforcement of contracts for residents of C2, instead, is determined by ϕ^2 for incomes earned at home and by ϕ^1 for incomes earned abroad. The enforcement constraint for C2 becomes,

$$\begin{aligned} a(s_j) - a(s_1) \quad \geq \quad & (1-\phi^2) \cdot \left[w^j - w^1 + (z_2^j - z_2^1) A_{2,t}^{1-\nu} k_{2,t}^{\nu} \right] + \\ & (1-\phi^1)(z_1^j - z_1^1) A_{1,t}^{1-\nu} k_{1,t}^{\nu} \end{aligned}$$

B) The enforcement of contracts for residents of country C2 remains as in the baseline model. For residents of C1, instead, the enforcement is based on the source principle. This leads to the following enforcement constraint for agents in C1:

$$\begin{aligned} a(s_j) - a(s_1) \quad \geq \quad & (1-\phi^1) \cdot \left[w^j - w^1 + (z_1^j - z_1^1) A_{1,t}^{1-\nu} k_{1,t}^{\nu} \right] + \\ & (1-\phi^2)(z_2^j - z_2^1) A_{2,t}^{1-\nu} k_{2,t}^{\nu} \end{aligned}$$

C) The enforcement is in part source-based and in part residence-based for the residents of both countries. More specifically, the foreign incomes earned by the residents of both countries are enforced according to $\tilde{\phi} = (\phi^1 + \phi^2)/2$. This implies that agents in C1 get less insurance on foreign earned incomes than on domestic incomes but still greater than the insurance available to residents of C2. Similarly, C2 agents can get better insurance on incomes earned abroad but not as good as the C1 residents. The enforcement constraint for C1 is:

$$\begin{aligned} a(s_j) - a(s_1) \quad \geq \quad & (1-\phi^1) \cdot \left[w^j - w^1 + (z_1^j - z_1^1) A_{1,t}^{1-\nu} k_{1,t}^{\nu} \right] + \\ & (1-\tilde{\phi})(z_2^j - z_2^1) A_{2,t}^{1-\nu} k_{2,t}^{\nu} \end{aligned}$$

The same constraint applies to country 2, after inverting the subscripts.

D) The enforcement is fully source-based in both countries.

The first three panels of Table 3 show that C1 continues to accumulate a large negative NFA position and a positive position in the productive assets. Therefore, the qualitative properties of the model do not change. In Panel D we again find that C1 accumulates a negative NFA position, but the net foreign position in productive assets is now negative. This is not because C1 buys less units of the foreign productive asset but because the foreign asset is cheaper. In terms of units of the productive asset, the net position is not very different from zero. If the integration of C1 was with a smaller country, then the price of the productive asset in C2 would be higher than in C1 and the value of the net position in productive assets of C1 would be positive. Also notice that we get similar results in terms of welfare. The numbers change somewhat but it is still the case that the gains are positive for C1 and negative for C2.

In summary, the numbers reported in Table 3 show that the NFA position is only marginally affected by the source or residence nature of ϕ. The net position in productive assets tends to decline as we switch from the residence to the source principle but it remains positive, at least when measured in physical units. Therefore, we conclude that the key properties of the model remain valid regardless of the enforcement nature of insurance contracts.

6 Alternative forms of financial development: Industrialized versus emerging economies

It is reasonable to argue that the United States and other industrial countries do not differ much in the institutional and technological environment that allows for the insurance of income risks. Yet, the evidence reviewed in the Introduction shows that the development of non-bank financial intermediation has progressed more in the United States, and this is also consistent with the higher ratio of domestic credit to the private sector to GDP of the

Table 3: Sensitivity to alternative assumptions about the nature of ϕ.

	Autarky		Capital mobility	
	C1	*C2*	*C1*	*C2*
A) Source based only for residents of C2				
Prices of productive assets	3.08	3.40	3.47	3.20
Returns on productive assets	4.81	4.30	4.43	4.54
Interest rate	3.25	2.60	2.97	2.97
Net foreign asset positions	-	-	-54.98	23.67
Productive assets	-	-	4.36	-1.88
Bonds	-	-	-59.34	25.55
Gross holdings of productive assets				
Domestic	1.00	1.00	0.42	0.72
Foreign	-	-	0.65	0.25
Welfare gains from liberalization			2.67	-0.38
B) Source based only for residents of C1				
Prices of productive assets	3.08	3.40	3.43	3.19
Returns on productive assets	4.81	4.30	4.52	4.57
Interest rate	3.25	2.60	3.10	3.10
Net foreign asset positions	-	-	-51.16	22.07
Productive assets	-	-	10.41	-4.49
Bonds	-	-	-61.57	26.56
Gross holdings of productive assets				
Domestic	1.00	1.00	0.13	0.58
Foreign	-	-	0.97	0.37
Welfare gains from liberalization			2.87	-0.05
D) Partially source based for residents of both countries				
Prices of productive assets	3.08	3.40	3.45	3.20
Returns on productive assets	4.81	4.30	4.48	4.55
Interest rate	3.25	2.60	3.03	3.03
Net foreign asset positions	-	-	-52.21	22.50
Productive assets	-	-	5.07	-2.18
Bonds	-	-	-57.28	24.68
Gross holdings of productive assets				
Domestic	1.00	1.00	0.27	0.65
Foreign	-	-	0.80	0.31
Welfare gains from liberalization			2.71	-0.22
C) Source based for residents of both countries				
Prices of productive assets	3.08	3.40	3.50	3.17
Returns on productive assets	4.81	4.30	4.54	4.53
Interest rate	3.25	2.60	3.02	3.02
Net foreign asset positions	-	-	-54.02	23.31
Productive assets	-	-	-22.13	9.55
Bonds	-	-	-31.89	13.76
Gross holdings of productive assets				
Domestic	1.00	1.00	0.31	0.70
Foreign	-	-	0.69	0.30
Welfare gains from liberalization			2.80	-0.11

Notes: See Table 1.

U.S. compared to other industrialized countries.[11] This suggests that the differences in financial markets between the U.S. and other industrial countries are more likely to derive from differences in $\underline{a}$ than in ϕ. On the other hand, the financial markets differences between the United States and emerging economies, where the ability to insure risks is much weaker and the volume of credit is much lower, are likely to derive from both, $\underline{a}$ and ϕ.

We show in this section that, by adding a third country and characterizing financial heterogeneity in terms of both, $\underline{a}$ and ϕ, it is possible to replicate some of the key features of the composition of foreign assets observed separately for the U.S., other industrialized countries and emerging economies.

Before moving to the three-country analysis, we show the implications of differences in ϕ and/or $\underline{a}$ in the two-country setup. This will facilitate the exposition of the results obtained with the three-country model.

Table 4 compares steady state equilibria under autarky and financial integration for different combinations of ϕ and $\underline{a}$. Panel A assumes that both countries have the same ϕ but C1 is still more financially developed because it has a lower value of $\underline{a}$. Panel B allows C1 to be more financially developed in both dimensions, higher ϕ and lower $\underline{a}$.

Independently of whether financial heterogeneity derives from differences in ϕ or $\underline{a}$, C1 ends up with a large negative NFA position. There are important differences, though, in the composition of NFA. In Panel B, with differences in ϕ, C1 takes a positive net position in the productive assets. In Panel A, where the differences are only in $\underline{a}$, the total units of the productive assets (the sum of gross domestic and foreign holdings) owned by the two countries are equal. In this case there is no significant difference in the amount of investment risk that agents in the two countries choose to take.[12]

The above results show that, in order to generate a situation in which the United States accumulates a negative NFA position and a positive position in high-return assets, we need cross-country differences in ϕ. Differences in $\underline{a}$ cannot yield this outcome because lower values of $\underline{a}$ decrease the propensity to save but do not change the propensity to take investment risks. Even if agents can borrow more, they do not have a greater ability to insure these

[11]According to the World Bank's *World Development Indicators*, in 2004 domestic credit to the private sector was 191 percent of GDP in the United States v. 136 percent for the other G7 countries and 122 percent for the average of OECD countries excluding the U.S.

[12]Notice that the value of the net position in productive assets for C1 is negative in Panel A not because the country owns a smaller number of productive assets worldwide, but because the market price of the foreign asset is lower.

Table 4: Steady state with heterogeneity in ϕ and $\underline{a}$.

	Autarky		**Capital mobility**	
	C1	*C2*	*C1*	*C2*
A) Differences in $\underline{a}$ only: $\underline{a}^1=-1$, $\underline{a}^2=0$, $\phi^1=\phi^2=0.35$				
Prices of productive assets	2.96	3.40	3.39	3.16
Returns on productive assets	4.94	4.30	4.56	4.56
Interest rate	3.02	2.60	3.00	2.85
Net foreign asset positions	-	-	-65.81	28.31
Productive assets	-	-	-13.96	6.01
Bonds	-	-	-51.85	22.30
Gross holdings of productive assets				
Domestic	1.00	1.00	0.30	0.70
Foreign	-	-	0.70	0.30
Welfare gains from liberalization			2.99	-0.46
B) Differences in both: $\underline{a}^1=-1$, $\underline{a}^2=0$, $\phi^1=0.35$, $\phi^2=0$				
Prices of productive assets	2.74	3.40	3.25	3.09
Returns on productive assets	5.42	4.30	4.59	4.77
Interest rate	3.68	2.60	3.18	3.18
Net foreign asset positions	-	-	-105.25	45.30
Productive assets	-	-	35.89	-15.45
Bonds	-	-	-141.14	60.75
Gross holdings of productive assets				
Domestic	1.00	1.00	0.24	0.61
Foreign	-	-	0.91	0.33
Welfare gains from liberalization			4.50	-0.89

Notes: See Table 1.

risks. Higher values of ϕ, instead, induce lower propensities to save and higher propensities to take investment risks.

6.1 A three-country model

We extend the model to study the implications of financial integration amongst three countries or regions: the United States (C1), other developed countries (C2) and emerging economies (C3). Based on the above discussion we assume that C1 differs from C2 only in $\underline{a}$ while it differs from C3 in both ϕ and $\underline{a}$. We set $\phi=(0.5,0.5,0)$ and $\underline{a}=(-1,0,0)$.[13]

[13]While it is difficult to obtain direct evidence about the availability of insurance against income risks, there are some studies suggesting that insurance is smaller in emerging economies compared to developed countries, even if only for regional instead of individual shocks. For example, Xu (2008) finds that there is less consumption risk-sharing across

We capture the differences in the economic size of the three countries by setting relative population sizes to $\mu = (0.3, 0.5, 0.2)$. As explained earlier, by setting the population share of emerging economies to 0.2 we capture the fact that these economies contribute to about 20 percent of the world GDP.

Except for the parameters of the financial structure and relative population, all other parameters are as in the baseline parametrization. The key steady-state variables are reported in Table 5.

Table 5: Steady state in the three-country economy.

	Autarky			**Capital mobility**		
	C1	C2	C3	C1	C2	C3
Prices of productive assets	2.65	2.95	3.40	2.86	2.84	2.88
Returns on productive assets	5.63	5.05	4.30	5.16	5.17	5.36
Interest rate	3.96	3.53	2.60	3.73	3.63	3.63
Net foreign asset positions	-	-	-	-72.92	2.88	103.15
Productive assets	-	-	-	9.32	9.51	-38.56
Bonds	-	-	-	-82.24	-6.63	141.72
Gross holdings of productive assets						
Country 1	1.00	1.00	1.00	0.31	0.30	0.28
Country 2	-	-	-	0.54	0.54	0.34
Country 3	-	-	-	0.19	0.18	0.25

Notes: The heterogeneous parameters are $\phi = (0.5, 0.5, 0)$ $\underline{a} = (-1, 0, 0)$, $\mu = (0.3, 0.5, 0.2)$. See also Table 1.

The foreign asset structure of the three countries is broadly consistent with the asset structure shown in Figure 3 for the U.S., other industrialized countries and the residual group of emerging economies. In particular, under financial integration the other industrialized countries (C2) have a very

Chinese provinces than across US states and Canadian provinces, and concludes that "Chinese households would be willing to pay dearly to insure their consumption against idiosyncratic shocks". In the same vein, Kim, Kim, & Wang (2006) estimates the degree of consumption risk sharing among 10 East Asian countries and find that about 80 percent of the cross-sectional variation of GDP is not smoothed within the region. Compared to the OECD countries, the degree of risk sharing achieved is significantly lower and the potential gains are larger. An implication of the lower ϕ in emerging economies under autarky is that the risk free interest rate is lower. In this regard, Bailey (1994) reports that in the early stages of China's financial opening, there were A shares targeted at Chinese savers and B shares for non-Chinese. Type B shares were sold at a large discount, indicating that the internal rate of return was much lower for Chinese households.

similar position in risky assets as the U.S. (C1). However, the NFA position is significantly smaller compared to C1. On the other hand, C3, which represents the emerging economies, has a positive NFA position and a negative net position in risky assets. The large increase in net bond holdings suggests that, if the foreign bonds are held by official institutions, the model can explain the recent surge in the foreign reserves of emerging economies.

6.2 Adding differences in growth and income volatility

Our model is robust in predicting that, as long as there are differences in domestic financial markets between industrialized and emerging economies, financial globalization may result in the latter becoming net suppliers of funds to the former. In making this case we abstracted from two other important dimensions in which emerging economies differ from industrialized countries: growth rates and incomes volatility.

Growth differences can be important because, as predicted by the standard neoclassical open-economy model, countries experiencing faster growth (emerging economies) should borrow from slow-growing countries (industrialized economies). However, recent trends seem to suggest the opposite (see, for example, Gourinchas & Jeanne (2007)).

The prediction of the neoclassical model about the flow of capital for fast growing countries is an unavoidable consequence of CRRA preferences. Ignoring uncertainty, the Euler equation reads $(c_{t+1}/c_t)^\sigma = \beta(1 + r_t)$. Faster growth in consumption before financial integration implies a higher value in the left-hand-side term of the Euler equation, which in turn implies a higher interest rate. As a result, when countries experiencing faster than average growth become financially integrated, their interest rates converge to a lower 'world' interest rate and save less.

If we abstract from heterogeneity in domestic financial markets, our model shares the same features of the neoclassical model. However, once we introduce financial markets differences we have two opposing effects. The higher growth of emerging economies induces these countries to save less while the lower development of their financial markets induces higher savings. So ultimately, which mechanism dominates depends on the relative importance of 'growth differences' versus 'financial differences'.

In addition to growth, another important difference between industrialized and emerging economies is that the latter are, typically, countries that are experiencing significant structural changes, which are often associated with greater uncertainty at the individual level.[14] Therefore, if we want to capture the differences between industrialized and emerging economies that are relevant for savings, we should allow for three sources of heterogeneity: financial markets development, economic growth and income volatility.

We add heterogeneity in growth and income volatility to the three-country model examined above. An easy way to capture differences in growth rates is to assume that countries have different discount rates. If β is the discount factor for industrialized countries and the growth rate differential between emerging and industrialized countries is $1 + g$, then the discount factor of emerging countries is $\tilde{\beta} = \beta/(1 + g)^{\sigma}$. Assuming an annual growth differential of 3.5 percent, and given the baseline parametrization $\beta = 0.925$ and $\sigma = 2$, the discount factor for C3 is $\tilde{\beta} = 0.925/1.035^2 = 0.863$. Under these assumptions, if C1 and C2 grow at about 2 percent per year, emerging countries (C3) grow at 5.5 percent per year. To account for the higher uncertainty faced by agents in emerging economies, we assume that the standard deviations of endowment and investment shocks in C3 are 50 percent higher than in C1 and C2.

Table 6: Steady state in the three-country economy with heterogeneity in financial development, growth and income volatility.

	Autarky			**Capital mobility**		
	C1	C2	C3	C1	C2	C3
Prices of productive assets	2.65	2.95	3.84	2.85	2.82	2.87
Returns on productive assets	5.63	5.05	3.60	5.10	5.10	5.81
Interest rate	3.96	3.53	1.24	3.68	3.68	3.68
Net foreign asset positions	-	-	-	-76.89	-0.23	117.07
Productive assets	-	-	-	29.68	29.54	-120.70
Bonds	-	-	-	-106.57	-29.77	237.77
Gross holdings of productive assets						
Country 1	1.00	1.00	1.00	0.33	0.32	0.19
Country 2	-	-	-	0.57	0.57	0.21
Country 3	-	-	-	0.20	0.20	0.19

Notes: The heterogeneous parameters are $\phi = (0.5, 0.5, 0)$, $\underline{a} = (-1, 0, 0)$, $\beta = (0.925, 0.925, 0.863)$, $\Delta_w = (0.6, 0.6, 0.9)$, $\Delta_z = (2.5, 2.5, 3.75)$, $\mu = (0.3, 0.5, 0.2)$. See also Table 1.

[14] An indicator of this is that inequality tends to increase during phases of rapid growth. See Khan & Riskin (2001) and Naughton (2007). Also, several emerging economies have experienced Sudden Stops after entering the global financial markets.

Table 6 reports the steady state statistics. Even if C3 grows faster than the other two countries, the combination of greater uncertainty and lower financial development induces agents in C3 to save more. As a result, C3 accumulates a positive NFA position and the composition of its portfolio is titled toward less risky and less profitable assets. In short, our key findings seem robust to the introduction of relatively large differences in growth.

7 Conclusion

This paper shows that international financial integration can lead to large and persistent global imbalances when countries differ in the degree of domestic financial development. Financial integration induces countries with deeper financial markets to reduce savings and accumulate a large stock of net foreign liabilities in a long and gradual process. Financial heterogeneity also affects the composition of the portfolio of net foreign assets. Countries with deeper financial markets borrow heavily from abroad and invest in high-return foreign risky assets. These patterns are consistent with the features of the global external imbalances observed since the beginning of the 1980s. The model can generate these patterns as the outcome of financial integration in a world where the development of domestic financial markets is the only source of cross-country heterogeneity.

Our explanation of large and persistent global imbalances implies that these imbalances are consistent with intertemporal solvency conditions, so our analysis predicts that the large negative net foreign asset position of the U.S. is fully 'sustainable' and does not lead to a worldwide financial crisis. Yet, we also find that financial integration may be harmful for those countries with poorly developed financial systems.

The main implications of our analysis proved to be robust to: (a) introducing alternative forms of financial development; (b) allowing for international risk sharing; (c) considering residence- or source-based enforcement of contracts; (d) combining domestic financial heterogeneity with relatively large differences in growth rates and idiosyncratic income volatility. Thus, we conclude that financial globalization amongst countries with heterogenous domestic financial markets can be an important factor for explaining the large external imbalances that have emerged across the United States, other industrial countries and emerging economies.

A Appendix: Data

Emerging economies: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Malaysia, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Korea, Thailand, Turkey, Hong Kong, Singapore, Saudi Arabia.

Financial development indicators: The International Monetary Fund (IMF (2006)) proposes an index of financial markets development for industrial countries. The index combines information from three core sub-indexes: an index of traditional bank intermediation, an index of new financial intermediation (i.e. intermediation through direct market instruments, such as asset-backed securities and derivatives, and/or non-bank intermediaries, such as hedge funds) and an index of general characteristics of financial markets (e.g. stock market turnover, investor protection, bond market capitalization, etc.). Countries with a higher index undertake a larger volume of financial intermediation through direct market instruments and are viewed as having attained a higher degree of financial development.

Abiad, Detragiache and Tressel constructed a database of financial reforms for both industrialized and emerging economies over the period 1973-2002, covering 82 countries. See Abiad et al. (2007). The database includes seven dimensions of financial sector policies: 1) Credit controls and high reserve requirements; 2) Interest rate controls; 3) Entry barriers; 4) State ownership in the banking sector; 5) Capital account restrictions; 6) Prudential regulations and supervision of the banking sector; 7) Securities market policies. The index of financial liberalization plotted in the second panel of Figure 1 is an average of the seven indicators.

Financial globalization index: Chinn and Ito compiled an index of the degree of capital account openness for 163 countries from 1970 to 2004. See Chinn & Ito (2005). The index is based on binary dummy variables that codify the restrictions on cross-border financial transactions reported in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER). The dummy variables reflect the four major categories of restrictions: 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. The indices for country groups are computed by averaging the individual country indices, weighted by GDP.

Foreign asset positions: Lane and Milesi-Ferretti have compiled data on gross and net foreign assets and liabilities, for different instruments, over the period 1970-2004. See Lane & Milesi-Ferretti (2007). The NFA positions are calculated by aggregating the different assets and liabilities.

B Appendix: Set of feasible contingent claims

Suppose that agents have the ability to divert part of their income. 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 1. This can be interpreted as a fine or additional punishment. A similar assumption is made in Castro, Castro, Clementi, & MacDonald (2004) in an environment with information asymmetry.

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 $s_1 = (w_1, z_1)$ 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:

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

Incentive-compatibility requires:

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

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

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 from one period to the other 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 verifiable. The fraction of lost income ϕ can be interpreted as the cost for hiding (making non-verifiable) the diverted income and for hiding consumption. Again, the intermediary knows that the additional resources come from diversion but it cannot legally prove it.

The last assumption is limited liability. Agents can renegotiate negative values of net worth, and therefore, $a(s_j) \geq 0$. The agent's problem reads:

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

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.[15] 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 $j = 1, .., J$. This is the constraint we imposed on the original problem.

[15]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.

We shall remark that we arrived at this simple formulation of the enforcement constraints because of the particular environment we considered. With the alternative assumption of information asymmetries and persistent shocks, the characterization of the optimal contract becomes more complicated. Because the qualitative properties are similar to the frictions considered here (see, for example, Fernandes & Phelan (2000)), we opted for the simpler route.

C Appendix: Analytical proofs

Proof of Proposition 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 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 consumption growth is positive which cannot be an equilibrium because aggregate income 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) until the limited liability constraint (4) binds. Therefore, at some point, the net worth becomes zero for all agents. Because in country 1 the net holding of productive assets is equal to the domestic endowment of 1, the budget constraint becomes $c_t + P_t + \sum_{w_{t+1}} b(w_{t+1})q(w_t, w_{t+1}) = 0$. This implies $\sum_{w_{t+1}} b(w_{t+1})q(w_t, w_{t+1}) < 0$, that is, country 1 borrows from country 2 (the NFA is negative). *Q.E.D.*

Proof of Proposition 2 Suppose 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 consumption 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) until the limited liability constraint (4) binds. Therefore, at some point, the net worth becomes zero for all agents. As in Proposition 1, this implies that the NFA position of country 1 becomes negative.

To show that country 1 has a positive net position in the productive asset, consider again the first order conditions (10)-(13). From these conditions we have that $ER_t(k, z') = 1 + r$ in country 1 and $ER_t(k, z') > 1 + r$ in country 2. The monotonicity of R_t with respect to k implies that the productive asset used by agents in country 1 is bigger than the ownership of agents in country 2. Because the supply is the same, country 1 owns part of the productive asset of country 2.

What remains to be shown is that for country 1 the average return from the foreign productive investment is higher than the cost of its foreign liabilities. Even thought 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 higher than the interest rate. *Q.E.D.*

D Appendix: Computational procedure

We show first that the economy with contingent claims is equivalent to an economy where contingent claims are not allowed but agents face a different process for the exogenous shocks. We can then solve the equivalent economy where the agents' problem is a standard portfolio choice over riskless and risky assets. After showing this, we describe the computational procedures used to solve for the steady state and transitional equilibria.

D.1 Equivalent economy

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 $\sum_{s_{t+1}} x(s_{t+1})g(s_t, s_{t+1}) = 0$. The variable $\bar{b}_t$ can be interpreted as a non-contingent bond and $x(s_{t+1})$ is the pure insurance component of contingent claims. The law of motion for the next period assets becomes:

$$a(s_{t+1}) = w_{t+1} + \sum_{\ell=1}^{N} \left[k_{\ell,t}P_{\ell,t+1} + z_{\ell,t+1}A_{\ell,t}^{1-\nu}k_{\ell,t}^{\nu}\right] + \bar{b}_t + x(s_{t+1}) \qquad (19)$$

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

$$a(s^j) = a(s^1) + (1-\phi)\cdot\left[w^j - w^1 + \sum_{\ell=1}^{N}(z_\ell^j - z_\ell^1)A_{\ell,t}^{1-\nu}k_{\ell,t}^{\nu}\right]$$

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

$$x(s^j) - x(s^1) = -\phi\cdot\left[w^j - w^1 + \sum_{\ell=1}^{N}(z_\ell^j - z_\ell^1)A_{\ell,t}^{1-\nu}k_{\ell,t}^{\nu}\right]$$

which must hold for all $j \in \{2,..,J\}$. The variables $x(s^j)$ must also satisfy the zero-profit condition, that is,

$$\sum_j x(s^j)g(s_t, s^j) = 0$$

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

$$x(s^j) = -\phi \cdot W^j(s_t) - \phi \cdot \sum_{\ell=1}^{N} Z_\ell^j(s_t) \cdot A_{\ell,t}^{1-\nu} k_{\ell,t}^{\nu}$$

where $W^j(s_t)$ and $Z^j(s_t)$ are exogenous variables defined as

$$\begin{aligned} W^j(s_t) &= w^j - \sum_i g(s_t, s_i) w^i \\ Z_\ell^j(s_t) &= z_\ell^j - \sum_i g(s_t, s_i) z_\ell^i \end{aligned}$$

These variables depend on the current shocks because they affect the probability distribution for the next period shocks.

Define the following variables:

$$\begin{aligned} \tilde{w}^j(s_t) &= w^j - \phi \cdot W^j(s_t) \\ \tilde{z}_\ell^j(s_t) &= z_\ell^j - \phi \cdot Z_\ell^j(s_t) \end{aligned}$$

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

$$a(s^j) = \tilde{w}^j(s_t) + \sum_{\ell}^{N} \left[k_{\ell,t} P_{\ell,t+1} + \tilde{z}_\ell^j(s_t) \cdot A_{\ell,t}^{1-\nu} k_{\ell,t}^{\nu} \right] + \bar{b}_t$$

Therefore, by using the transformed shocks $\tilde{w}_j(s_t)$ and $\tilde{z}_\ell^j(s_t)$, it is as if agents choose only non-contingent claims. Then the problem becomes a standard portfolio choice between a risky assets, $k_{\ell,t}$, and a riskless asset, $\bar{b}_t$. Differences in financial development are captured by difference in the stochastic properties of the transformed shock. So, for example, if $\phi = 0$, we go back to the original shock because contingent claims are not feasible. If $\phi = 1$ and shocks are *iid*, the transformed shock becomes a constant. We are in the case of full insurance. Intermediate values of ϕ allow only for partial insurance. In the computation we will solve the portfolio choice in the transformed model.

D.2 Steady state equilibrium

1. Choose a grid for asset holdings a.

2. Guess the steady state interest rate, r, and the prices $\{P_\ell\}_{\ell=1}^N$.

3. Using the first-order conditions, solve for the optimal portfolio choices at each grid point of a and for each s, by iterating on the policy rules. The solutions at each grid point are joined with piece-wise linear functions.

4. Find the steady state distribution of agents using the decision rules and compute the clearing conditions for the risky and riskless assets.

5. Update the guesses for the interest rate and the prices of the productive asset (step 2) until the market clearing conditions are satisfied.

D.3 Transitional equilibrium

1. Solve for the initial and final steady states (autarky and mobility).

2. Choose the number of transition periods T. This number should be sufficiently large to allow the economy to reach, approximately, the new steady state in T periods.

3. Guess transition sequences for the interest rates, $\{r_t\}_{t=1}^{T}$, and for the price of the productive asset $\{\{P_{\ell,t}\}_{\ell=1}^{N}\}_{t=1}^{T}$. The final prices $\{P_{\ell,T+1}\}_{\ell=1}^{N}$ are set to the steady state values with mobility found in step 1.

4. Using the first-order conditions, solve for the optimal portfolio choices backward starting from T. This provides the sequence of optimal decision rules at $t = 1, 2, .., T$.

5. Using the optimal decision rules, find the sequence of distributions and compute the market-clearing conditions at time $t = 1, 2, .., T$.

6. Update the guess for the sequences of the interest rates and the prices of the productive asset (step 3) until the market-clearing conditions are satisfied at all times $t = 1, 2, .., T$.

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