Financial Integration and Capital Accumulation

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Abstract

How does financial integration impact capital accumulation when countries differ in the efficacy of internal financial markets? We examine this question within a two-country incomplete-markets model featuring a specific financial friction: agents face uninsurable idiosyncratic risk in their investment, or entrepreneurial, opportunities. Under financial autarchy, the South (the country with the least developed risk-sharing possibilities) features a higher precautionary motive for saving and a lower risk-free rate, but also a lower capital stock and lower output. Upon financial integration,capital flies out of the poor, capital-scarce South, causing a prolonged deep in domestic activity. At the same time, the rich, capital-abundant North runs large current-account deficits and enjoys a prolong boom. However, these effects are more than reversed in the long run: as time passes, capital starts flowing back into the South, eventually leading to higher domestic activity than under autarchy. Taken together, these results help explain the emergence of global imbalances while also providing a distinct policy lesson regarding the intertemporal costs and benefits of financial integration.

JEL codes: E13, F15, F41

Keywords: Financial integration, capital-account liberalization, incomplete markets, idiosyncratic risk, entrepreneurship, current-account deficits, global imbalances.

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1 Introduction

The last two or three decades have been characterized by significant liberalization of international capital flows. This, in turn, appears to have facilitated the rise of significant global imbalances—a large foreign debt on the side of the United States along with vast currency reserves and big positive holdings of US Treasury bills on the side of emerging countries such as China. Furthermore, whereas the standard neoclassical paradigm predicts that capital should be flowing from the rich to the poor, or from the least-growing to the fastest-growing countries, the empirical evidence often suggests the opposite direction of capital flows (Gourinchas and Jeanne, 2006). These observations, and more generally the themes of financial integration and global imbalances, have motivated a vast body of theoretical and empirical research.[1] In this paper, we contribute to this growing literature by studying the macroeconomic effects of financial globalization in the presence of a particular market friction—namely uninsurable idiosyncratic risk in investment, or entrepreneurial, opportunities.

In this regard, our paper is closely connected to Mendoza, Quadrini, and Rios-Rull (2008), which also studies how financial integration interacts with frictions in domestic risk sharing. However, their work abstracts from capital accumulation and, in the tradition of Aiyagari (1994) and most other Bewley-type macroeconomic models, focuses on idiosyncratic endowment or labor-income risk. Instead, we shift focus to capital accumulation under idiosyncratic investment risk.

This shift of focus is motivated by two empirical considerations. First, Bewley-type models featuring endowment or labor-income risk make the counterfactual prediction that the least financially developed countries are the *richest* ones. This is because a stronger precautionary motive manifests in higher capital accumulation. In contrast, our framework predicts that the least financial developed countries are the *poorest* ones. This is because idiosyncratic investment risk introduces a wedge between the marginal product of capital and the risk-free rate, thus breaking the tight relation between the precautionary motive and capital accumulation. And second, there appear to be significant idiosyncratic investment or entrepreneurial risks in all countries, and to be more pronounced in the least developed ones. Our contribution is thus to study how such cross-country differences in within-country risk sharing may matter for world-wide wealth inequality and for the macroeconomic effects of capital-account liberalization.[2]

[1] See, e.g., Aoki et al. (2005), Benigno, and Kiyotaki (2006), Blanchard, Giavazzi, and Sa (2005), Boyd and Smith (1997), Broner and Ventura (2008), Caballero, Farhi, and Gourinchas (2008), Engel and Rogers (2006), Fogli and Perri (2006), Gertler and Rogoff (1990), Gourinchas and Jeanne (2006), Gourinchas and Rey (2007), Hausmann and Sturzenegger (2006), Hunt and Rebucci (2005), Lane and Milesi-Ferretti (2007), Kraay et al. (2006), McGrattan and Prescott (2007), Mendoza, Quadrini, and Rios-Rull (2008, 2009), Obstefeld and Rogoff (2004), and Reinhart and Rogoff (2004).

[2] By "capital account liberalization" or "financial integration" we mean a reform upon which certain financial markets start clearing at the world level rather than at the country level; a more precise definition will be given once we move into the model.

The key lessons of our theoretical investigation can be summarized as follows. When the South is in financial autarchy, the domestic (risk-free) interest rate is depressed relative to the North because of a strong precautionary demand for saving. Upon financial integration, some of the South's precautionary saving can find outlet in the North—thus giving rise to global imbalances and also raising the interest rate in the South. This increase in the interest rate increases the opportunity cost of capital, implying a reduction in investment and output in the South. However, as time passes, agents in the South accumulate more wealth due to the higher safe returns they now enjoy in the North. In the process, they become more willing (or able) to engage in risky entrepreneurial activities or otherwise to invest in high-return, but risky, domestic investment opportunities. This in turn opens the door to a "reversal of fortune" in the long run: while capital initially flows out of the South, it starts flowing back after some transitional period, eventually leading to higher output, wages, and consumption than under autarchy. Our paper therefore provides not only an explanation of global imbalances, but also a distinct input to the ongoing debate on the costs and benefits of capital account liberalization.

Preview of model. We conduct our theoretical investigation within a multi-country variant of the Bewley-type model introduced in Angeletos (2007). Like other work based on Bewley-type models, this framework deviates from the standard neoclassical growth paradigm by introducing frictions in the ability of agents to share their idiosyncratic risks. However, while most Bewley-type models typically focus on idiosyncratic labor-income risk (e.g., Aiyagari, 1994, Hugget, 1997, Krusell and Smith, 1998), the focus here is on capital-income, or entrepreneurial, risk.

In particular, our model features two economies (countries), each of which is populated by a continuum of households (families). Each family includes a worker and an entrepreneur. The worker supplies his labor in the domestic labor market; the entrepreneur runs a family business that operates a constant-returns-to-scale technology, employs labor from the domestic labor market, and uses the capital stock owned by her family. Households can also save, or borrow, in a safe asset, but they cannot invest directly in one another's firms. Because our model abstracts from aggregate risk, this safe asset can be interpreted either as a riskless bond or as public equity.[3] Furthermore, households can diversify only a given fraction of the idiosyncratic shocks hitting their firms—this fraction can be interpreted as a measure of the level of financial development in a country. In our baseline specification, the two countries differ only in this measure: domestic risk-sharing possibilities are better in the "North" than in the "South". In an extension, the North has an advantage in supplying the riskless asset. In either case, the key difference is that investment opportunities are riskier in the South than in the North.

[3] More generally, both government bonds and a diversified portfolio of publicly-traded stocks are "safe" in the sense that they are free from idiosyncratic risk.

Within the context of this model, we define "financial autarky" as the regime in which the market for the safe asset has to clear on a country-wide level, and "financial integration" as the regime in which this market has to clear on a world-wide level. We then start the two economies at the steady state that obtains under the autarchic regime; we consider a reform that integrates the market for the safe asset; and we study the transition of the two economies from their old (autarchic) steady states to their new (integrated) steady state.

Preview of results. Under financial autarchy, the South necessarily features a higher demand for the safe asset and a lower (risk-free) interest rate, due to the stronger precautionary motive implied by the large amount of undiversifiable idiosyncratic risk. Despite its lower interest rate, the South may also feature a lower capital stock than the North. This is because the idiosyncratic risk introduces a wedge between the marginal product of capital and the interest rate. This wedge defines the risk premium on entrepreneurial activity, and it is higher in the South than in the North, reflecting the lower level of financial development in the South. It follows that, prior to financial integration, the South identifies the poor country and the North identifies the rich country: the South has a higher marginal product of capital, a lower capital-labor ratio, and a lower per-capita levels of GDP and consumption.

Under the standard neoclassical paradigm, the higher marginal product of capital in the South would lead to the prediction that financial integration will cause financial capital to fly out of the North and into the South, until the gap between the two countries is eliminated (Lucas, 1990). However, this is not the case in our context: financial integration requires equalization of the interest rates (the return on financial capital), but this does not mean equalization of the marginal products of physical capital, as long as idiosyncratic risk introduces a wedge between the safe and the risky return. In particular, as long as idiosyncratic risk remains higher in the South, this wedge will continue to be higher in the South, and hence the South will continue to have lower levels of capital, GDP and consumption.

Instead, in our framework, because the South has a lower autarchic interest rate, the North should start borrowing from the South upon financial integration. Indeed, we find that the North runs large current account deficits and, symmetrically, the South accumulates a large positive foreign asset position. This is due to the fact that the South has a higher precautionary demand for the safe asset and/or the fact that the North has a higher supply of the safe asset. The first mechanism is similar to the one in Mendoza et al. (2007); the second is reminiscent of Caballero et al. (2008). Either way, if the North is interpreted as the United States, our result helps explain the emergence of significant "global imbalances" like those observed in recent history.

Furthermore, because financial integration is bound to increase interest rates, and thereby also increase the opportunity cost of capital in the South, the capital stock should be initially expected to fall in the South. Indeed we find that, unless financial integration permits households in the South to diversify a sufficiently big fraction of their idiosyncratic investment risks, the South experiences a significant depression upon financial integration: the capital stock falls, driving down domestic wages, GDP, and consumption. Conversely, the North experiences an investment boom.

Perhaps more surprisingly, we find that these effects can be more than reversed in the long run: in the steady state that obtains under financial integration, the South enjoys a higher capital stock and higher levels of wages, GDP and consumption than in its autarchic steady state, despite the fact that it also faces a higher interest rate and therefore a higher cost of capital. This result rests on the dynamics of the wedge between the marginal product of capital and the interest rate. In our model, this wedge is a decreasing function of the level of domestic wealth, because more wealth increases the willingness to take risk and hence reduces the risk premium on entrepreneurial activity. In the sort run, wealth is nearly fixed and therefore this wedge is also nearly fixed. It follows that the increase in the domestic interest rate upon financial integration is necessarily associated with an increase in the domestic cost of capital, and hence with a reduction in the domestic capital stock, as mentioned in the previous paragraph. In the long run, however, the level of domestic wealth is variable. In particular, because the households in the South are now able to save abroad at higher safe returns, they are also able to accumulate higher wealth in the long run. But as they accumulate more wealth, they also require a lower risk premium on entrepreneurial activity. It follows that in the long run the South experiences not only a positive foreign asset position, but also higher levels of capital, wages, output and consumption than under autarchy.

At the same time, as long as entrepreneurial activity in the South remains more risky than in the North, the level of capital, wages, and output remain lower in the South than in the North even after financial integration. We infer that financial integration may reduce the gap between the rich and the poor, but not necessarily eliminate it.

Finally, because the aforementioned transition in the South may feature a reallocation of capital from safe but low-return activities to risky but high-return ones, measured TFP in the South may increase along the transition. Conversely, the North may experience a drop in TFP (or a lower growth rate than the South). Along with the property that the South runs current account surpluses, while the North runs current account deficits, this implies our model predicts that capital flows from the faster growing countries to the slower growing countries—a prediction that is the opposite of the one made by the standard neoclassical paradigm and that helps resolve the empirical puzzle documented by Gourinchas and Jeanne (2008).

Related literature. The literature that uses Bewley-type models to study the macroeconomic implications of incomplete markets is quite extensive. Key references include, among many others, Aiyagari (1994), Huggett (1997), Krusell and Smith (1998), and Rios-Rull (1995).[4] However, the vast majority of this literature focuses on idiosyncratic labor-income risk, abstracting from idiosyncratic investment, or capital-income, risk. The first papers to emphasize the distinct implications of investment risk for aggregate saving within the context of the neoclassical growth model are Angeletos and Calvet (2000, 2006) and Angeletos (2007). Other papers that feature the same theme, but focus on different questions, include Angeletos and Panousi (2008), Basin, Benhabib and Zhu (2009), Cagetti and De Nardi (2006), Covas (2006), Mall (2009), Meh and Quadrini (2006), and Panousi (2009). The novelty of our paper compared to this earlier work is to study how cross-country differences in the level of idiosyncratic investment risk impact global macroeconomic dynamics.

In so doing, our paper complements a growing literature that studies the macroeconomic implications of financial integration and the origins and consequences of "global imbalances".[5] As already mentioned, most closely related in this regard is the recent work by Mendoza, Quadrini, and Rios-Rull (2008, 2009); see also Willen (2004) for an earlier take on related ideas. Like our paper, this work focuses on the role of cross-country differences in the degree of internal risk-sharing and shows how these differences can help explain significant and persistent global imbalances. However, unlike our paper, this work rules out either endogenous capital accumulation or idiosyncratic investment risk.[6] It is precisely the combination of these two features—endogenous capital accumulation and idiosyncratic investment risk—that distinguishes our paper and that explains the novelty of our results vis-a-vis this earlier, complementary work.

Our paper is also related to Caballero, Farhi, and Gourinchas (2008). In particular, in both papers global imbalances are explained, in a certain sense, by a shortage of assets (stores of value) in the South. But whereas that paper assumes that the South has a lower capacity in supplying *any* asset, we only assume that the North has a comparative advantage in supplying the *safe* asset and/or that the South has a stronger precautionary motive. Furthermore, there are a number of important modeling differences: that paper considers an OLG setting which breaks Ricardian equivalence, rules out idiosyncratic risk, and imposes an exogenous supply of physical capital. As a result, our paper makes novel, and distinct, predictions about the consequences of financial integration on the dynamics of capital accumulation.

Finally, our paper makes a broader contribution to the growth-and-development literature by studying how cross-country differences in domestic financial development can explain wealth in-

[4] See Heathcote, Storesletten, and Violante (2008) and Krusell and Smith (2006) for eclectic reviews.

[5] See the references in footnote 1.

[6] Mendoza et al. (2008) allow for a certain type of "investment risk", but this is very different than the one considered in our paper: the investment opportunity in Mendoza et at (2008) is an exogenous "Lucas tree", so that, unlike our paper, there is no endogenous capital accumulation. Mendoza et al. (2009), on the other hand, allow for capital accumulation, but rule out idiosyncratic investment risk.

equality in the cross-section of countries. In particular, it highlights the importance of studying the dynamic adjustment of the economy when debating the costs and benefits of capital-account liberalization. In this regard, our work complements Aoki, Benigno and Kiyotaki (2009), who also stress the same point, albeit within a different framework.

2 The basic model

Time is continuous, indexed by $t \in [0, \infty)$. There is a single good, which can be used for either consumption or investment purposes. There are two countries, indexed by $j \in \{1, 2\}$. Each country is populated by a continuum of infinitely-lived households, indexed by i and distributed uniformly over $[0, 1]$. Each household includes a worker and a producer ("entrepreneur"). The worker supplies his labor inelastically to the domestic labor market. The entrepreneur runs a privately-held firm ("family business"). Each household can freely save or borrow in the riskless bond—up to a natural borrowing constraint—and can accumulate physical capital within its own family business, but it cannot invest in firms held by other households. Firms are hit by idiosyncratic shocks, which the households cannot only partially diversify. Finally, to maintain tractability, we abstract from any aggregate uncertainty.

Fix a household i in county j. The preferences of this household are given by a standard CRRA specification:

$$U_{ij} = \int_0^\infty e^{-\beta t} u(c_{ijt})\, dt \quad \text{with} \quad u(c) = \frac{c^{1-\gamma} - 1}{1 - \gamma}, \tag{1}$$

where c_{ijt} is the household's consumption flow at t, $\beta > 0$ is the discount rate, and $\gamma > 0$ is the coefficient of relative risk aversion.

The financial wealth of this household, denoted by x_{ijt}, is the sum of its holdings in private capital, k_{ijt}, and the riskless bond, b_{ijt}:

$$x_{ijt} = k_{ijt} + b_{ijt}. \tag{2}$$

The evolution of x_{ijt} is given by the following budget constraint:

$$dx_{ijt} = d\pi_{ijt} + [R_t b_{ijt} + \omega_{jt} - c_{ijt}]dt + dT_{ijt}. \tag{3}$$

Here, $d\pi_{ijt}$ is the household's capital income (i.e., the profits from the private firm it owns), R_{jt} is the interest rate on the riskless bond, ω_{jt} is the wage rate, c_{ijt} is the household's consumption, and dT_{ijt} is a transfer that captures risk-sharing opportunities (to be defined later on).

Whereas the sequences of the interest rate and of the wage are deterministic (due to the absence of aggregate risk), firm profits, and hence household capital income, are subject to undiversified idiosyncratic risk:

$$d\pi_{ijt} = [F(k_{ijt}, n_{ijt}) - \omega_{jt} n_{ijt} - \delta k_{ijt}]dt + \sigma_j k_{ijt} dz_{ijt}. \tag{4}$$

Here, n_{ijt} is the amount of labor the firm hires in the competitive labor market, δ is the mean depreciation rate, and F is a constant-returns-to-scale neoclassical production function. For simplicity, we assume a Cobb-Douglas specification: $F(k, n) = k^{\alpha} n^{1-\alpha}$, with $\alpha \in (0, 1)$.

Idiosyncratic risk is introduced through dz_{ijt}, a standard Wiener process that is i.i.d. across agents and time. Literally taken, dz_{ijt} represents a stochastic depreciation, or productivity, shock. However, we wish to interpret this shock more broadly as encompassing various sources of idiosyncratic risk in the entrepreneurial activity and, more generally, in the returns to private investment. For example, putting aside the details of how this would be modeled from first principles, we could re-interpret this risk as idiosyncratic liquidation risk. Alternatively, this risk could represent some form of idiosyncratic expropriation risk, caused by the inefficiency of legal and political institutions in a country. In any case, what matters for our results is that dz_{ijt} introduces idiosyncratic risk in the return to investment. The scalar σ_j then parameterizes the level of this risk in country j.

Since risk is purely idiosyncratic, agents would be able to obtain full insurance against it if financial markets were complete. A number of reasons—moral hazard, adverse selection, costly state verification, inefficient legal and enforcement systems, or mere lack of sophistication—may explain why this does not happen in the real world. In this paper, as in most other papers in the Bewley tradition, we abstract from the deeper micro-foundations of incomplete markets. Instead, we exogenously impose that the available risk-sharing possibilites are limited, and more severely so in the South. We capture this by assuming that:

$$dT_{ijt} = -\lambda_j \sigma_j k_{ijt} dz_{ijt}, \tag{5}$$

for some $\lambda_j \in (0, 1)$. This assumption can also be justified by introducing an exogenous asset structure that permits agents to diversify only certain components of their idiosyncratic risk.[7] Either way, the scalar λ_j measures the fraction of idiosyncratic risk that agents are able to diversify

[7] To see this, consider the following exercise. First, suppose that the idiosyncratic risk dz_{ijt} can be decomposed into multiple components: $dz_{ijt} = \sum_{s \in S} dz_{s,ijt}$, where the variables $dz_{s,ijt}$, for all $s \in S$, are standard Wiener processes, independent from one another and i.i.d. across time and agents. Next, suppose that there exists an $S'_j \subset S$ such that the following are true: for each $s \in S'_j$, there exists a risky financial asset whose return is perfectly correlated with $dz_{s,ijt}$; and there exists no other risky asset. Under these assumptions, if we let agents trade these assets, then the equilibrium price of these assets will be zero and the agents will choose their optimal portfolios of these assets so as to diversify fully the shocks $s \in S'_j$, leaving themselves exposed only to the residual shocks in S. Indeed, the return they enjoy from their optimal portfolio is $dT_{ijt} = -k_{ijt} \sum_{s \in S'} dz_{s,ijt}$. Our analysis could then proceed simply by re-interpreting λ_j as the ratio of the number of the shocks in S'_j over the number of shocks in S.

in country j; this is what defines the level of financial development in our model.

Combining conditions (3)-(5), we get that the household budget reduces to:

$$dx_{ijt} = d\tilde{\pi}_{it} + [R_t b_{ijt} + \omega_{jt} - c_{ijt}]dt, \tag{6}$$

where

$$d\tilde{\pi}_{ijt} \equiv d\pi_{ijt} - dT_{ijt} = [F(k_{ijt}, n_{ijt}) - \omega_{jt} n_{ijt} - \delta k_{ijt}]dt + (1 - \lambda_j)\sigma_j k_{ijt} dz_{ijt}.$$

It is then evident that the quantity $\tilde{\sigma}_j \equiv (1 - \lambda_j)\sigma_j$ measures the amount of undiversifiable idiosyncratic risk in country j. Without any loss of generality, we set $\sigma_1 = \sigma_2 = \sigma$ and assume $\lambda_1 > \lambda_2$ (equivalently, $\tilde{\sigma}_1 < \tilde{\sigma}_2$), so as to identify country 1 as the country with better risk sharing or more developed financial markets. We henceforth refer to country 1 as the "North" or the "developed economy", and to country 2 as the "South" or the "developing economy".

Let $Y_{jt}, C_{jt}, N_{jt}, K_{jt}$, and B_{jt} denote the aggregate levels of output, consumption, employment, capital, and bond holdings in country j at date t (that is, the cross-sectional averages of y_{ijt}, c_{ijt} and so on). We consider two scenarios. In the first, countries are in financial autarchy: the riskless bond cannot move across borders. In the second, they are financially integrated: countries can borrow and lend to one another. We define the corresponding equilibrium concepts as follows.

An **autarchic equilibrium** for country j, $j \in \{1, 2\}$, is defined by a deterministic sequence of country-specific interest rates, wages, and macroeconomic quantities, $\{R_{jt}, \omega_{jt}, Y_{jt}, C_{jt}, K_{jt}\}_{t\in[0,\infty)}$, along with a collection of individual contingent plans, $(\{c_{ijt}, n_{ijt}, k_{ijt}, b_{ijt}\}_{t\in[0,\infty)})_{i\in[0,1]}$, such that the following are true: (i) individual plans are optimal given the sequences of prices; (ii) macroeconomic quantities are obtained by aggregating individual plans; (iii) labor and bond markets clear at the country level, namely $N_{jt} = 1$ and $B_{jt} = 0$ for all j, t.

An **integrated equilibrium** for the entire world is defined by a deterministic sequence of wordwide interest rates, $\{R_t\}_{t\in[0,\infty)}$, a deterministic sequence of country-specific wages and macroeconomic quantities, $\{\omega_{jt}, Y_{jt}, C_{jt}, K_{jt}\}_{t\in[0,\infty)}$, along with a collection of individual contingent plans, $(\{c_{ijt}, n_{ijt}, k_{ijt}, b_{ijt}\}_{t\in[0,\infty)})_{i\in[0,1]}$, such that the following are true: (i) individual plans are optimal given the sequences of prices; (ii) macroeconomic quantities are obtained by aggregating individual plans; (iii) labor markets clear at the country level, namely $N_{jt} = 1$ for all j, t; (iv) the bond market clears at the world level, namely $B_{1t} + B_{2t} = 0$ for all t.

3 Equilibrium

In this section, we first characterize the individual household's problem for a given sequence of prices. We then proceed to characterize the autarchic and integrated equilibria.

3.1 Individual behavior

Since employment is chosen after the capital stock has been installed and the idiosyncratic shock has been observed, optimal employment maximizes profits state-by-state. Furthermore, by constant returns to scale, optimal employment and profits are linear in own capital. We therefore have that:

$$n_{ijt} = \bar{n}_{jt} k_{ijt} \qquad \text{and} \qquad d\pi_{ijt} = \bar{r}_{jt} k_{ijt} dt + \sigma_j k_{ijt} dz_{ijt}, \tag{7}$$

where $\bar{n}_{jt} = \bar{n}(\omega_{jt}) \equiv \arg\max_n [F(1,n) - \omega_{jt} n]$ and $\bar{r}_{jt} = \bar{r}(\omega_{jt}) \equiv \max_n [F(1,n) - \omega_{jt} n] - \delta$. As in Angeletos (2007), the key result here is that households face linear, albeit risky, returns to their capital. This linearity, together with the homotheticity of preferences, ensures that the household's consumption-saving problem reduces to a tractable homothetic problem, much like in Samuelson's and Merton's classic portfolio analysis. It then follows that the optimal policy rules are linear in wealth, as shown in the next lemma.

Lemma 1. *Let $\{\omega_{jt}, R_{jt}\}_{t\in[0,\infty)}$ be equilibrium price sequences (with $R_{1t} = R_{2t} = R_t$ if the world is integrated) and let $h_{jt} \equiv \int_t^\infty e^{-\int_t^s R_{j\tau} d\tau} \omega_{js} ds$ denote the present discounted value of future labor income (a.k.a. human capital). Then, optimal consumption, investment and bond holdings are given by*

$$c_{ijt} = m_{jt}(x_{ijt} + h_{jt}), \quad k_{ijt} = \phi_{jt}(x_{ijt} + h_{jt}), \quad \text{and} \quad b_{ijt} = (1 - \phi_{jt})(x_{ijt} + h_{jt}) - h_{jt}, \tag{8}$$

where ϕ_{jt}, the marginal propensity to invest in capital, is given by

$$\phi_{jt} = \frac{\bar{r}_{jt} - R_{jt}}{\gamma \tilde{\sigma}_j^2}, \tag{9}$$

while m_{jt}, the marginal propensity to consume, satisfies the recursion

$$\frac{\dot{m}_{jt}}{m_t} = m_t + (\theta - 1)\hat{\rho}_{jt} - \theta\beta, \tag{10}$$

with $\hat{\rho}_{jt} \equiv \rho_{jt} - \frac{1}{2}\gamma\phi_{jt}^2\tilde{\sigma}_j^2$ denoting the risk-adjusted return to saving, $\rho_{jt} \equiv \phi_t \bar{r}_{jt} + (1 - \phi_{jt})R_t$ the mean return to saving, and $\theta \equiv 1/\gamma$ the elasticity of intertemporal substitution.

Condition (8) establishes the linearity of the optimal consumption c_{ijt}, capital k_{ijt}, and bond holding b_{ijt} in financial wealth x_{jt}. Condition (9) identifies the propensity to invest in the risky asset as an increasing function of the risk premium $\mu_t \equiv \bar{r}_t - R_t$ and a decreasing function of the coefficient of relative risk aversion γ and the amount of uninsurable risk $\tilde{\sigma}_j = (1 - \lambda_j)\sigma$. Finally, condition (10) is essentially the Euler condition: it describes the growth rate of the marginal propensity to consume as a function of the anticipated path of risk-adjusted returns to saving. Whether higher risk-adjusted returns increase or reduce the marginal propensity to consume depends on whether the elasticity of intertemporal substitution θ exceeds one; this is is due to the familiar tension between the income and substitution effects implied by an increase in the rate of return.[8]

3.2 General equilibrium

Let $f(K) \equiv F(K,1) = K^{\alpha}$. From Proposition 1, we have that the equilibrium values of the propensity to invest and the risk-adjusted return to saving are given by $\phi_{jt} = \phi(K_{jt}, R_t, \tilde{\sigma}_j)$ and $\hat{\rho}_{jt} = \hat{\rho}(K_{jt}, R_t, \tilde{\sigma}_j)$, where

$$\phi(K,R,\tilde{\sigma}) \equiv \frac{(f'(K)-\delta-R)}{\gamma\tilde{\sigma}^2} \quad \text{and} \quad \hat{\rho}(K,R,\tilde{\sigma}) \equiv R + \frac{(f'(K)-\delta-R)^2}{2\gamma\tilde{\sigma}^2}.$$

Furthermore, the equilibrium wage satisfies $\omega_{jt} = f(K_{jt}) - f'(K_{jt})K_{jt} = (1-\alpha)f(K_{jt})$. Using these facts, aggregating the policy rules of the agents, and imposing market clearing for the risk-free bond, we arrive at the following characterization of the general equilibrium of the economy.

Proposition 1. *In either the autarchic or the integrated equilibrium, the aggregate dynamics of country j satisfy the following ODE system:*

$$C_{jt} + \dot{K}_{jt} + \dot{B}_{jt} = f(K_{jt}) - \delta K_{jt} + R_{jt}B_{jt} \tag{11}$$

$$\frac{\dot{C}_{jt}}{C_{jt}} = \theta(\hat{\rho}_{jt} - \beta) + \tfrac{1}{2}\gamma\tilde{\sigma}_j^2\phi_{jt}^2 \tag{12}$$

$$\dot{H}_{jt} = R_{jt}H_{jt} - (1-\alpha)f(K_{jt}) \tag{13}$$

$$B_{jt} = (1-\phi_{jt})(K_{jt}+B_{jt}) - \phi_{jt}H_{jt} \tag{14}$$

where $\phi_{jt} = \phi(K_{jt}, R_{jt}, \tilde{\sigma}_j)$ and $\hat{\rho}_{jt} = \hat{\rho}(K_{jt}R_{jt}, \tilde{\sigma}_j)$. The autarchic equilibrium is then obtained by letting $R_{1t} \neq R_{2t}$ and requiring that, for each j, R_{jt} adjusts so that

$$B_{jt} = 0. \tag{15}$$

In contrast, the integrated equilibrium is obtained by imposing $R_{1t} = R_{2t} = R_t$ and requiring that

[8] We have assumed expected utility, which imposes that the EIS coincides with the reciprocal of the coefficient of relative risk aversion. However, we have introduced the different notation for the EIS, namely θ, in order to accommodate an extension of our results to Epstein-Zin preference, which would allow the EIS to differ from the reciprocal of the coefficient of relative risk aversion. In all that follows, the reader should interpret θ as the elasticity of intertemporal substitution and γ as the coefficient of relative risk aversion, leaving open the possibility that $\theta \neq 1/\gamma$.

R_t adjusts so that

$$B_{1t} + B_{2t} = 0 \tag{16}$$

This proposition has a simple interpretation. Condition (11) is the resource constraint of the economy. Condition (12) is the aggregate Euler condition for the economy. Condition (13) is the law of motion for human capital. Finally, condition (14) is the equilibrium level of aggregate holdings of the riskless bond, or the net foreign asset position of the country. Once these conditions are combined with the appropriate market-clearing condition for the bond market, the general equilibrium is pinned down. Under financial autarchy, the domestic interest rate of each country must be such that the net foreign asset position of that country is zero. When instead the two countries are financially integrated, the world-wide interest rate must be such that the asset positions of the two countries balance one another.

At this point, it is important to recognize how the presence of idiosyncratic risk impacts the general-equilibrium system. When $\tilde{\sigma}_j = 0$, arbitrage imposes that $R_t = f'(K_{jt}) - \delta = \hat{\rho}_{jt}$ and the Euler condition reduces to its familiar complete-markets version, $\frac{\dot{C}_{jt}}{C_{jt}} = \theta\left(R_t - \beta\right)$. When instead $\tilde{\sigma}_j > 0$, there are two important changes. First, the precautionary motive for saving introduces a positive drift in consumption growth, represented by the term $\frac{1}{2}\gamma\tilde{\sigma}_j^2\phi_{jt}^2$ in the Euler condition (12). Second, the fact that investment is subject to undiversifiable idiosyncratic risk introduces a wedge between the risk-free rate and the marginal product of capital, so that $R_{jt} < \hat{\rho}_{jt} < f'(K_{jt}) - \delta$. The first effect is shared by Aiyagari (1994), Hugget (1997), Krusell and Smith (1998), Mendoza et al (2008, 2009) and may other Bewley-type models that feature only *labor-income* risk. The second effect distinguishes the class of models that introduce *capital-income* risk and is key for the results that follow.

4 Steady State

In this section we study the steady state of the two economies under the two cases of interest: autarchy and financial integration. We start by deriving some results that apply to either case and by identifying a wealth effect on investment that is crucial for our results. We then proceed to the characterization of the autarchic and integrated steady states.

4.1 Partial characterization and the wealth effect on investment

In steady state, the growth rate of aggregate consumption in each country must be zero. The Euler condition (12) then reduces to the following:

$$\hat{\rho}_j = \beta - \frac{1}{2}\frac{\gamma}{\theta}\tilde{\sigma}_j^2 \phi_j^2. \tag{17}$$

This condition simply requires that the risk-adjusted return to saving in country j be lower than the discount rate as much as it takes for the associated negative intertemporal substitution effect to just offset the positive precautionary motive. Using the facts that $\hat{\rho}_j = R_j + \frac{1}{2\gamma\tilde{\sigma}_j^2}\mu_j^2$ and $\phi_j = \frac{1}{\gamma\tilde{\sigma}_j^2}\mu_j$, where $\mu_j = f'(K_j) - \delta - R_j$ is the risk premium, we can restate condition (17) as follows:

$$f'(K_j) - \delta = R_j + \sqrt{\frac{2\theta\gamma\tilde{\sigma}_j^2\left(\beta - R_j\right)}{\theta + 1}}. \tag{18}$$

We infer that this condition pins down the combinations of the domestic capital stock and the interest rate that are consistent with stationarity of aggregate consumption—equivalently, with stationarity of aggregate wealth—in country j.

For future reference, it is useful to note the following. If there were no idiosyncratic risk ($\sigma = 0$), then condition (18) would have reduced to the familiar condition $f'(K) - \delta = R$, i.e. the marginal product of capital would have been equated to the interest rate. Furthermore, this would have implied that the capital stock is a decreasing function of the interest rate. Now, instead, we have that the marginal product of capital exceeds the interest rate: $f'(K) - \delta > R$. This is simply because agents require a positive risk premium in order to be willing to hold capital. In addition, the steady state value of this premium, which is given by the square-root term in (18), is decreasing in the interest rate. This is because a higher interest rate permits the domestic agents to accumulate more wealth in the long run. Indeed, for any given initial level of aggregate wealth, a higher interest rate necessarily increases the mean return to saving and therefore also increases the level of aggregate wealth in subsequent periods. It follows that the long-run level of aggregate wealth also increases.[9] The accumulation of more wealth, in turn, increases agents' willingness to take risk—due to diminishing absolute risk aversion—and thereby reduces the premium they require in order to hold any given amount of capital. Hence, the overall impact of the interest rate on capital accumulation is now ambiguous: a higher interest rate may actually induce *more* investment in the long run, due to the wealth effect on risk taking. This wealth and risk-taking effect plays a central role in the results of our paper; we will revisit it shortly.

[9] Of course, this statement is valid only for aggregates: the wealth of any particular individual could either increase or fall, because of the presence of idiosyncratic risk.

Going back to the determination of the steady state, we now note that, because the interest and the wage are constant in steady state, the present value of labor income must also be constant, which gives $H_j = (1-\alpha)f(K_j)/R_j$. Using this into condition (14), we infer that aggregate bond holdings—equivalently, the net foreign asset position—of country j must satisfy:

$$B_j = \frac{1-\phi_j}{\phi_j} K_j - \frac{(1-\alpha)f(K_j)}{R_j}. \tag{19}$$

Combining this result with the one in condition (18), we reach the following lemma.

Lemma 2. *(i) There exist continuous functions* $\mathbf{K}, \mathbf{B} : (0, \beta) \times \mathbb{R}_+ \to \mathbb{R}$ *such that, under either autarchy or integration, the steady-state levels of aggregate capital and bond holdings satisfy*

$$K_j = \mathbf{K}(R_j, \tilde{\sigma}_j) \qquad \text{and} \qquad B_j = \mathbf{B}(R_j, \tilde{\sigma}_j)K_j \tag{20}$$

These functions are defined by

$$\mathbf{K}(R, \tilde{\sigma}) \equiv (f')^{-1}(R + \mu(R, \tilde{\sigma}) + \delta) \quad \text{and} \quad \mathbf{B}(R, \tilde{\sigma}) \equiv \frac{1-\phi(R,\tilde{\sigma})}{\phi(R,\tilde{\sigma})} - \frac{(1-\alpha)f(\mathbf{K}(R,\tilde{\sigma}))}{R\mathbf{K}(R,\tilde{\sigma})},$$

where $\mu(R, \tilde{\sigma}) \equiv \sqrt{\frac{2\theta\gamma\sigma^2}{1+\theta}(\beta - R)}$ *and* $\phi(R, \tilde{\sigma}) \equiv \frac{1}{\gamma\sigma^2}\mu(R, \tilde{\sigma})$.

(ii) $\frac{\partial \mathbf{K}(R,\tilde{\sigma})}{\partial R} > 0$ *if and only if* $\phi(R, \tilde{\sigma}) < \frac{\theta}{1+\theta}$, *which in turn is true if and only if* $R > \hat{R}(\tilde{\sigma})$, *where* $\hat{R}(\tilde{\sigma}) \equiv \beta - \frac{\theta}{1+\theta}\frac{\gamma\sigma^2}{2} < \bar{R}$.

(iii) $\frac{\partial \mathbf{K}(R,\tilde{\sigma})}{\partial \sigma} < 0$ *necessarily.*

(iv) $\frac{\partial \mathbf{B}(R,\tilde{\sigma})}{\partial R} > 0$ *necessarily.*

(v) $\frac{\partial \mathbf{B}(R,\tilde{\sigma})}{\partial \sigma} > 0$ *if and only if* $R > \underline{R}$, *where* $0 < \underline{R} \equiv \beta\frac{2\theta(1-\alpha)}{\alpha+(2-\alpha)\theta} < \bar{R}$.

Part (i) follows from conditions (18) and (19). The functions $\mathbf{K}$ and $\mathbf{B}$ give, respectively, the domestic capital stock and the net foreign-asset position that are consistent with stationarity of aggregate wealth when the interest rate is R and the level of risk is σ. These functions will turn out to be particularly helpful in the characterization of the steady states.

Parts (ii) through (iv) then provide us with the comparative statics of these functions with respect to the interest rate and the level of risk. Part (ii), in particular, establishes that the steady-state capital stock is a U-shaped function of the interest rate. What lies behind this U-shaped relation is our wealth-and-risk-taking effect: for sufficiently high R, this effect dominates the familiar opportunity-cost effect, guaranteeing that a higher interest rate *increases* the capital stock in the steady state. This result plays a crucial role in our subsequent analysis. Part (iv), then, complements this result by showing that, as the interest rate increases, the propensity to save in the bond also increases: as the risk-free rate increases, saving in the riskless asset (bond) increases *relative* to aggregate saving in the risky asset (capital).

Finally, parts (iii) and (v) establish that, for any given interest rate, an increase in the level of risk necessarily reduces the steady-state capital stock, while it increases the propensity to save in the bond as long as the interest-rate is not too low. These properties capture, respectively, the risk-aversion and precautionary-saving effects of higher idiosyncratic risk.

Combined, these results facilitate the characterization of the autarchic and integrated steady states. To sharpen this characterization, we now introduce the following assumption, which we will invoke for a subset of our results.

Assumption 1. *Suppose that either of the following conditions holds:*

$$\tilde{\sigma}_j > \sqrt{\frac{2\alpha\beta(1+\theta)}{\theta\gamma(\alpha+\theta(2-\alpha))}} \qquad or \qquad \frac{\alpha - s_j^{aut}}{1-s_j^{aut}} < \frac{\theta}{1+\theta},$$

where $s_j^{aut} \equiv \delta K_j^{aut}/f(K_j^{aut})$ *is the autarchic steady-state saving rate of country* j.

This assumption requires either (i) that the uninsurable idiosyncratic risk exceeds some minimal level, or (ii) that the elasticity of intertemporal substitution is sufficiently high relative to the autarchic propensity to invest. It can be shown that the former property implies the latter (see Appendix). The advantage of the former, stronger, property is that it is stated in terms of purely exogenous parameters, thus guaranteeing the existence of economies for which this assumption holds. The advantage of the latter, weaker, property is that it can be assessed on the basis of macroeconomic data. In particular, consider the following back of the envelope exercise. Using US data, we can set $\alpha \approx .36$ and $s^{aut} \approx .23$ as empirically plausible values. It then follows that this property is satisfied if $\theta > .2$. For countries with higher saving rates, this condition might be satisfied for even lower values of θ. Since most estimates of θ, the elasticity of intertemporal substitution, are above .5, and often close to 1, we conclude that Assumption 1 is a very plausible benchmark. In any event, the role of this assumption is to guarantee that the autarchic steady states lie in the increasing portion of the function $\mathbf{K}$; that is, $R_j^{aut} > \hat{R}(\tilde{\sigma}_j)$ and therefore, by part (ii) of Lemma 2, $\partial\mathbf{K}(R,\tilde{\sigma}_j)/\partial R > 0$ for all $R \geq R_j^{aut}$. In other words, Assumption 1 guarantees that, in the neighborhood of the autarchic steady state, the wealth-and-risk-taking effect of a higher interest rate dominates the standard opportunity-cost effect.

4.2 Autarchy

We are now ready to provide our first main result, the characterization of the autarchic steady state.

Proposition 2. *There always exists an autarchic steady state, it is unique, and it features the following properties:*

(i) The autarchic interest rates are given by R_j^{aut}, where R_j^{aut} solves $\mathbf{B}(R_j^{aut}, \tilde{\sigma}_j) = 0$, and satisfy

$$\underline{R} < R_2^{aut} < R_1^{aut} < \bar{R},$$

where $\bar{R}$ is the complete-markets interest rate, $\bar{R} = \beta$.

(ii) The autarchic capital stocks are given by $K_j^{aut} = \mathbf{K}(R_j^{aut}, \tilde{\sigma}_j)$. Furthermore, under Assumption A1,

$$0 < K_2^{aut} < K_1^{aut} < \bar{K},$$

where $\bar{K}$ is the complete-markets capital stock, defined by $f'(\bar{K}) = \beta + \delta$.

(iii) The autarchic consumption levels are given by $C_j^{aut} = f(K_j^{aut}) - \delta K_j^{aut}$. Furthermore, under Assumption A1,

$$0 < C_2^{aut} < C_1^{aut} < \bar{C},$$

where $\bar{C}$ is the complete-markets consumption level, defined by $\bar{C} = f(\bar{K})$.

The existence and the uniqueness of the autarchic steady state follow from the continuity and monotonicity of the function $\mathbf{B}$ with respect to R (which we established in Lemma 2), along with appropriate limit properties (which we establish in the Appendix).

Part (i) characterizes the steady-state levels of the interest rate: it establishes that the interest rate is lower than the discount rate in both countries, and more so in the South than in the North. The first property, namely that the autarchic interest rates are lower than the discount rate, reflects the presence of a precautionary motive for saving, much alike the one in Aiyagari (1994) and Mendoza et al. (2008). The second property, that the interest rate in the South is lower than the one in the North, is then a consequence of the fact that the precautionary motive is stronger in the South, due to the higher level of idiosyncractic risk. Formally, this is captured by the monotonicity of the function $\mathbf{B}$ with respect to σ: the higher the level of undiversifiable idiosyncratic risk, the higher the steady-state demand for the risk-free asset for any given R; but since the net supply of this asset is zero when the economy is in autarchy, it must be that the autarchic interest rate is lower the higher the σ.

This result is also illustrated in Figure 1. The interest rate is on the horizontal axis. The blue line is the curve $\mathbf{B}$ for the North; the green line is the curve $\mathbf{B}$ for the South. These curves can be interpreted as the aggregate demand for the safe asset in each country (normalized, though, by the corresponding capital stocks). Both curves are increasing in R, but the one for the South lies above the one for the North, reflecting the stronger precautionary motive in the South. The autarchic steady-state interest rates are given by the intersections of the two curves with the horizontal zero line. Clearly, the South has a lower autarchic interest rate, $R_2^{aut} < R_1^{aut}$.

Part (ii) characterizes the steady-state levels of the capital stock: it establishes, under Assumption 1, that the capital stock is lower than its complete-markets counterpart in both countries, and more so in the South than in the North. The first property, namely that the autarchic capital stocks are lower than their complete-markets counterparts, revisits the key result in Angeletos (2006). As mentioned in the Introduction, this is a core prediction that differentiates our framework from prior work, including Aiyagari (1994), Krusell and Smith (1998), Medoza et al (2008, 2009), and most other Bewley-type models where incomplete risk sharing is typically associated with higher capital accumulation. Furthermore, this prediction is obviously more consistent with the data than the alternative featured in the aforementioned class of models: our framework predicts that the least financially developed countries are the poorest ones, not the richest ones.[10]

The key for this difference is the type of risk featured in those models versus the type of risk in our model. In those models, agents face only idiosyncratic labor-income risk. This risk introduces a precautionary motive for saving, which reduces the interest rate, but does not break the equality between the interest rate and the marginal product of capital. In contrast, our model features entrepreneurial, or capital-income, risk. This risk introduces not only a precautionary motive, but also a positive wedge between the interest rate and the marginal product of capital; this wedge is the risk premium on private investment. It follows that, while incomplete risk-sharing necessarily encourages more capital accumulation in Bewley models by reducing the interest rate, it can discourage capital accumulation in our model by introducing the risk-premium wedge. The conditions in Assumption A1 then suffice for this wedge to dominate the reduction in the interest rate, thus guaranteeing that the capital stock is lower than under complete markets. Finally, the result that the autarchic capital stock is lower in the South than in the North reflects the fact that the wedge is higher in the South. Formally, this last result follows combining the facts that σ is higher in the South, that R is lower in the South, that the function $\mathbf{K}$ is necessarily decreasing in σ, and that, under Assumption 1, this function is also increasing in R for all $R \geq R_j^{aut}$.

Finally, part (iii) characterizes the steady-state level of consumption: it establishes, under Assumption 1, that the aggregate level of consumption is lower than its complete-markets counterpart in both countries, and more so in the South than in the North.

Combined, the above results show that, under autarchy, the South—the economy with more severe financial frictions—features a lower risk-free rate, a higher marginal product of capital, and lower levels of aggregate capital, wealth and consumption.

[10] This property is established above for the case of financial autarchy, but as we will see it extends also to the case of financial integration.

4.3 Financial Integration

We now proceed to our second main result, the characterization of the integrated steady state.

Proposition 3. *An integrated steady state exists, and it necessarily features the following properties:*

(i) The interest rate is given by R^{int}, where R^{int} solves $\sum_{j\in\{1,2\}} \mathbf{B}(R^{int},\tilde{\sigma}_j)\mathbf{K}(R^{int},\tilde{\sigma}_j) = 0$, and satisfies

$$R_2^{aut} < R^{int} < R_1^{aut} < \beta.$$

(ii) The capital stocks are given by $K_j^{int} = \mathbf{K}(R^{int},\tilde{\sigma}_j)$. Furthermore, under Assumption A1,

$$K_2^{aut} < K_2^{int} < K_1^{int} < K_1^{aut}$$

(iii) The foreign asset positions are given by $B_j^{int} = \mathbf{B}(R^{int},\tilde{\sigma}_j)K_j^{int}$ and satisfy

$$B_2^{int} > 0 > B_1^{int}$$

(iv) The consumption levels are given by $C_j^{int} = f(K_j^{int}) + R^{int}B_j^{int}$. Furthermore, under Assumption A1,

$$C_2^{aut} < C_2^{int} < C_1^{int} < C_1^{aut}$$

Part (i) establishes that the interest rate in the integrated steady state falls between the two autarchic values.

Part (ii) then establishes that the South has a higher capital stock than in autarchy. This is a direct implication of our earlier result in Lemma 2 that the function $\mathbf{K}$ is increasing in R and embodies the key prediction of our model for the long-run effects of financial integration: agents in the South enjoy a higher capital stock in the integrated steady state because a prolonged access to higher safe returns permits them to accumulate more wealth, and therefore to take more risk. The converse is true for the North.

Part (iii) then states that in the integrated steady state the South is a net creditor, while the North is a net debtor. As we will see in the next section, this steady-state position is attained after a long transition throughout which the North runs persistent current-account deficits (and, symmetrically, the South runs persistent current-account surpluses). This part thus contains the explanation that our model offers for global imbalances.

Finally, part (iv) spells out the implications for aggregate consumption: the South enjoys a higher level of consumption, both because it has accumulated more capital domestically and because it has accumulated a positive position against the North.

Parameters	Values
Preferences	
β	0.05
γ	8
θ	1
Technology	
α	0.40
δ	0.10
Risk	
$\tilde{\sigma}_1$	0.10
$\tilde{\sigma}_2$	0.40

Table 1. Benchmark Calibration Values.

5 Transitional dynamics

In this section we examine in more detail the dynamic responses of the two countries to the integration of their financial markets, starting an initial position that coincides with the autarchic steady states. For this purpose, we henceforth focus on a specific numerical exercise. However, it is important to keep in mind that the qualitative patterns we identify with this particular numerical exercise are robust to a wide range of parameters values as long as Assumption A1 is maintained.

5.1 Calibration

The two economies are parameterized by $(\alpha, \beta, \gamma, \delta, \theta, \tilde{\sigma}_1, \tilde{\sigma}_2)$, where α is the income share of capital, β is the discount rate, γ is the coefficient of relative risk aversion, δ is the depreciation rate, and θ is the elasticity of intertemporal substitution, and $\tilde{\sigma}_j$ is the undiversifiable risk in country j. Table 1 presents the parameter choices for the preferred parameterization of our model.

The time period is interpreted as one year. All the preference and technology parameters are then broadly consistent with the macro and macro-finance literature. In particular, the discount rate is $\beta = 0.05$. The elasticity of intertemporal substitution is $\theta = 1$, a value broadly consistent with recent micro and macro estimates,[11] while the coefficient of relative risk aversion is chosen to be $\gamma = 8$, a value commonly used in the macro-finance literature to help generate plausible risk premia. Finally, the depreciation rate is $\delta = 0.10$ and the share of capital in production is $\alpha = 0.4$.

We are then left with $\tilde{\sigma}_1$ and $\tilde{\sigma}_2$, the levels of undiversifiable idiosyncratic risk. Unfortunately, there is no direct measure of the rate-of-return risk faced by the "typical" investor or entrepreneur, even in the US economy. However, there are various indications that investment risks are significant.

[11] See Angeletos (2007) for a more thorough discussion of the relevance of this parameter within the type of model we have employed here, and also for references on the empirical estimates of this parameter.

For instance, the probability that a privately held firm survives five years after entry is less than 40%. Furthermore, even conditional on survival, the risks faced by entrepreneurs and private investors appear to be very large: as Moskowitz and Vissing-Jørgensen (2002) document, not only is there a dramatic cross-sectional variation in the returns to private equity, but also the volatility of the book value of a (value-weighted) index of private firms is twice as large as that of the index of public firms—one more indication that private equity is more risky than public equity. Note then that the standard deviation of annual returns is about 15% per annum for the entire pool of public firms; it is over 50% for a single public firm (which gives a measure of firm-specific risk); and it is about 40% for a portfolio of the smallest public firms (which are likely to be similar to large private firms).

Given this suggestive evidence, and lacking any better alternative, we let the levels of undiversifiable risk for the North and the South be, respectively, $\tilde{\sigma}_1 = 0.10$ and $\tilde{\sigma}_2 = 0.40$. If we think of the North as the United States and the South as a developing economy, these values are not implausible—one could even argue that they are rather conservative. In any event, the precise values of these parameters are not essential for the qualitative patterns we identify below—all that matter is that the North has a lower level of risk than the South.

5.2 Dynamic Responses

In this section we examine the entire impulse responses of both economies to financial integration. Both economies start at their respective autarchic steady states. Subsequently, the economies integrate their bond (financial) markets. We then track the entire transition of both economies towards their new integrated steady state.

Tracking the transitional dynamics of incomplete-market models is often a daunting exercise. This is not the case for our model, thank to the low dimensionality of the general equilibrium system. In particular, note from Lemma 1 that, when the EIS is $\theta = 1$, the marginal propensity to consume out of total wealth reduces to $m_{jt} = \beta$ for all j, t. It then follows from Proposition 1 that the transitional dynamics of the world economy can be reduce to a simple system of four first-order ODE's in $(X_{jt}, H_{jt})_{j\in\{1,2\}}$, where $X_{jt} \equiv K_{jt} + B_{jt}$. Our numerical algorithm then works as follows. First, we solve for both the autarchic and the integrated steady-state aggregates. Next, we numerically solve the aforementioned ODE system using the autarchic steady-state values of capital, $X_{j0} \equiv K_j^{aut}$, as initial conditions and the integrated steady-state values of human wealth, H_j^{int}, as boundary conditions.

The dynamic path of the South is illustrated in Figure 2, and that of the North in Figure 3. Time in years is on the horizontal axis, and levels of several variables are on the vertical axis. The blue lines indicate the levels of the variables at the autarchic steady state. The red lines indicate the levels of the variables at the integrated steady state. The black lines show the dynamic response of the variables.

Figure 2 shows that, immediately upon integration, the capital stock in the South falls below its autarchic steady-state level. But after this initial fall, the capital stock starts recovering. In fact, it is back to the autarchy level in about thirty years and it keeps increasing after that, eventually asymptoting to the new, higher, integrated steady state. In other words, the South faces a bleak picture in the short run, with a significant outflow of capital immediately after integration, but this picture is reversed in the long run, as capital starts fly back into the country, eventually reaching a higher level than under autarchy. In particular, the capital stock in the South falls by almost 7% immediately after integration, compared to its autarchic steady state. But, at the long-run integrated steady state, the capital stock in the South has increased almost 18% above its autarchic level. The same qualitative picture is true for the other aggregate variables, such as aggregate output, consumption, and the wage. For example, aggregate output in the South falls by almost 3% in the short run, and it increases by almost 7% in the long run, compared to its autarchic value.

Figure 3 demonstrate the exact opposite picture for the North. Immediately upon integration, the North experiences an inflow of capital, and capital remains above its autarchic level for about a hundred years. However, in the long run, that is in about five hundred years, capital settles at an integrated level lower than the autarchic one. The same is true for the other aggregate variables. The interest rate jumps down from the autarchic steady state upon integration, and it settles at an even lower level in the long run. Finally, in the long run the North ends up borrowing from the South. In other words, the North experiences an initial period of prosperity, put in the long run this picture is reversed. For example, capital in the North increases by about 3.5% upon integration, but it falls by about 5% in the long-run steady state, compared to its autarchy level. And aggregate output in the North increases by 1.5% upon integration, but it falls by 2% in the long run, compared to autarchy.

The intuition behind these results is as follows. While in autarky, the South faces higher levels of idiosyncratic risk and therefore features a higher demand for precautionary saving than the North. This stronger precautionary motive keeps the domestic (risk-free) interest rate suppressed in the South relative to the North. Upon integration, however, the precautionary savings of the South are partly absorbed by the North, implying that the domestic interest rate has to increase in the South (and decrease in the North). This in turn has very different implications for the macroeconomic outcomes of the South depending on whether we look at the short or the long run. In the short run, the increase in interest rates means an increase in the opportunity cost of capital, causing a reduction in the capital stock of the South. In the long run, however, this increase in interest rates permits the residents of the South to accumulate more wealth. As they do so, they become willing to undertake more investment risk, which explains why the capital stock recovers over time. The fact that the capital stock eventually increases beyond its autarchic value then follows from Proposition 3.

Finally, note that, along the transition to the new steady state, the South runs significant current account surpluses, so that it keeps increasing its financial position abroad. Conversely, the North runs significant current account deficits, eventually reaching a dramatic level of foreign debt, equal to about 9 times its GDP. Clearly, this is the manifestation of the precautionary savings of the South rushing for safety in the North.

Our findings thus provide an explanation of "global imbalances" that is similar to the one in Mendoza et. al. (2008) in that it rests on the presence of a stronger precautionary motive in the South than in the North. At the same time, our findings providing a novel perspective on the ongoing debate on the cost and benefits of capital-market liberation. In particular, while many fear that such a reform may cause an outflow of capital, here we find that this effect is indeed valid in the short run, but we also find that this effect is reversed once enough time has passed.

At this point, it is also worthwhile noting that the magnitude of the effects depends critically on the share of capital in production. Figure 4 shows the dynamic responses of the aggregate capital stock in the two countries for a "broader" definition of the capital stock: all parameters are the same as in the benchmark calibration, except for the income share of capital, which is now set at $\alpha = 0.60$.

6 Extension: Shortage of Safe Assets

In this section we consider a variant of our model that introduces a "storage technology", namely a technology that provides the economy with a safe store of value—this technology has a lower mean return than entrepreneurial activity, but entails no risk. We further assume that this storage technology is better in the North than in the South. What we thus capture with this variant is the idea that the less developed countries may have a relative shortage of safe assets, due to weaker enforcement of property rights. As mentioned in the Introduction, this builds a bridge between our paper and that of Caballero, Farhi and Gourinchas (2008).

To focus on this possibility, we now assume that the countries do not differ in the amount of risk in their "entrepreneurial sector": $\tilde{\sigma}_1 = \tilde{\sigma}_2$. Instead, the North is now identified solely by its ability to access a better storage technology. This storage technology can also be interpreted as a sector in which all idiosyncratic risks are diversified—think of this as the "public equity sector".[12] The

[12] However, see Panousi and Papanikolaou (2009) for some evidence that idiosyncratic risks are relevant for investment decisions even within the public-equity sector.

production function in the storage technology has the form $g_j(M_{jt}) = A_j^{1-\alpha} M_{jt}^{\alpha}$, where M_{jt} is the level of capital in the safe sector, and A_j determines the size of the public or safe sector relative to the size of the private or risky sector. Therefore total aggregate capital is $K_{jt}^{total} = K_{jt} + M_{jt}$, aggregate financial wealth is $X_{jt} = K_{jt} + M_{jt} + B_{jt}$, and aggregate wealth is $W_{jt} = K_{jt} + M_{jt} + B_{jt} + H_{jt}$. The storage technology provides a safe asset in positive net supply in the autarchic economy, while agents still have access to the bond, which is a safe asset in zero net supply in autarchy. The key assumption here is that $A_1 > A_2$, meaning that the South can create safe assets at a lower efficiency than the North.

Clearly, in equilibrium the risk-free rate must satisfy $R_t = g_j'(M_t)$ for country j. This pins down the stock of safe assets in the South as an increasing function of the interest rate. The rest of the equilibrium characterization then proceeds in similar lines as in our benchmark model. In particular, the general-equilibrium dynamics under either autarchy or integration are given by the following, which is a direct adaptation of Proposition 1 to the introduction of a storage technology for each country. The analysis of such a variant, as well as the quantification of our mechanism, is left for future work.

Proposition 4. *In either the autarchic or the integrated equilibrium, the aggregate dynamics of country j satisfy the following ODE system*

$$\begin{gathered}
C_{jt} + \dot{K}_{jt} + \dot{M}_{jt} + \dot{B}_{jt} = f\left(K_{jt}\right) - \delta K_{jt} + g_j\left(M_{jt}\right) - \delta M_{jt} + R_{jt} B_{jt} \\
\frac{\dot{C}_{jt}}{C_{jt}} = \theta\left(\hat{\rho}_{jt} - \beta\right) + \tfrac{1}{2}\gamma \tilde{\sigma}_j^2 \phi_{jt}^2 \\
\dot{H}_{jt} = R_{jt} H_{jt} - (1-\alpha) f(K_{jt}) \\
B_{jt} = (1-\phi_{jt})(K_{jt} + B_{jt}) - \phi_{jt} H_{jt} \\
R_{jt} = g_j'(M_{jt})
\end{gathered}$$

where $\phi_{jt} = \phi(K_{jt}, R_{jt}, \tilde{\sigma}_j)$ and $\hat{\rho}_{jt} = \hat{\rho}(K_{jt} R_{jt}, \tilde{\sigma}_j)$. The autarchic equilibrium is then obtained by letting $R_{1t} \neq R_{2t}$ and requiring that, for each j, R_{jt} adjusts so that

$$B_{jt} = 0. \tag{21}$$

In contrast, the integrated equilibrium is obtained by imposing $R_{1t} = R_{2t} = R_t$ and requiring that R_t adjusts so that

$$B_{1t} + B_{2t} = 0 \tag{22}$$

Parameters	Values
Preferences	
β	0.05
γ	8
θ	1
Technology	
α	0.40
δ	0.10
A_1	0.45
A_2	0
Risk	
$\tilde{\sigma}_1$	0.40
$\tilde{\sigma}_2$	0.40

Table 2. Calibration Values with Storage Technology.

6.1 Calibration

The economies are now parameterized by (α, β, γ, δ, θ, $\tilde{\sigma}_1$, $\tilde{\sigma}_2$, A_1, A_2). Table 2 presents our parameter choices. Here, most parameters are as in our benchmark model, except for the fact that the level of idiosyncratic risk is now the same in both countries at $\tilde{\sigma}_1 = \tilde{\sigma}_2 = 0.40$. As anticipated, we set the level of risk to be the same in both countries in order to isolate the impact of differences in the capacity to produce safe assets. For simplicity, and without serious loss of generality, we set $A_2 = 0$, in which case $M_{2t} = 0$; that is, we take the extreme scenario where the South has no ability to produce safe assets. Finally, we choose $A_1 = 0.45$, because this ensures that, at the autarchic steady state, total capital in the North is allocated equally between the two sectors of production. This choice is somewhat arbitrary but is motivated by the experience of the United States, where about one half of the capital stock is owned by the private-equity sector and the other half by the public-equity sector.

6.2 Dynamic Responses

We now consider the dynamic response of the two economies to financial integration, starting from autarchy. The transitional dynamics once again reduce to a simple ODE system in $(X_{1t}, X_{2t}, H_{1t}, H_{2t})$, except that now $X_{jt} \equiv K_{jt} + M_{jt} + B_{jt}$. The dynamics of the South are presented in Figure 5, the dynamics of the North in Figure 6. As before, time in years is on the horizontal axis, the blue lines indicate the levels of the variables at the autarchic steady state, the red lines indicate the levels of the variables at the integrated steady state, and the black lines show the dynamic response of the variables.[13]

As in the baseline model, the North is richer than the South in autarchy, and features higher interest rates. However, this is not anymore because the entrepreneurial sector is riskier in the South—the entrepreneurial sectors have now been assumed to have the same risk in both economies. Rather, it is because the safe asset is in positive supply in the North—this limits both the precautionary pressures on domestic interest rates and the risk premium in the entrepreneurial sector. As a result, relative to the South, the North has both a higher interest rate and a higher capital-labor ratio in the entrepreneurial sector.

The dynamic responses upon financial integration then mimic those in the baseline model. Once again, the short run looks bleak for the South, with an outflow of capital to the North. But as the Southerners get richer over time by getting access to the safe assets of the North, they become more willing to undertake risk, and they return to the South in order to take advantage of the higher capital returns in the entrepreneurial sector there. Hence, in the long run the picture is reversed, and the South ends up with a higher capital stock than it had under autarchy. The opposite is true for the North.

Figures 5 and 6 present the dynamic responses of the North and the South, respectively. In the short run, aggregate capital in the South drops by -4.3% whereas in the North it increases by 1.9%. In the long run, aggregate capital in the South increases by 10.8% whereas in the North it drops by 2.6%.

Interestingly, the dynamic adjustment of the economies now also features changes in the measure TFP, as capital gets reallocated between the two sectors within each country. In the North, aggregate TFP, as measured by the Solow residual,[14] falls by 2.3% between the autarchic and the integrated steady state. If we had allowed for some storage in the South, the converse picture would emerge for the measured TFP of this country: its Solow residual would grow between the autarchic and the integrated steady states.

At the same time, it remains true, as in the baseline model, that the North runs current account deficits, while the South runs current account surpluses. It follows that our model can solve the empirical "puzzle" documented by Gourinchas and Jeanne (2008). This worked show that capital appears to flow from countries that experience positive higher growth to countries that experience lower productivity growth. While this fact is inconsistent with the standard neoclassical growth paradigm, it is consistent with our model.

[13]Note that here aggregate capital is given by $K_{jt}^{total} = K_{jt} + M_{jt}$.

[14]With the amount of labor normalized to 1, the Solow residual is given by approximately $SR_{1t} \equiv ln(Y_{jt}) - \alpha ln(K_{jt} + M_{jt})$.

7 Conclusion

This paper studies the global macroeconomic implications of financial integration within a Bewley-type model that feature idiosyncratic investment, or entrepreneurial risk. The key lessons we obtained can be summarized as follows. When the South is in financial autarchy, the domestic (risk-free) interest rate is depressed relative to the North because of a strong precautionary demand for saving. Upon financial integration, some of the South's precautionary saving can find outlet in the North—thus giving rise to global imbalances and also raising the interest rate in the South. This increase in the interest rate increases the opportunity cost of capital, implying a reduction in investment and output in the South. However, as time passes, agents in the South accumulate more wealth due to the higher safe returns they now enjoy in the North. In the process, they become more willing (or able) to engage in risky entrepreneurial activities or otherwise to invest in high-return, but risky, domestic investment opportunities. This in turn opens the door to a "reversal of fortune" in the long run: while capital initially flows out of the South, it starts flowing back after some transitional period, eventually leading to higher output, wages, and consumption than under autarchy. Our paper therefore provides not only an explanation of global imbalances, but also a distinct input to the ongoing debate on the costs and benefits of capital account liberalization.

Furthermore, because the aforementioned transition in the South may feature a reallocation of capital from safe but low-return activities to risky but high-return ones, measured TFP in the South may increase along the transition. Conversely, the North may experience a drop in TFP (or a lower growth rate than the South). Along with the property that the South runs current account surpluses, while the North runs current account deficits, this implies our model predicts that capital flows from the faster growing countries to the slower growing countries—a prediction that is the opposite of the one made by the standard neoclassical paradigm and that helps resolve the empirical puzzle documented by Gourinchas and Jeanne (2008).

Underlying these results were a two key properties. First, a positive wedge was present between the marginal product of capital and the risk-free rate. Second, this wedge was decreasing in wealth. In our model, the first property was due to undiversified idiosyncratic risk and the second due to deminishing absolute risk aversion. However, these properties may also emerge in models with borrowing constraints: these models typically feature a positive wedge between the marginal product of capital (internal returns) and the interest rate faced by savers (external returns), but this wedge vanishes as wealth increases and the borrowing constraint is overcome. We thus conjecture that similar results would obtain in a variant of our model that would introduce borrowing constraints on investment/entrepreneurial activity.

Appendix

Proof of Lemma 1 (individual policy rules). This result is essentially a variant of the Merton-Samuelson optimal portfolio problem; see also Proposition 1 in Angeletos and Panousi (2009).

Proof of Proposition 1 (equilibrium dynamics). For simplicity, we drop the index j. Since aggregate labor demand is $\int_i n_t^i = \bar{n}(\omega_t)K_t$ and aggregate labor supply is 1, the labor market clears if and only if $\bar{n}(\omega_t)K_t = 1$. It follows that the equilibrium wage satisfies $\omega_t = F_L(K_t, 1)$ and, similarly, the equilibrium mean return to capital satisfies $\bar{r}_t = F_K(K_t, 1) - \delta$. The bond market, on the other hand, clears if and only if $B_t = 0$, or equivalently $(1 - \phi_t)W_t - H_t = 0$. Combining this with $K_t = \phi_t W_t$ gives condition (17).

Combining the intertemporal government budget with the definition of human wealth, we get

$$H_t = h_t = \int_t^\infty e^{-\int_t^s R_j dj}(\omega_s - G_s)ds. \tag{23}$$

Expressing this in recursive form gives condition (16).

Let $\bar{\rho}_t \equiv \phi_t \bar{r}_t + (1 - \phi_t)R_t$ denote the *mean* return to total saving. Aggregating the household budgets gives $\dot{W}_t = \bar{\rho}_t W_t - C_t$. Combining this with (16) and with $K_t + H_t = W_t$, we get that $\dot{K}_t = \dot{W}_t - \dot{H}_t = (\bar{\rho}_t W_t - C_t) - (R_t H_t - \omega_t + G_t)$. Using $\bar{\rho}_t W_t = \bar{r}_t \phi_t W_t + R_t (1 - \phi_t) W_t = \bar{r}_t K_t + R_t H_t$, we get $\dot{K}_t = \bar{r}_t K_t + \omega_t - C_t - G_t$. Together with the fact, in equilibrium, $\bar{r}_t K_t + \omega_t = F(K_t, 1) - \delta K_t$, this gives condition (14), the resource constraint.

Finally, using $C_t = m_t W_t$, and therefore $\dot{C}_t/C_t = \dot{m}_t/m_t + \dot{W}_t/W_t$ together with $\dot{W}_t = \bar{\rho}_t W_t - C_t = (\bar{\rho}_t - m_t) W_t$ and (10), gives condition (12), the aggregate Euler condition.

Proof of Lemma 2. (i) The form of the function **K** is evident from condition (16), while the form of the function **B** follows from condition (17).

(ii) Since $K(R) = \left[\frac{\mu(R)+\delta+R}{\alpha}\right]^{\frac{1}{\alpha-1}}$, it follows that K_R has the same sign as $\frac{1}{\alpha-1}(\mu_R + 1)$. Since $\mu(R) = (\frac{2\theta\gamma\tilde{\sigma}^2}{1+\theta}(\beta - R))^{1/2}$, we get that $\mu_R = (-\frac{1}{2}\frac{2\theta\gamma\tilde{\sigma}^2}{1+\theta})^{1/2}(\beta - R)^{-1/2}$. Using this, we have that $K_R > 0 \Leftrightarrow R > \beta - \frac{1}{2}\frac{\theta\gamma\tilde{\sigma}^2}{\theta+1} \equiv \hat{R}(\tilde{\tilde{\sigma}}) < \beta \equiv \bar{R}$.

In addition, since $\dot{W}_t = \bar{\rho}_t W_t - C_t = (\bar{\rho}_t - m_t) W_t$, wealth stationarity requires $\bar{\rho} = m$. Combining this with the Euler equation in steady state, we get

$$\frac{\theta + 1}{2}\phi(f'(K) - \delta - R) - \theta(\beta - R) = 0.$$

From this, and for steady-state capital to be lower than under complete markets, that is, for $f'(K) -$

$\delta > \beta$, it has to be the case that

$$\frac{\theta+1}{2}\phi(\beta-R)-\theta(\beta-R)<0,$$

which, since $\beta - R > 0$, gives $\theta > \phi/(2-\phi)$ or $\phi < \theta/(\theta+1)$.

(iii) Since $K(R) = \left[\frac{\mu(R)+\delta+R}{\alpha}\right]^{\frac{1}{\alpha-1}}$ it follows that $K_{\tilde{\sigma}}$ has the same sign as $-\mu_{\tilde{\sigma}}$. Since $\mu(R) = (\frac{2\theta\gamma\tilde{\sigma}^2}{1+\theta}(\beta-R))^{1/2}$, we get that $\mu_{\tilde{\sigma}} = \frac{\theta\gamma}{1+\theta}(\frac{2\theta\gamma\tilde{\sigma}^2}{1+\theta})^{-1/2}(\beta-R)$. Using this, we have that $K_{\tilde{\sigma}} < 0$.

(iv) We have that

$$B(R) = -(1-\alpha)\frac{K(R)^{\alpha}}{R} + \frac{1-\phi(R)}{\phi(R)}K(R). \tag{24}$$

Consider the limits of B as $R \to 0^+$ and $R \to \beta^-$. Note that $\mu(0) = (\frac{2\theta\gamma\tilde{\sigma}^2}{1+\theta}\beta)^{1/2}$ is finite and hence both $\phi(0)$ and $K(0)$ are finite. It follows that

$$\lim_{R\to 0^+} B(R) = -(1-\alpha)K(0)^{\alpha}\lim_{R\to 0^+}\frac{1}{R} + (\frac{1}{\phi(0)}+1)K(0) = -\infty.$$

Furthermore, $\mu(\beta) = 0$, implying $\phi(\beta) = 0$ and $K(\beta) = K_{compl} \equiv (f')^{-1}(\beta)$ is finite. It follows that

$$\lim_{R\to\beta^-} B(R) = -(1-\alpha)K(\beta)^{\alpha}\frac{1}{\beta} + \lim_{R\to\beta^-}(\frac{1}{\phi(R)}+1)K(\beta) = +\infty.$$

Next, note that, from (24),

$$\frac{\partial B}{\partial R} = -(1-\alpha)\frac{K(R)^{\alpha}}{R^2}\left[\alpha R\frac{K'(R)}{K(R)}-1\right] - \frac{\phi'(R)}{\phi(R)^2}K(R) + \frac{1}{\phi(R)}K'(R). \tag{25}$$

Now note that, since $K(R) = \left[\frac{\mu(R)+\delta+R}{\alpha}\right]^{\frac{1}{\alpha-1}}$ and $\phi(R) \equiv \sqrt{\frac{2\theta}{\gamma\tilde{\sigma}^2(1+\theta)}(\beta-R)}$, we have

$$K^{\alpha-1} = \frac{f'(K)}{\alpha}, \quad \frac{K'}{K} = \frac{1}{\alpha-1}\frac{\mu'+1}{f'(K)}, \quad \text{and} \quad \frac{\phi'}{\phi^2} = \frac{\gamma\tilde{\sigma}^2\mu'}{\mu^2},$$

where we suppress the dependence of K, μ, and ϕ on R for notational simplicity. It follows that

$$\frac{\partial B}{\partial R} = -\frac{1-\alpha}{\alpha}\frac{R\mu'+R-f'(K)}{R^2} - \frac{\gamma\tilde{\sigma}^2\mu'}{\mu^2}.$$

Since $\mu'(R) < 0$ and $R < f'(K(R))$ for all $R \in (0,\beta)$, we have that $\partial B/\partial R > 0$ for all $R \in (0,\beta)$.

(v) Using the formulas for $\mu(R)$ and $\phi(R)$ from above, we get

$$\frac{\partial \mathbf{B}}{\partial \tilde{\sigma}} = \frac{\partial}{\partial \tilde{\sigma}}(\frac{B}{K}) = \frac{\partial}{\partial \tilde{\sigma}}(\phi^{-1} - 1 - (1-\alpha)K^{\alpha-1}R^{-2}) = -\phi^{-2}\phi_{\tilde{\sigma}} - \frac{1-\alpha}{\alpha}R^{-1}\mu_{\tilde{\sigma}}$$

where $\phi_{\tilde{\sigma}} = -\frac{1}{\tilde{\sigma}^2}(\frac{2\theta(\beta-R)}{\gamma(1+\theta)})^{1/2}$ and $\mu_{\tilde{\sigma}} = (\frac{2\theta\gamma(\beta-R)}{1+\theta})^{1/2}$. Substituting this into $\frac{\partial \mathbf{B}}{\partial \tilde{\sigma}} > 0$ yields

$$R > \frac{2\theta\beta(1-\alpha)}{\alpha + \theta(2-\alpha)} \equiv \underline{R} < \bar{R} \equiv \beta.$$

Proof that the first part of Assumption 1 implies its second part. For simplicity, we drop the index j. After some algebra using the definitions of $\hat{R}$ and $\underline{R}$, we get

$$\hat{R} < \underline{R} \Leftrightarrow \tilde{\sigma} < \frac{2\alpha\beta(1+\theta)}{\theta\gamma(\alpha + \theta(2-\alpha))}$$

In this region of interest rates, $K_R > 0$, and therefore $\phi < \theta/(1+\theta)$. Next, let $f(K) = K^\alpha$, $\hat{f}(K) = K^\alpha + \delta K$, and $s \equiv \delta K/\hat{f}$. We have that

$$\frac{1-\phi}{\phi} = \frac{H}{K} = \frac{\omega}{RK} = \frac{f(K) - f'(K)K}{RK} > \frac{f/K - f'}{f'}$$

and therefore

$$\phi < \frac{\hat{f}'K/\hat{f} - \delta K/\hat{f}}{1 - \delta K/\hat{f}} = \frac{\alpha - s}{1-s}.$$

For $\tilde{\sigma}$ very small, $\phi \simeq \frac{\alpha-s}{1-s}$, which implies that $K_R > 0 \Leftrightarrow \frac{\alpha-s}{1-s} < \frac{\theta}{1+\theta}$.

Proof of Proposition 2. (i) This part follows from the proof of Lemma 2, part (iii). The limits of $B(R)$, together with the continuity of $B(R)$ in R, establish the existence of an R that solves $B(R) = 0$. This is in fact the unique steady-state R, since $B_R > 0$ always.

(ii) The equation $\mathbf{B}(R_j^{aut}, \tilde{\sigma}_j) = 0$ is simply bond market clearing for each country. Under Assumption 1, we are in the region where $\mathbf{B}_{\tilde{\sigma}} > 0$. From (1) we have that $\mathbf{B} = B/K \equiv D$. Using a proof similar to that in Proposition 1(iv), we get that $D_R < 0$. Hence, $\mathbf{B}_R < 0$. We also have that $\mathbf{B}_{\tilde{\sigma}} = B_R R_{\tilde{\sigma}} > 0$, with $B_R < 0$. Therefore, it has to be that $R_{\tilde{\sigma}} < 0$ in autarky. In other words, $R_1^{aut} > R_2^{aut}$.

(iii) Under Assumption 1, we are in the region where $K_R > 0$. Hence, the fact that $R_1^{aut} > R_2^{aut}$ implies that $K_1^{aut} > K_2^{aut} > 0$. Since consumption is increasing in capital, we also have that $C_1^{aut} > C_2^{aut}$.

Proof of Proposition 3. (i) Consider the function $\mathbf{WB}(R)$ defined by

$$\mathbf{WB}(R) \equiv \mathbf{B}(R, \tilde{\sigma}_1)\mathbf{K}(R, \tilde{\sigma}_1) + \mathbf{B}(R, \tilde{\sigma}_2)\mathbf{K}(R, \tilde{\sigma}_2)$$

An integrated steady state is given by any solution to $\mathbf{WB}(R) = 0$. Note that the function $\mathbf{K}$ is always positively valued, while the function $\mathbf{B}$ can take both signs and is increasing in R and $\tilde{\sigma}$. Furthermore, recall that $R_2^{aut} < R_1^{aut}$. Whenever $R \leq R_2^{aut} (< R_1^{aut})$, by the monotonicity of $\mathbf{B}$ in R we have that $\mathbf{B}(R, \tilde{\sigma}_2) \leq \mathbf{B}(R_2^{aut}, \tilde{\sigma}_2) = 0$ and $\mathbf{B}(R, \tilde{\sigma}_1) < \mathbf{B}(R_2^{aut}, \tilde{\sigma}_2) = 0$; it follows that $\mathbf{WB}(R) < 0$. Similarly, whenever $R \geq R_1^{aut}$, we have that $\mathbf{WB}(R) > 0$. Along with the fact that the function $\mathbf{WB}(R)$ is continuous in R, this implies that a solution R^{int} to $\mathbf{WB}(R) = 0$ always exists and it necessarily satisfies $R_2^{aut} < R^{int} < R_1^{aut}$.

(ii) Since $K_{\tilde{\sigma}} < 0$, it follows that $K_1^{int} > K_2^{int}$, Since Assumption A1 ensures that $K_R > 0$, and using (i), we get the desired result.

(iii) Under Assumption A1, we are in the area where $\mathbf{B}_{\tilde{\sigma}} > 0$, which implies that $B_1^{int} < B_2^{int}$, and since the world bond market has to clear, this means that $B_1^{int} < 0 < B_2^{int}$.

(iv) This part follows directly from parts (ii) and (iii).

Proof of Proposition 4 (storage). This follows from a direct adaptation of Proposition 1, replacing B_{jt} with $B_{jt} + M_{jt}$ in all the conditions of this proposition and adding the new optimality condition $R_{jt} = g_j'(M_{jt})$.

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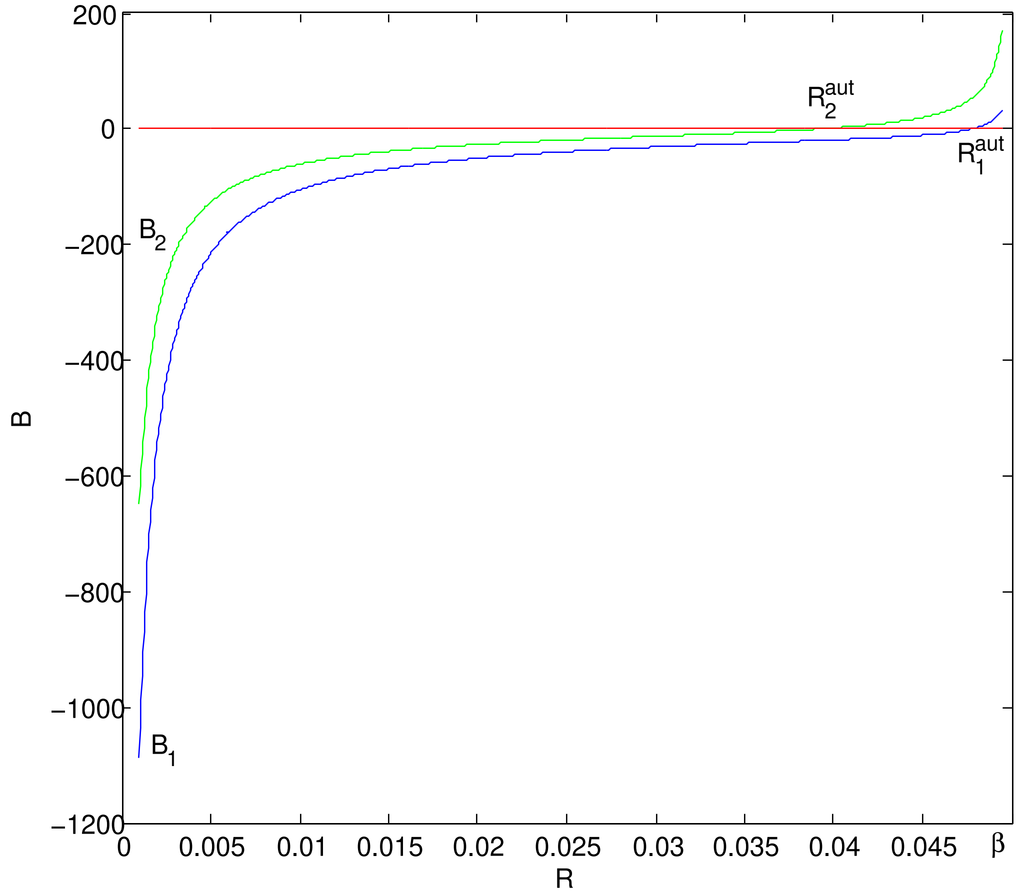
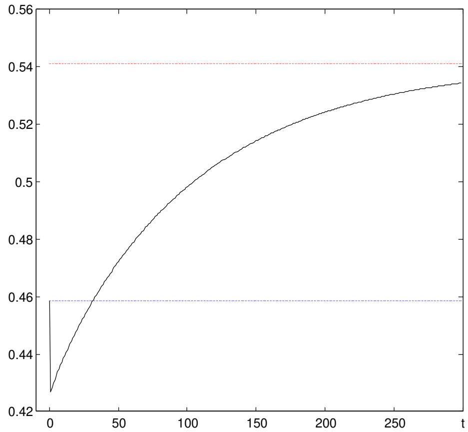
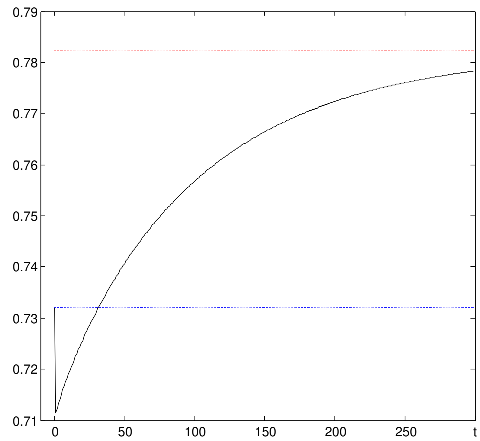


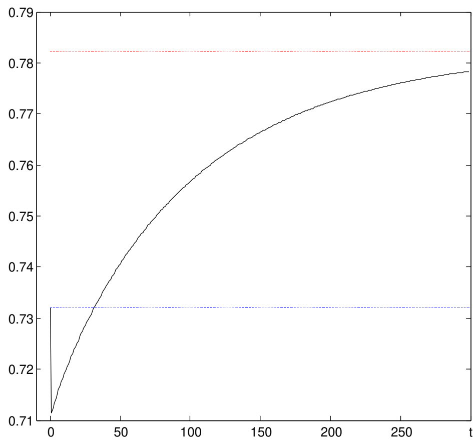
Figure 1: ***Autarchic Steady States.*** *The interest rate is on the horizontal axis. The blue line is the function $B(R)$ for the North. The green line is the function $B(R)$ for the South. The intersection of the $B(R)$-curves with the red zero line gives the autarchic interest rates, where $R_2^{aut} < R_1^{aut}$.*



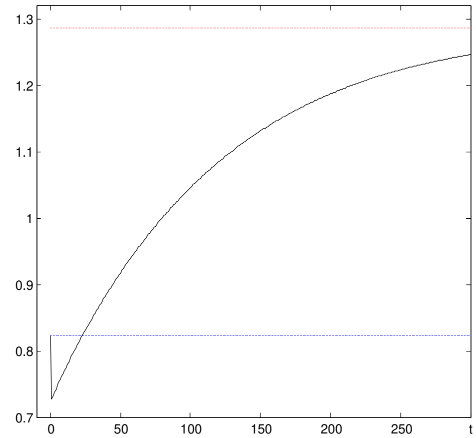
(a) Aggregate Capital Stock



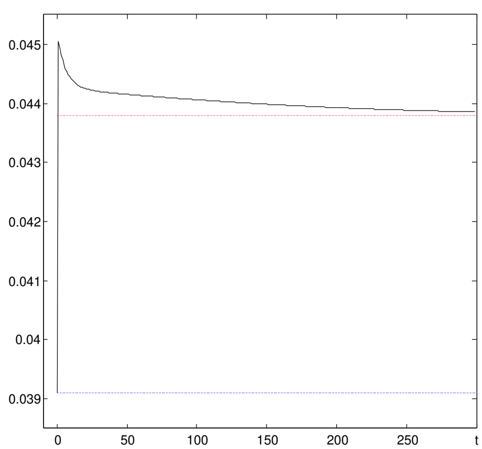
(b) Aggregate Output



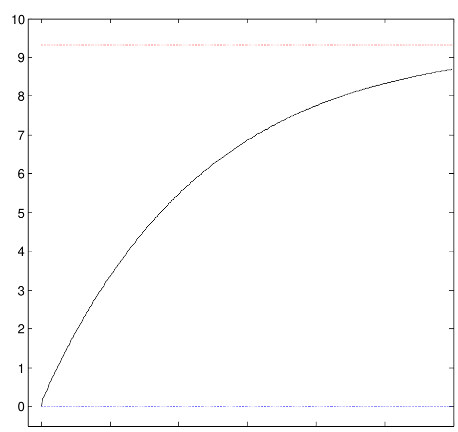
(c) Wage



(d) Aggregate Consumption

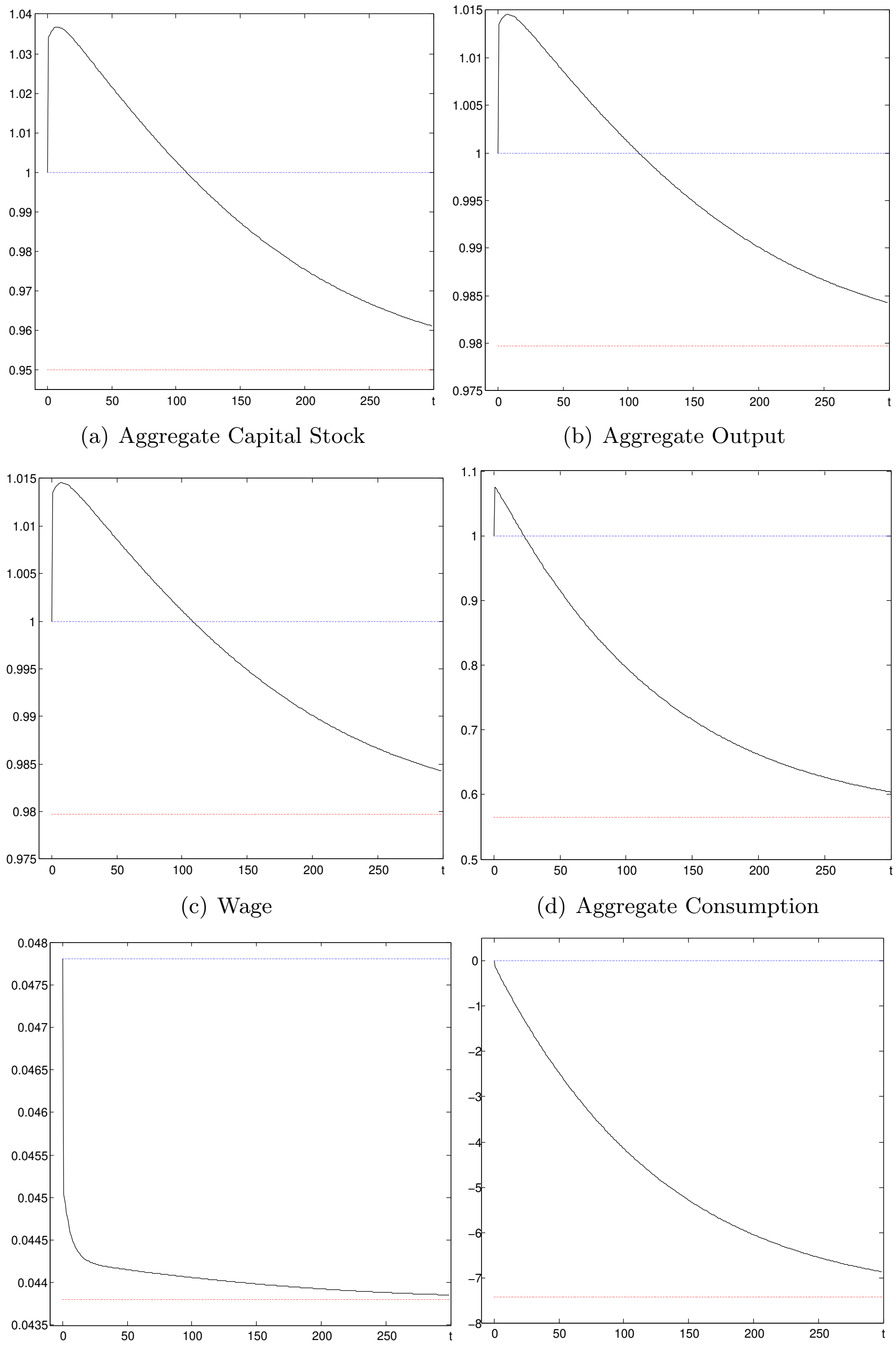


(e) Interest Rate



(f) Net Foreign Asset Position

Figure 2: ***Dynamics of the South.*** *Time in years is on the horizontal axis. The economies are integrated at time zero. The blue line indicates the value of the variables in the autarchic steady state. The red line indicates the value of the variables in the integrated steady state. The black line indicates the dynamic path of the variables. Capital, output, consumption, and the wage are normalized by the corresponding autarchy values of the North. The net foreign asset position is given as a fraction of GDP.*

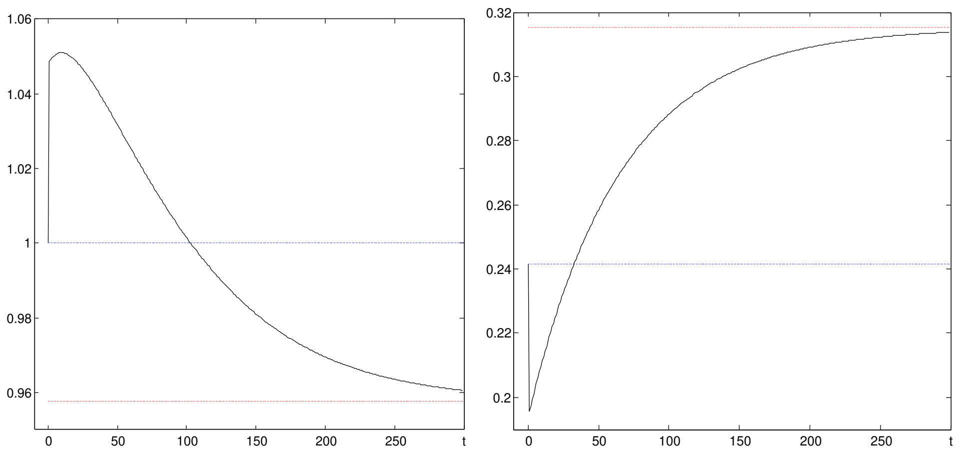


(a) Aggregate Capital Stock (b) Aggregate Output

(c) Wage (d) Aggregate Consumption

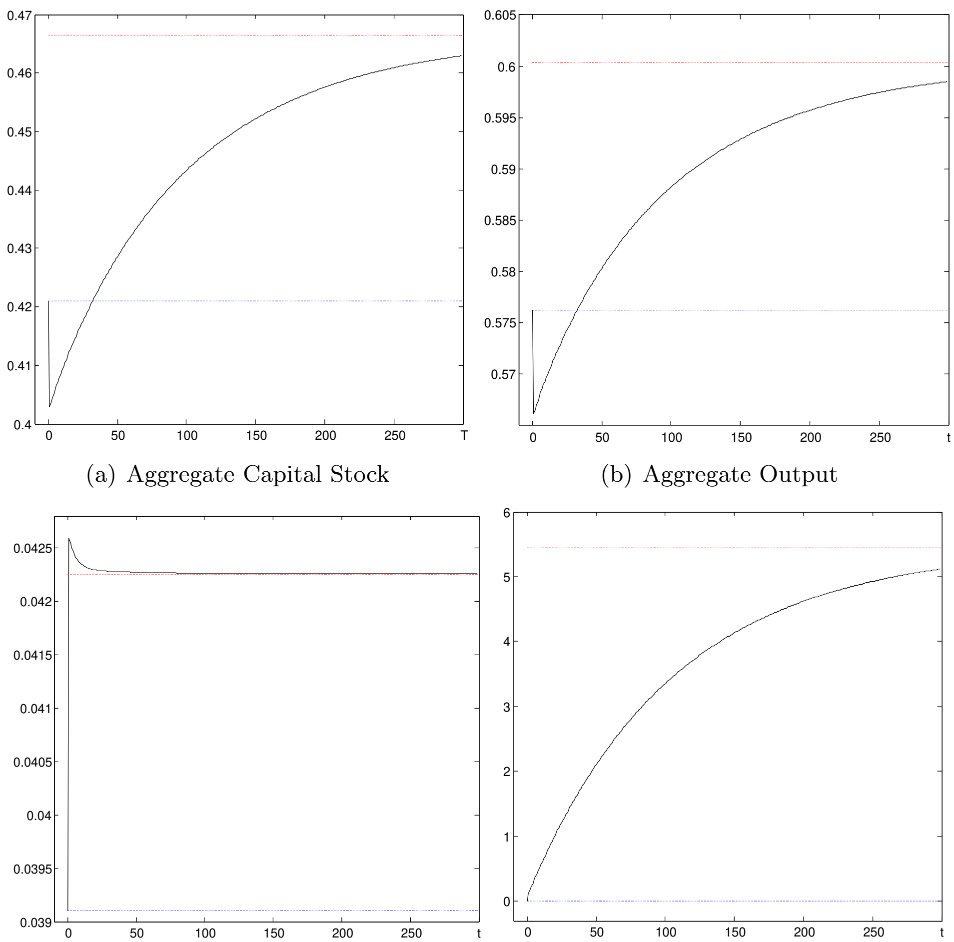
(e) Interest Rate (f) Net Foreign Asset Position

Figure 3: ***Dynamics of North.*** *Time in years is on the horizontal axis. The economies are integrated at time zero. The blue line indicates the value of the variables in the autarchic steady state. The red line indicates the value of the variables in the integrated steady state. The black line indicates the dynamic path of the variables. Capital, output, consumption, and the wage are normalized by their corresponding autarchy values. The net foreign asset position is given as a fraction of GDP.*



(a) Aggregate Capital Stock of North   (b) Aggregate Capital Stock of South

Figure 4: ***A broad definition of capital.*** *This figure revisits the dynamic adjustment the North and the South when* $\alpha = 0.6$. *As in Figures 1 and 2, the economies are integrated at time zero the variables are normalized by the Northern autarchic values.*



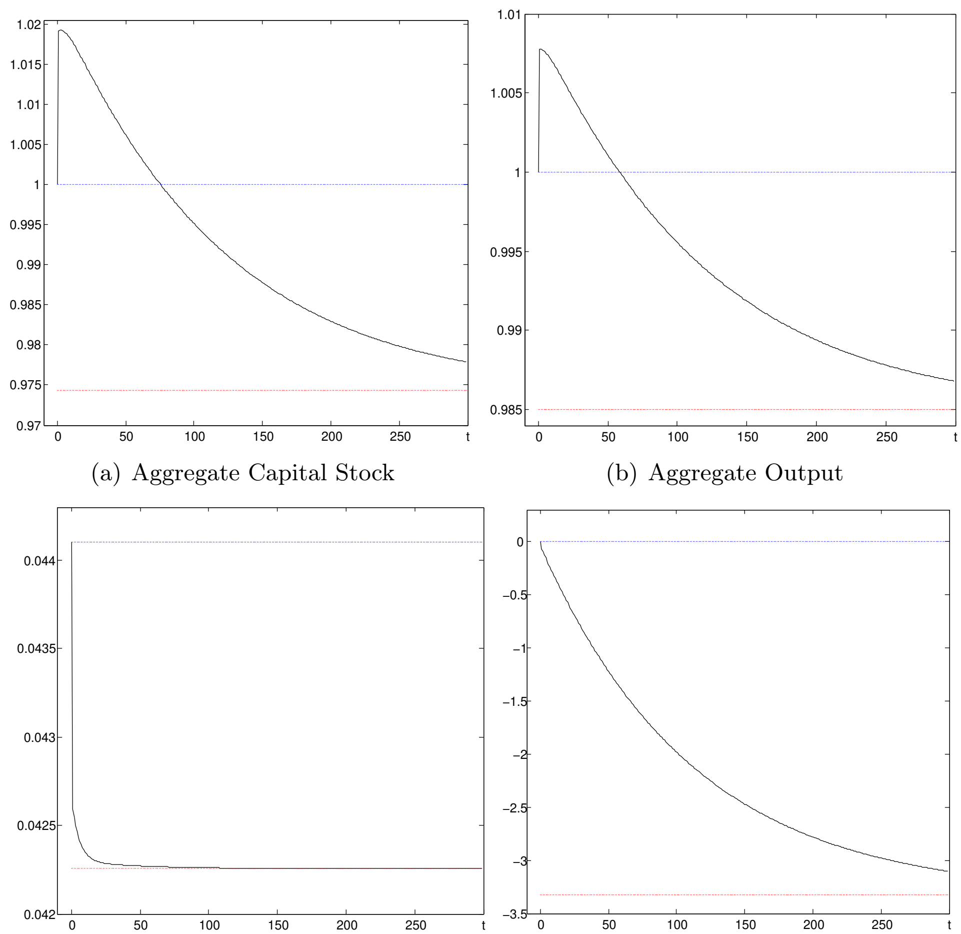
(a) Aggregate Capital Stock

(b) Aggregate Output

(c) Interest Rate

(d) Net Foreign Asset Position

Figure 5: ***Shortage of safe assets in the South–the dynamics of the South.*** *This figure revisits the dynamic response of the South (as in figure 2) when the only difference between the two economies is that the North has access to a better technology for producing safe assets.*



(a) Aggregate Capital Stock

(b) Aggregate Output

(c) Interest Rate

(d) Net Foreign Asset Position

Figure 6: ***Shortage of safe assets in the South–the dynamics of the North.*** *This figure revisits the dynamic response of the North (as in figure 3) when the only difference between the two economies is that the North has access to a better technology for producing safe assets.*