NBER WORKING PAPER SERIES

TRADE AND CAPITAL FLOWS:
A FINANCIAL FRICTIONS PERSPECTIVE

Pol Antràs
Ricardo J. Caballero

Working Paper 13241
http://www.nber.org/papers/w13241

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 2007

We are grateful to Davin Chor, Elhanan Helpman, Kalina Manova, Jim Markusen, and seminar participants at MIT, LSE, Stanford and the 2007 NOITS conference for useful comments. We thank Sergi Basco and especially Eduardo Morales for valuable research assistance. Caballero thanks the NSF for financial support. First draft: May 11, 2007. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

Trade and Capital Flows: A Financial Frictions Perspective
Pol Antràs and Ricardo J. Caballero
NBER Working Paper No. 13241
July 2007
JEL No. E2,F1,F2,F3,F4

ABSTRACT

The classical Heckscher-Ohlin-Mundell paradigm states that trade and capital mobility are substitutes, in the sense that trade integration reduces the incentives for capital to flow to capital-scarce countries. In this paper we show that in a world with heterogeneous financial development, the classic conclusion does not hold. In particular, in less financially developed economies (South), trade and capital mobility are complements. Within a dynamic framework, the complementarity carries over to (financial) capital flows. This interaction implies that deepening trade integration in South raises net capital inflows (or reduces net capital outflows). It also implies that, at the global level, protectionism may backfire if the goal is to rebalance capital flows, when these are already heading from South to North. Our perspective also has implications for the effects of trade integration on factor prices. In contrast to the Heckscher-Ohlin model, trade liberalization always decreases the wage-rental in South: an anti-Stolper-Samuelson result.

Pol Antràs
Department of Economics
Harvard University
1805 Cambridge Street
Littauer Center 319
Cambridge, MA 02138
and NBER
pantras@fas.harvard.edu

Ricardo J. Caballero
Department of Economics
MIT
Room E52-252a
Cambridge, MA 02142-1347
and NBER
caball@mit.edu

1 Introduction

The process of globalization involves the integration of goods and financial markets of heterogeneous economies. While these two dimensions of integration are deeply intertwined in practice, the economics literature has kept them largely separate. International trade deals with the former while macroeconomics with the latter. In this paper we argue that such separation is not warranted when financial frictions are an important source of heterogeneity across countries and sectors. In particular, we show that in this context trade and net capital flows are *complements* in less financially developed economies. A financially underdeveloped economy that opens the capital account without liberalizing trade is likely to experience capital outflows. An aggressive trade liberalization can reverse these outflows. At the global level, a rise in protectionism may exacerbate rather than reduce the so called "global imbalances."

While some of these implications may resonate with practitioners, they are in stark contrast with those that follow from the classical Heckscher-Ohlin-Mundell paradigm (HOM). In the neoclassical two-good, two-factor model, provided that a small open economy produces both goods, free trade brings about factor price equalization (FPE) with the rest of the world. When this happens, international capital mobility becomes irrelevant. By the same token, if a capital-scarce small open economy sets a tariff on its import sector, it triggers a capital inflow to the point at which FPE is restored. In sum, in HOM trade and capital inflows are substitutes: trade integration reduces the incentives for capital to flow to capital-scarce countries.

The key difference between our model and the HOM one, aside from the dynamic aspects that allow us to talk about financial flows rather than just physical capital mobility, is the presence of financial frictions. Motivated by the findings of King and Levine (1993), Shleifer and Vishny (1997), Rajan and Zingales (1998), Manova (2007), and many others, we highlight two dimensions of heterogeneity in financial frictions. First, there is *cross-country* heterogeneity. The ability to pledge future output to potential financiers is higher in rich "North" than in developing "South." Second, there is *cross-sectoral* heterogeneity. Even when operating under a common financial system, producers in certain sectors find it more problematic to obtain financing than producers in others sectors. Paraphrasing Rajan and Zingales (1998), some sectors are more "dependent" on financial infrastructure than others. In this context, both trade and capital flows become market mechanisms to circumvent the misallocation of capital induced by financial frictions in South. If we close the trade channel, then both physical and financial capital outflows from South become the vehicle through which the return to savers and the sectoral allocation of capital are improved in South. In contrast, with free trade, it is the reorganization of domestic production in South that does the heavy-lifting, and by doing so raises the return on capital in South and palliates or even reverses capital outflows. Intuitively, international trade allows for an allocation of factors across sectors that is (partially) detached from local demand conditions and this allows Southern capital to work with more labor in the sector with lower financial frictions.

In order to formalize these insights, in section 2 we develop a standard 2×2 general equilibrium model of international trade in which firms hire capital and labor to produce homogenous goods in two sectors. To capture the role of heterogeneous financial frictions across countries and sectors in the simplest possible way, we enrich the standard model by incorporating a financial market imperfection in one of the sectors. This friction limits the amount of capital allocated to the sector affected by it.

We first consider the autarkic equilibrium of this simple economy in which goods and factor markets have to clear domestically. In such a case, countries with worse financial institutions feature a lower relative price of the unconstrained sector's output (since a disproportionate share of resources ends up being allocated to this sector) and also feature relatively depressed wages and returns to capital. If we now allow capital to move across countries that differ only in financial development, capital flows from the financially underdeveloped South to the financially developed North.

These closed (to trade) economy outcomes are in sharp contrast to those when South can freely trade with a financially developed North. We show that in that case South specializes in the unconstrained sector and thus becomes a net importer of the output of the "financial dependent" sector. From the point of view of South, trade integration raises the relative price of the unconstrained sector's output and the real return to capital. Trade does *not* bring about factor price equalization and the rate of return to capital ends up being higher in South than in North. This "overshooting" follows from the fact that in the free trade equilibrium North produces a disproportionate amount of output in an industry (the financially dependent one) where capital intensity is suboptimal. It follows that the residual capital-labor ratio available to the unconstrained sector is larger in North than in South, and this makes the return to capital higher in South. The counterpart of this result is that workers in South produce with relatively less capital in the unconstrained sector, and thus wages remain lower in South than in North.

Although we initially derive our conclusions for the case in which South is a small open economy and preferences and technologies are Cobb-Douglas, we later demonstrate that the *complementarity* between trade and return to capital (and hence capital mobility) is fully general. In particular, *in a world in which countries differ only in financial development and sectors differ only in financial dependence, trade integration reduces the gap between the real return to capital in North and South, and with free trade, the real return to capital is higher in the less financially developed South.* In section 3, we characterize the equilibrium with capital mobility and show that the complementarity between trade and net capital inflows works in both directions, in the sense that Northern capital flows to the unconstrained sector in South and increases trade flows between countries.

All the statements up to now follow from a static model where the only possible type of capital flows involve movements of physical capital across countries. In section 4 we develop a dynamic model that illustrates that our mechanism has similar implications for financial capital flows (that is, for flows of ownership claims). In doing so, we build on the overlapping-generations framework developed by Caballero, Farhi, and Gourinchas (2006). Under the plausible assumption that neither labor income nor entrepreneurial rents are capitalizable, our model implies that countries with underdeveloped financial markets feature relatively low interest rates under trade and financial autarky, but relatively high interest rates with free trade and financial autarky. It follows that, again, *trade and financial capital inflows are complements in South.*

Our benchmark model isolates the effects of cross-country and cross-sectoral heterogeneity in financial frictions on the structure of trade and capital flows. In section 5, we introduce Heckscher-Ohlin determinants of international trade into our static model. We focus on the empirically relevant case in which the financially underdeveloped South is also relatively capital scarce and the constrained sector features a higher elasticity of output with respect to capital than the unconstrained sector. Under these circumstances, we show that our main results go through and often are reinforced. Furthermore, regardless of relative factor endowment differences and relative factor intensity differences, our model always generates a decrease in the Southern wage-rental ratio after trade liberalization: an anti-Stolper-Samuelson effect.

Our paper relates to several literatures in international finance and international trade. From the point of view of international finance, the closest models are those studying the role of financial frictions in shaping capital flows. These models are typically cast in terms of one-sector models, where capital flows is the only mechanism to increase the return to capital in financially underdeveloped countries. The literature highlighting this mechanism is large and includes Gertler and Rogoff (1990), Boyd and Smith (1997), Shleifer and Wolfenzon (2002), Reinhart and Rogoff (2004), Kraay et al. (2005), as well as the more recent (working) papers by Caballero, Farhi and Gourinchas (2006), Aoki, Benigno and Kiyotaki (2006), and Mendoza, Quadrini and Rios-Rull (2007). There is also a trade literature emphasizing the role of the interaction between financial development and financial dependence in shaping international trade flows. It includes the work of Bardhan and Kletzer (1987), Beck (2002), Matsuyama (2005), Wynne (2005), Ju and Wei (2006), and Manova (2007). These papers, however, focus on deriving (and testing) implications for trade flows and do not allow for capital mobility. In terms of complementarities between trade and capital flows, our paper shares with Markusen (1983) who shows that our second level of complementarity (from capital mobility to trade flows) can be derived in a variety of models in which comparative advantage is *not* driven by differences in capital-labor ratios across countries. In our paper, we focus on the first type of complementarity going from trade integration to capital mobility, which is absent in his framework. Another difference between Markusen (1983) and our paper is that he did not explore the role of financial frictions, which are of course central in our context. Finally, in terms of comparative statics, our extended model with Heckscher-Ohlin elements have some similarities with the specific-factors model of Jones (1971) and Samuelson (1971). Although uninformed capital is not specific to the unconstrained sector, its allocation across sectors is pinned down by the parameters governing the tightness of the financial constraint. Amano (1977), Brecher and Findlay (1983), Jones (1989) and Neary (1995) study capital mobility within variants of the specific-factors model, but the conclusions generally depend on the *assumed* pattern of specialization and factor mobility.

The rest of the paper is organized as follows. In section 2, we develop our benchmark 2×2 model of financial frictions and compare the autarky and free trade equilibria. In section 3, we derive and discuss our main result on the complementarity between trade flows and capital mobility. In section 4, we develop a dynamic version of our model that generalizes our complementarity result to the link between trade flows and financial capital flows. In section 5, we enrich the static model by incorporating Heckscher-Ohlin determinants of comparative advantage into the analysis. In section 6, we offer some concluding remarks.

2 A Stylized Model of Trade with Financial Frictions

In this section we develop our benchmark model. In order to isolate the main mechanism in the paper, we make a series of simplifying assumptions that we later relax sequentially. In particular, our benchmark model imposes a specific log-linear structure and abstracts from standard Heckscher-Ohlin determinants of comparative advantage.

2.1 The Environment

Consider an economy that employs two factors (capital K and labor L) to produce two goods (1 and 2). The country is inhabited by a continuum of measure μ of entrepreneurs (or informed capitalists), a continuum of measure $1-\mu$ of uninformed capitalists, and a continuum of measure L of workers. All capitalists are endowed with K units of capital and each worker supplies inelastically one unit of labor, so the aggregate capital-labor ratio of the economy is K/L, with a fraction μ of K being "informed" capital and the remaining fraction being "uninformed" capital.

All agents have identical Cobb-Douglas preferences and devote a fraction η of their spending to sector 1's output, which we take as the numeraire:

$$U = \left(\frac{C_1}{\eta}\right)^{\eta} \left(\frac{C_2}{1-\eta}\right)^{1-\eta}. \tag{1}$$

Production in both sectors combines capital and labor according to:

$$Y_i = Z\left(K_i\right)^{\alpha}\left(L_i\right)^{1-\alpha}, \;\; i = 1, 2, \tag{2}$$

where K_i and L_i are the amounts of capital employed in sector i and Z is a Hicks-neutral productivity parameter. From a technological point of view, informed and uninformed capital are perfect substitutes. Notice also that, for the time being, we focus on symmetric technologies to eliminate any source of comparative advantage other than financial development.

Goods and labor markets are perfectly competitive, and factors of production are freely mobile across sectors. If the capital market is also perfectly competitive, then the autarky equilibrium of this economy is straightforward to characterize. In particular, given identical technologies in both sectors, the marginal rate of transformation is equal to -1 and thus the relative price of sector 2's output, p, is equal to 1. It is then easily verified that the economy allocates a fraction η of K and L to sector 1, and the remaining fraction $1-\eta$ to sector 2. If this frictionless economy is open to international trade and faces an exogenously given relative price p, then it completely specializes in sector 1 if $p < 1$ and completely specializes in sector 2 if $p > 1$.

2.2 Financial Friction

We shall assume, however, that the capital market has a friction. Consistently with the empirical literature discussed in the introduction, we assume that the financial friction has an asymmetric effect in the two sectors. To simplify matters, we assume that financial contracting in sector 2 is perfect in the sense that producers in that sector can hire any desired amount of capital at the equilibrium rental rate, which we denote by δ.

Conversely, there is a financial friction in sector 1, which we associate with the production process in that sector as being relatively "complex." We appeal to this complexity to justify the following two assumptions: (i) that only entrepreneurs know how to produce in sector 1 (i.e., their "human capital" is essential), and (ii) that because of informational frictions, producers in that sector (i.e., entrepreneurs) can only borrow a limited amount of capital. We capture the latter capital market friction in a stark (though standard in the literature) way by assuming that lenders are only willing to lend to entrepreneurs a multiple $\theta - 1$ of the entrepreneur's capital endowment, so their investment is constrained by

$$I \leq \theta K, \quad \text{for } \theta > 1. \tag{3}$$

For the purposes of this paper we need not take a particular stance on what is the friction behind this borrowing constraint. It could be related to an ex-post moral hazard problem, to limited commitment or to the inalienability of human capital investments.[1]

Regardless of the source of the constraint, it is clear that if θ is sufficiently large, then entrepreneurs are able to jointly allocate a fraction η of capital to the constrained sector 1. In such a case, constraint (3) does not bind and the equilibrium is as described above. Hereafter we focus on the more interesting case in which θ is low enough so that (3) binds. This requires:

Assumption 1: $\mu\theta < \eta$.

2.3 Closed Economy Equilibrium

We next turn to explore the autarky equilibrium of this economy. As noted above, under Assumption 1 the financial constraint (3) binds, each entrepreneur invests an amount θK (of which $(\theta - 1)K$ is borrowed), and the aggregate amount of capital allocated to sector 1 is:[2]

$$K_1 = \mu\theta K < \eta K. \tag{4}$$

[1] A simplifying assumption in our setup is that the credit multiplier θ is independent of δ. Aghion, Banerjee and Piketty (1999) provide a microfoundation for this rental-rate insensitivity in a model with ex-post moral hazard and costly state verification. See Tirole (2006) for a theoretical overview of different models of financial contracting.

[2] This imposes that entrepreneurs invest all their endowment of K in sector 1. But this is necessarily a feature of the equilibrium since, as we will see shortly, they can always obtain a higher return in that sector.

Because labor can freely move across sectors, it is allocated to equate the value of its marginal product, which using (4) implies

$$(1-\alpha) Z \left(\frac{\mu\theta K}{L_1}\right)^{\alpha} = p (1-\alpha) Z \left(\frac{(1-\mu\theta) K}{L-L_1}\right)^{\alpha}, \tag{5}$$

where, remember, p denotes the price of good 2 in terms of good 1 (the numeraire).

>From the consumer's first order condition and goods market clearing we have

$$(1-\eta) Z (\mu\theta K)^{\alpha} (L_1)^{1-\alpha} = p\eta Z ((1-\mu\theta) K)^{\alpha} (L-L_1)^{1-\alpha}, \tag{6}$$

which together with the labor market condition in (5) implies that

$$L_1 = \eta L \tag{7}$$

and

$$p = \left(\frac{\mu\theta (1-\eta)}{\eta (1-\mu\theta)}\right)^{\alpha} < 1, \tag{8}$$

where the inequality follows again from Assumption 1.

As indicated by equations (4) and (7), in our benchmark model financial frictions do not distort the allocation of labor across sectors but shift capital to the unconstrained sector (sector 2). As a result, sector 2's output is "oversupplied" and its relative price p is depressed.

Financial frictions also have significant effects on equilibrium factor prices. The rewards to labor and uninformed capital (in terms of the numeraire) are pinned down by their marginal products in the unconstrained sector, which using (8) yields:

$$w = (1-\alpha) Z \left(\frac{\mu\theta}{\eta} \frac{K}{L}\right)^{\alpha} \tag{9}$$

and

$$\delta = \frac{\mu\theta (1-\eta)}{(1-\mu\theta)\eta} \alpha Z \left(\frac{\mu\theta}{\eta} \frac{K}{L}\right)^{\alpha-1}. \tag{10}$$

Note that both w and δ are increasing functions of the degree of financial contractibility θ. Other things equal, less financially developed economies feature depressed wages and depressed returns to uninformed capital.

The effect of a fall in θ on the rental rate of uninformed capital is clear: the tighter borrowing constraint reduces the demand for this type of capital in the constrained sector, thus increasing the capital-labor ratio in the unconstrained sector and reducing its marginal product in terms of sector 2 output.[3] Because the relative price p is an increasing function of θ, the rental δ drops with the fall in θ not only in terms of sector 2's output but also in terms of sector 1's output.

In order to facilitate a comparison with the open economy results, it is useful to decompose the

[3] Note that $\delta/p = \alpha Z ((1-\mu\theta) K / ((1-\eta) L))^{\alpha-1}$ is increasing in θ.

increase in the capital-labor ratio in sector 2 in three parts. The first effect, which we label the *"capital allocation effect,"* relates to the fact that a decrease in θ directly reduces the amount of capital that the constrained sector can attract and thus increases the amount of capital employed in the unconstrained sector. Because capital and labor are complements in production, this shift in the allocation of capital induces a similar shift of labor from the constrained sector to the unconstrained sector: a *"capital-labor complementarity effect."* In our log-linear model, this second effect is exactly cancelled by a *"goods-market clearing effect":* a decrease in θ leads to an increase in supply of sector 2's good, depresses its relative price p and induces labor to remain in sector 1 (see eq. (7)). Overall, we thus have that the capital-labor ratio increases in sector 2 because capital rises while labor stays constant.

The changes in sectoral capital-labor ratios are also crucial for understanding the effects of a fall in θ on the remuneration of workers. Wages fall in terms of sector 1 output (the numeraire) because the capital-labor ratio in that sector is lower when θ is lower. By the same token, and since the capital-labor ratio rises in sector 2, we have that w/p rises with the decline in θ. All in all, however, one can show that the real purchasing power of wages, that is $w/p^{1-\eta}$, falls with a decline in θ.[4]

This discussion also suggests that uninformed capital suffers disproportionately more from a low value of θ. In order to see this formally, notice that (9) and (10) imply that the wage-rental ratio

$$\frac{w}{\delta} = \frac{(1-\alpha)(1-\mu\theta)}{\alpha(1-\eta)}\frac{K}{L}$$

is decreasing in θ. In sum, labor is hurt by the financial constraint but less so than capital because the capital-labor ratio rises in sector 2, offsetting the downward pressure on wages due the decline in p.

So far we have been silent on the return obtained by entrepreneurs (or informed capital). In the frictionless economy, informed and uninformed capital are perfect substitutes and both obtain a common rental rate δ. However, when the borrowing constraint (3) binds, informed capital becomes relatively scarce in sector 1 and entrepreneurs obtain a premium over the return of uninformed investors in that sector. In particular, their return per unit of capital is

$$R = \delta + \lambda\theta, \tag{11}$$

where λ is the Lagrange multiplier corresponding to the financial constraint (3).[5] In equilibrium, the marginal product of capital in the constrained sector 1 needs to equal $\delta + \lambda$, from which we obtain:

$$\lambda = \left(1 - \frac{\mu\theta(1-\eta)}{(1-\mu\theta)\eta}\right)\alpha Z\left(\frac{\mu\theta}{\eta}\frac{K}{L}\right)^{\alpha-1}, \tag{12}$$

which is strictly positive (under Assumption 1) and also decreasing in θ. Hence, the shadow value

[4] This follows from the fact that $w/p^{1-\eta} \propto (\mu\theta)^{\alpha\eta}(1-\mu\theta)^{\alpha(1-\eta)}$, which is increasing in θ under Assumption 1.

[5] The return R follows from $R = \theta(\delta+\lambda) - (\theta-1)\delta$. Notice that the fact that $R > \delta$ justifies our assumption above that entrepreneurs invest all their endowment of capital in sector 1.

of entrepreneurial capital is higher in economies with less developed financial markets. Note from (11), however, that this does not imply that the welfare of entrepreneurs is necessarily decreasing in θ.

Finally, because all agents in the economy share identical preferences, aggregate welfare is given by total income in terms of consumption units. That is

$$U = \frac{wL + \delta(1-\mu)K + R\mu K}{p^{1-\eta}}.$$

Using the expressions above, it is straightforward to check that U is proportional to $w/p^{1-\eta}$, which as argued above is strictly increasing in θ. In sum, economies with more developed financial systems attain higher welfare levels. We summarize our results as follows:

Proposition 1 *In the closed economy equilibrium, an increase in financial contractibility θ has the following effects: it raises the relative price of the unconstrained sector, the real return to uninformed capital, real wages, and welfare; it lowers the wage-rental ratio, and it has an ambiguous effect on entrepreneurial income.*

2.4 Open Economy Equilibrium

Consider now a situation in which the economy we are studying, which we refer to as South, is open to international trade with the rest of the world (or North). For expositional simplicity, we focus for now on the case in which South is small, in the sense that it faces a fixed world relative price p. As we will show below, our substantive implications do not depend on this assumption. We think of the rest of the world as having the same preferences in (1) and the same production technologies in (2) as South and also facing a financial friction, though smaller, in sector 1. For these reasons, it is natural to focus on a situation in which $p < 1$. Below, however, we briefly discuss the case in which $p \geq 1$.

As argued at the end of section 2.1, whenever $p < 1$, a frictionless small South would like to fully specialize in the production of good 1. However the borrowing constraint in that sector prevents this by limiting the aggregate allocation of capital to that sector to be no larger than $\mu\theta K$. Thus, the distribution of capital across sectors is identical to that in the closed economy.

Conversely, the allocation of labor across sectors *is* affected by the access to international trade in goods. Condition (5) equating the value of the marginal product of labor across sectors still needs to hold in equilibrium, but the allocation of labor no longer needs to be consistent with goods market clearing as dictated by equation (6) above. This is the distinguishing effect of international trade in the model: it detaches the allocation of factors across sectors from local demand conditions. Instead, South faces an exogenously given relative price p, and thus (5) yields

$$L_1 = \frac{\mu\theta L}{(1-\mu\theta)\,p^{1/\alpha} + \mu\theta}. \tag{13}$$

The amount of labor allocated to the financially constrained sector 1 is decreasing in p and increasing in θ. Intuitively, a larger p raises the value of the marginal product of labor in sector 2, thus pulling labor away from sector 1. Similarly, a lower θ increases the amount of capital allocated to the unconstrained sector 2, thus again raising the marginal product of labor in that sector. When the world relative price p happens to coincide with South's autarky price (in equation (8)), then L_1 coincides as well with the autarky allocation, i.e., $L_1 = \eta L$. But when international trade allows South to face a less depressed relative price p, South tilts the allocation of labor towards the unconstrained sector 2, thus specializing in the less "financially dependent" sector.[6]

The equilibrium rewards to labor and uninformed capital are again pinned down by their marginal products in the unconstrained sector, which using (4) and (13) can be expressed as:

$$w = (1-\alpha) Z \left(\left((1-\mu\theta) p^{1/\alpha} + \mu\theta \right) \frac{K}{L} \right)^{\alpha} \tag{14}$$

and

$$\delta = \alpha Z p^{1/\alpha} \left(\left((1-\mu\theta) p^{1/\alpha} + \mu\theta \right) \frac{K}{L} \right)^{\alpha-1}. \tag{15}$$

It is straightforward to verify that both w and δ are increasing functions of the relative price p. A larger p raises the incentive to shift resources to the unconstrained sector. This shift relaxes the financial constraint in sector 1, and consequently reduces the premium remuneration obtained by entrepreneurs, and increases the remuneration of labor and capital in terms of sector 1's output. Formally, from the first order condition for capital in sector 1 we have (after replacing δ in it)

$$\lambda = \left(1 - p^{1/\alpha}\right) \alpha Z \left(\left((1-\mu\theta) p^{1/\alpha} + \mu\theta \right) \frac{K}{L} \right)^{\alpha-1}, \tag{16}$$

which is strictly decreasing in p.[7]

In sum, by allowing South to specialize in the sector with lower financial frictions, international trade reduces the negative impact of financial underdevelopment on the rewards of labor and capital.[8]

[6] Although, we have made the assumption that South is relatively financially underdeveloped, the expressions in this section apply also to the case in which the financial friction is lower in South. In the latter case, however, trade integration leads to a *decrease* in p in South.

[7] In fact, the total return to entrepreneurial capital is necessarily decreasing in p as well. To see this, use equations (15) and (16) to obtain:

$$R = \delta + \lambda\theta = \left(\theta - (\theta-1) p^{1/\alpha}\right) \alpha Z \left(\left((1-\mu\theta) p^{1/\alpha} + \mu\theta \right) \frac{K}{L} \right)^{\alpha-1},$$

which is strictly decreasing in p.

[8] Although, the decrease of the capital-labor ratio in sector 2 leads to a fall in the marginal product of labor in terms of that sectors' output (i.e., a fall of w/p), it is straightforward to show that the real wage $w/p^{1-\eta}$ is strictly increasing in p. On the other hand, both δ and δ/p are increasing in p, so a rise in p raises the real return to uninformed capital.

Note also that the wage-rental ratio

$$\frac{w}{\delta} = \frac{(1-\alpha)}{\alpha} \frac{\left((1-\mu\theta)\, p^{1/\alpha} + \mu\theta\right)}{p^{1/\alpha}} \frac{K}{L}, \tag{17}$$

is strictly decreasing in the relative price p. This implies that an increase in p benefits uninformed capital more than workers. The logic is straightforward: as p rises, sector 1 releases labor but not capital to sector 2, so w/δ has to fall for sector 2 to absorb these new workers.

Given equations (14), (15), (16) and (17), we can also study the effects of an improvement in financial contractibility, that is an increase in θ, on equilibrium factor prices. Remember that in the autarky equilibrium we established that w and δ were increasing in θ, while w/δ and λ were decreasing in θ. In the open economy equilibrium, it continues to be the case that w increases in θ and λ decreases with it.

In contrast to the closed economy, the return to uninformed capital is now *decreasing* in the level of financial contractibility. This surprising result comes as the outcome of two opposing effects that we discussed in the closed-economy section. The first effect is the direct *"capital allocation effect"*: a decrease in θ shifts capital from the constrained to the unconstrained sector. Holding constant the allocation of labor across sectors, this diminishes the marginal product of capital. But because of the second effect, the *"capital-labor complementarity effect,"* the allocation of labor is no longer independent of θ: in particular, a lower θ shifts labor from the constrained sector to the unconstrained sector. In the closed-economy equilibrium, this second effect was exactly offset by the *"goods-market clearing effect,"* but this is precisely the effect that is absent in a small-open economy equilibrium. Hence, we are left with the first two effects and it is straightforward to show that the capital-labor complementarity effect dominates the capital allocation effect as long as the constrained sector operates at a lower capital-labor ratio than the unconstrained one. With symmetric technologies and financial constraints binding in the North, this is always true (see below for more on this) and the marginal product of capital is decreasing in θ.

We have thus shown that a small-open economy with a lower θ features lower wages but higher rates of return to capital. It then follows that the wage-rental ratio is lower in small-open economies with underdeveloped financial markets, a result which again stands in sharp contrast to that obtained in the closed economy case.

2.5 Trade Integration with a More Financially Developed North

In this section we study more systematically an equilibrium in which South can freely trade with a large North (or rest of the world). In order to isolate the role of financial development in shaping trade flows, we assume that North is identical to South in every respect except for the level of financial development (and scale). We shall assume that

$$\theta^N > \theta^S,$$

so that North is more financially developed. We now can use the analysis in section 2.3 to conclude that this large, financially developed North, pins down the following world relative price

$$p^N = \left(\frac{\mu\theta^N (1-\eta)}{\eta \left(1 - \mu\theta^N\right)} \right)^{\alpha} < 1. \tag{18}$$

Note that because $p^N < 1$, both North and South produce both goods in equilibrium. The more developed financial system in North implies, however, that South has a comparative *dis*advantage in the constrained sector 1. Using equations (2), (14), (15), (16) and (18), we can express imports of sector 1's output in South as

$$M_1^S = ZK^{\alpha}L^{1-\alpha} \left(\left(1-\mu\theta^S\right) \frac{\mu\theta^N (1-\eta)}{\eta\left(1-\mu\theta^N\right)} + \mu\theta^S \right)^{\alpha} \left(\eta - \frac{\mu\theta^S}{\left(1-\mu\theta^S\right) \frac{\mu\theta^N(1-\eta)}{\eta\left(1-\mu\theta^N\right)} + \mu\theta^S} \right) > 0,$$

where the sign follows from $\theta^N > \theta^S$.

Despite the fact that there is diversification in production, factor price equalization does not attain, since factor prices were shown above to depend on the particular level of financial development in the corresponding region. Furthermore, from the derivations above, we have the following result:

Proposition 2 *In the free trade equilibrium, South produces both goods and is a net importer of the "financially dependent" good 1. Furthermore, free trade does not result in factor price equalization and leads to*

$$\begin{aligned} w^N &> w^S \\ \delta^N &< \delta^S \\ \lambda^N &< \lambda^S. \end{aligned}$$

The results on the ranking of factor prices follow from the comparative statics with respect to θ derived in the previous section. North and South share a common relative price p^N, but South features a lower θ. Hence, relative to North, it must allocate a disproportionate amount of labor to sector 2, it must have a relatively lower wage rate, and it must feature a relatively larger return to informed and uninformed capital.

Using the results in section 2.4, we can also study the effects of trade integration from the point of view of the South. This amounts to comparing the autarky and free trade equilibria in South, which is in turn analogous to describing the effects of an increase in the relative price p in the small open economy equilibrium since $\theta^N > \theta^S$ implies $p^N > p^S$, where p^S is the autarky relative price in South. As demonstrated in the previous section, this increase in p shifts labor to the unconstrained sector 2 and raises the real return of uninformed capital in terms of both goods. This positive effect of trade integration on the real return to capital is at the core of the complementarity between trade and capital mobility discussed below and hence it is worth restating it in the form of a Proposition:

Proposition 3 *Trade integration raises the real return to uninformed capital in the financially underdeveloped South.*

As discussed above, trade integration (i.e., an increase in p) also raises real wages in South but reduces the wage-rental ratio as well as the return to entrepreneurial capital. Overall, however, one can show that aggregate welfare in South is necessarily higher in the free trade equilibrium (see section 2.6.E. for a general proof).

2.6 Robustness and Generalizations

Even though we explore a generalized version of our model later in section 5, here we briefly comment on the robustness and generality of the results stated in Propositions 2 and 3. This discussion helps understanding the mechanisms behind our results.

A. No Financial Constraints in North

We focused above on the case in which North sets a world relative price p lower than 1. This is the natural case to consider in a world in which countries are fully symmetric except for financial development and the inequality $\mu\theta^N < \eta$ (analogous to Assumption 1) holds. Suppose instead that financial contracting in North is not a constraint so that $\mu\theta^N \geq \eta$. Then, North features a value of λ equal to 0 and sets a world relative price of $p = 1$. In the free trade equilibrium, South again specializes in the unconstrained sector, but trade brings about factor price equalization. In this case, free trade again raises the equilibrium values of the real return of uninformed capital in South, but δ^S does not "overshoot" the Northern rental δ^N.

The case in which the North sets a relative price higher than 1 can be studied analogously. The South *completely* specializes in sector 2, which necessarily implies $\lambda = 0$. Factor prices are pinned down by their marginal values in sector 2. In that case, however, factor prices depend on Southern variables, so factor price equalization generally fails. The direction of failure depends on the exact source of the relative price $p > 1$ in North.

In terms of the results above, we thus have that Proposition 3 continues to hold, which implies that even when $p \geq 1$ we have that trade and *net* capital inflows are complements in South. Henceforth, we focus on the case where the financial constraint is binding in North (i.e., $p < 1$).

B. General Symmetric Technologies

As shown in Appendix A.2., Propositions 2 and 3 continue to hold if we relax the Cobb-Douglas assumptions and assume general homothetic preferences and general symmetric production functions with constant returns to scale and diminishing marginal products. The key three equilibrium properties that ensure the generality of the results are as follows: (a) the autarky relative price p is always increasing in θ; (b) the real return to uninformed capital is always increasing in p; (c) capital intensity is necessarily lower in the constrained sector 1 than in the unconstrained sector 2. The generality of (a) implies that trade integration is associated with an increase in p in South, which together with (b) implies that Proposition 3 holds for general symmetric production technologies. Condition (c) in turn ensures that with free trade the rental rate is higher in South than in North (Proposition 2). Furthermore, property (a) also implies that South is a net importer of the financially dependent sector 1.[9]

We can thus conclude that whenever countries differ *only* in financial development and sectors differ *only* in financial dependence, South specializes in the least financially dependent sector, trade integration raises the real return to capital in South and, with free trade, this rental rate is larger in South than in the more financially developed North.[10]

C. A Large South

We have so far treated North as a large enough country to fix world prices at p^N in equation (18). Suppose instead that both North and South are large enough to impact world prices. The equilibrium is identical to that of two "small" open economies facing a common relative price p, with the additional restriction that p should now ensure goods-market clearing *at the world level*. If countries differ only in financial development, then for general homothetic preferences and symmetric production technologies, the equilibrium relative price p has to fall between the Southern and Northern autarkic relative prices: $p^S < p < p^N$. Hence, it is still the case that trade integration increases the real return to uninformed capital in South (Proposition 3). Furthermore, all the statements in Proposition 2 continue to hold. The reason is that both countries share a common p in equilibrium, and thus cross-sectional comparisons still follow from studying the comparative statics with respect to θ holding p constant.

D. Adding Heckscher-Ohlin Features: A Preview

What happens when we introduce cross-sectional asymmetries in factor intensity as well as cross-country asymmetries in relative factor endowments? Perhaps surprisingly, we show in section 5 (see also Appendix A.2) that an increase in p is *always* associated with an increase in the real return to uninformed capital. Hence, in situations in which trade integration is associated with an increase in the relative price p in South (as would be the case when countries differ only in their level of financial development and $\theta^N > \theta^S$), Proposition 3 continues to hold for general asymmetric production technologies. This leads us to conclude that the complementarity between trade integration and net capital inflows in South is quite general (see section 5 for details).

[9] This follows from the fact that, with homothetic preferences, the consumption ratio C_1/C_2 in South is larger in free trade than in autarky. On the other hand, the increase in p shifts labor to sector 2, and thus the production ratio Y_1/Y_2 in South is lower in free trade than in autarky. Because consumption and production are equal in autarky and trade balance must hold in the trade equilibrium, with free trade we must have $C_1 > Y_1$ and $C_2 < Y_2$.

[10] Conversely, the beneficial effect of trade liberalization on real wages that we obtained in the log-linear model is not general. Although Southern wages in terms of sector 1 output always increase with p, once we relax our Cobb-Douglas assumption, the purchasing power of these wages may or may not increase in p depending on demand patterns.

Consider next the generality of the ranking of factor prices derived in Proposition 2. Note that whenever both North and South produce good 2 in equilibrium, the zero-profit condition in that sector ensures

$$p = c_2 \left(\delta^j, w^j \right) \text{ for } j = N, S, \tag{19}$$

where $c_2(\cdot)$ is a general neoclassical unit cost function and is thus increasing in both arguments. Hence, unlike in the autarkic equilibrium case, with free trade it must be the case that either $w^S > w^N$ *or* $\delta^S > \delta^N$. On the other hand, for a general constant returns to scale technology in sector 2, we must also have that

$$\frac{w^j}{\delta^j} = \vartheta \left(\frac{K_2^j}{L_2^j} \right) \text{ for } j = N, S. \tag{20}$$

where $\vartheta(\cdot)$ is necessarily increasing in K_2^j / L_2^j. Equations (19) and (20) combined imply that the ranking of factor prices is necessarily as derived in Proposition 2 provided that North operates the technology in the unconstrained sector 2 at a higher capital-labor ratio than South does, $K_2^N / L_2^N > K_2^S / L_2^S$, which is an empirically likely scenario.[11] In section 5 below, we show that for general asymmetric production functions, this condition holds provided that North is sufficiently capital abundant relative to South.

E. Relationship with the Specific-Factors Model

It may be apparent to the savvy reader that in the region of the parameter space in which financial constraints bind, our model behaves similarly to a two-sector, three-factor specific-factors model. In fact, we next discuss a perfectly competitive three-factor model that features the *same* equilibrium as our model. This will prove useful in understanding the mechanics of the model and also in proving some general welfare results. We also argue, however, that there are important differences between our framework and a standard specific-factors model.

Consider a model analogous to the one we developed above, but now let uninformed capital and entrepreneurial (informed) capital be distinct factors which are imperfect substitutes in production. Production in sector 2 combines uninformed capital and labor according to a standard neoclassical production function: $Y_2 = F_2 \left(K_2^U, L_2 \right)$. Production in sector 1 combines uninformed capital, informed capital and labor according to

$$Y_1 = F_1 \left(\theta \min \left\{ K^I, \frac{K_1^U}{\theta - 1} \right\}, L_1 \right), \tag{21}$$

where F_1 is again a standard neoclassical production function. Assuming that all markets are perfectly competitive, this model yields equilibrium allocations and factor prices identical to those in our model whenever the endowments of informed and uninformed capital are equal to μK

[11] With symmetric production technologies, $K_2^N / L_2^N > K_2^S / L_2^S$ is ensured by the fact that North specializes in the constrained sector 1, which operates at an inefficiently low capital-labor ratio.

and $(1-\mu)K$, respectively. Because the allocation of the two types of capital to each sector is independent of factor prices, the model behaves similarly to a standard specific-factors model in which θ governs the *effective* relative supply of the two types of factors to each sector.

Note, however, that there are important differences between our model and the specific-factors model. First, the specification in (21) is not imposed in an ad hoc manner, but it follows from credit constraints. Second, the financial constraint mechanism also sheds light on why uninformed capital may move more easily across borders than informed capital (it does not require individuals to move with it). Third, as is apparent in (21), the parameter θ not only affects the allocation of capital across sectors, but also operates as a sector-biased technological parameter in sector 2. As a result of these features, our model provides sharp predictions for the pattern of comparative advantage as well as for the incentives for capital to flow across borders with and without trade integration. Conversely, in the specific-factors model one could obtain just about any pattern of comparative advantage and factor mobility by appropriate choices of the endowments of each type of capital as well as their assumed ease of mobility across borders.

However, the most useful aspect of the analogy with a specific-factors model is in terms of welfare analysis. We argued above that in our benchmark model with Cobb-Douglas preferences and technologies, welfare in South rises when moving from autarky to free trade. The mapping between our model and a perfectly competitive three-factors model has the implication that this welfare gain result continues to hold for general (well-behaved) preferences and technologies. Furthermore, when both North and South are large, North also gains from trade liberalization with South.

3 Trade and Capital Mobility as Complements

As usual in international trade theory, so far we have studied scenarios in which goods can freely move across countries, but factors of production cannot. In this section we consider the implications of allowing for *physical* capital mobility. Following the lead of Mundell (1957), we study the interaction of capital mobility and trade integration by comparing the incentives for capital mobility with and without trade frictions. For simplicity, we develop our results within the log-linear model developed above, but the discussion in section 2.6 should make it clear that our main results are more general.

3.1 Capital Mobility with Prohibitive Trade Frictions

Consider first the case with trade frictions. In particular, consider a situation in which trade in the numeraire sector 1 is costless, but trade costs in sector 2 are prohibitive. Without capital mobility, the equilibrium is then as described in section 2.3 above. With free trade in just one good, South cannot specialize in its comparative advantage sector and the equilibrium is identical to the autarkic one. From equation (10), it is then clear that in such a case we have $\delta^N > \delta^S$. In words, despite both countries sharing the same aggregate capital-labor ratio, the marginal product of capital is higher in North than in South.

If we then allow for physical capital mobility, uninformed capitalists in South have an incentive to move their endowment of capital to North. The counterpart of this instantaneous flow of capital is the future sequence of positive net imports of good 1 in South equal to the interest payments of the capital stock exported from South to North.[12] To see this formally, note that the amount of non-entrepreneurial capital $F^{S \to N}$ that needs to flow to North in order to ensure that δ^S in equation (10) converges up to the (unaffected) Northern rental δ^N is given by

$$\frac{F^{S \to N}}{K} = \left(1 - \mu\theta^S\right) - \left(1 - \mu\theta^N\right) \left(\frac{\mu\theta^S \left(1 - \mu\theta^N\right)}{\mu\theta^N \left(1 - \mu\theta^S\right)} \right)^{\alpha/(1-\alpha)} .$$

This expression is increasing in θ^N and decreasing in θ^S. Hence, the larger the difference in financial contractibility, the larger that share should be.[13] As a counterpart of this capital flow, South features perpetual net imports of good 1 in an amount $M_1^S = \delta^N F^{S \to N}$.

This result bears some resemblance to those derived in the literature arguing that financial frictions may help explain the Lucas (1990) paradox (Gertler and Rogoff, 1990, Shleifer and Wolfenzon, 2002, Reinhart and Rogoff, 2004, Kraay et al., 2005). To the extent that capital-scarce countries also are financially underdeveloped, our closed-economy equilibrium can help rationalize why capital does not flow to those countries.

Notice that we have restricted our analysis to allowing for mobility of uninformed capital. Because the return to informed capital varies across countries, there might be an incentive for that capital to move as well. If, however, we make the reasonable assumption that entrepreneurs have to reside in the country where their projects are run, then our emphasis on uninformed capital mobility is a natural one. Our stylized model simply captures the fact that machines are relatively less costly to move internationally than human beings. In the conclusion we briefly discuss the main implications that follow from allowing for mobility of informed capital in our framework.

3.2 Capital Mobility with No Trade Frictions

We next consider the case in which there is free trade in both goods. Conceptually, this is analogous to considering a situation in which there is substantial heterogeneity in financial dependence across the set of goods that are traded in world markets. The equilibrium without physical capital mobility we derived above then indicates that $\delta^S > \delta^N$: even though both countries feature the same aggregate-capital labor ratio, the return to capital is higher in South. It then follows that if we allow uninformed capitalists to move their endowment across borders, capital moves from North to South. Furthermore, because the allocation of capital to the constrained sector in South is bounded above by $\mu\theta^S K$, Northern capital flowing to South is necessarily employed in sector 2.

[12] The assumption that interest payments are settled in sector 1 output is not important. In the case in which sector 2 prices are equalized, we still obtain that the rental rate for uninformed capital is lower in South in autarky. The reason for this is that in autarky both δ *and* δ/p are increasing in θ.

[13] If South is large enough, this (physical) capital flow has a non-negligible effect on the rental rate δ^N in North. In such a case, the required capital flow F continues to be increasing in θ^N/θ^S but it is quantitatively smaller (relative to South's capital).

Using equations (5), (10), (15), and (18), the exact capital flow required to ensure rental rate equalization is now given by

$$\frac{F^{N \to S}}{K} = \frac{\left(\eta - \mu\theta^N\right)\left(\theta^N - \theta^S\right)}{\theta^N\left(1 - \eta\right)},$$

and again vanishes when $\theta^S \to \theta^N$. Importantly, because the capital flow makes both countries share a common relative price p and a common rental rate δ, wages w and the shadow price λ are also equalized across countries. Hence, as in the classical Heckscher-Ohlin-Mundell model, free good and factor mobility lead to factor price equalization. The main difference is that our model requires *both* types of mobility for equalization to take place.

Our results show that, from the point of view of South, trade integration and capital inflows are *complements*. Only when trade is sufficiently free, does allowing for capital mobility lead to a capital inflow into South. It is interesting to note that this complementarity is reinforced by the fact that the capital inflow into South further increases trade flows between North and South. In particular, we can show that capital mobility increases consumption but reduces production of good 1 in South. Consider production first. As argued before, the financial constraint in South implies that Northern capital flowing to South is employed in sector 2. As a result, this capital inflow increases the marginal product of labor in sector 2, which leads (by equation (5)) to a rellocation of labor towards that sector. In sum, the Southern allocation of labor to sector 1 is lower than without capital flows and hence production of sector 1's output falls in South. On the other hand, consumption in that sector is proportional to income, and capital mobility ensures that Southern income converges up to the level of Northern income.[14] Given these results, we can safely conclude that capital mobility leads to an increase in trade flows between North and South.

This complementarity between trade flows and capital mobility in our model is in sharp contrast with the substitutability present in the standard Heckscher-Ohlin model. As shown by Mundell (1957), in that model trade frictions generate incentives for capital to flow into the capital-scarce South, while a move toward free trade leads to factor price equalization and therefore eliminates the incentive for capital to move across countries. Even when trade does not fully equalize factor prices, trade integration induces a convergence of factor prices and reduces the incentive for capital to move across countries. Hence, in the Heckscher-Ohlin-Mundell world, trade and capital mobility are *substitutes*.[15]

3.3 Capital Mobility with Intermediate Trade Frictions

The above results suggest that the real effects of allowing for capital mobility crucially depend on the extent of trade integration. In this section we formalize this insight by considering cases

[14] The fact that the convergence is upwards follows from the fact that, in the small-open-economy equilibrium, income in South is increasing in the relative price p, and North features a higher relative price $p^N > p$.

[15] Another distinction between our result and Mundell's is that, without trade integration, in our model physical capital mobility leads to a divergence in wage levels rather than a convergence, as wages in South are further depressed by the capital outflow. With free trade and physical capital mobility our model generates factor price equalization and the capital inflow pushes Southern wages up to the Northern level.

with intermediate trade frictions. In order to do so, we again maintain the assumption that the numeraire good 1 is freely tradable, but that good 2 is subject to an iceberg transport cost such that a fraction $\tau \in (0,1)$ of the good is lost in transit. Because in equilibrium South exports good 2, this is formally equivalent to North levying a tariff on Southern imports. Alternatively, we could have assumed that the trade friction is in sector 1. This would lead to identical expressions, but the trade friction would then have analogous effects to an import tariff levied by South (with the tariff revenue being wasted). In either case, we can think of reductions in τ as reduction in transportation costs or as trade liberalizations.

Given our assumption that South is a small open economy, the trade friction amounts to Southern producers facing relative prices equal to $p^N(1-\tau)$ rather than p^N.[16] As long as

$$p^N(1-\tau) > \left(\frac{\mu\theta^S(1-\eta)}{\eta\left(1-\mu\theta^S\right)}\right)^{\alpha} = p^S_{aut},$$

the trade friction is not prohibitive and it continues to be the case that South is a net exporter of sector 2's output. Values of τ between 0 and $1 - p^S_{aut}/p^N$ represent levels of trade integration that fall in between the free trade and autarky levels.

Because the trade friction τ has a monotonic effect on the relative price p faced by South, and because the rental rate to uninformed capital is increasing in this relative price p, we obtain the following result:

Proposition 4 *There exists a unique level of trade frictions $\bar{\tau} \in \left(0, 1 - p^S_{aut}/p^N\right)$ such that for $\tau < \bar{\tau}$ we have $\delta^N < \delta^S$, while for $\tau > \bar{\tau}$ we have $\delta^N > \delta^S$. Consequently, (physical) capital migrates South when $\tau < \bar{\tau}$ and North if $\tau > \bar{\tau}$.*

Proposition 4 summarizes the sense in which trade and capital mobility are complements in our model. The particular value for the threshold integration level $\bar{\tau}$ cannot be derived in closed form, but applying the implicit function theorem to (15), we can conclude that $\partial\bar{\tau}/\partial\theta^S < 0$. In words, the lower is financial development in South, the lower is the amount of trade integration needed to ensure that capital flows into South when allowing for capital mobility.

Finally it is worth mentioning that with positive trade frictions, it is no longer the case that trade integration and free physical capital mobility necessarily lead to factor price equalization. Even when the direction of capital flows is from North to South, the presence of trade frictions ensures that wages in South remain depressed.

4 Trade and Financial Capital Flows as Complements

Up to now we have studied the interaction of financial frictions and trade integration in shaping the desired *location* of physical capital. We concluded that when trade frictions are significant,

[16] If the trade friction was in sector 1, then Southern consumers would have to pay a price $1/(1-\tau)$ when importing the good (since Northern producers can obtain a price of 1 in North). The relative price of sector 2's output would again be $p^N(1-\tau)$.

there is an incentive for physical capital to migrate from the financially underdeveloped South to the financially developed North, while the opposite is true when trade is frictionless. A related but distinct issue is that of capital *ownership*. Who owns the capital located in each region? Answering this question requires to model the implications of our earlier analysis for portfolio decisions and capital flows, which is what we do in this section.[17]

By modeling the net capital flows implications of our view, we are able to connect with the "global imbalances" literature, which attempts to explain the large capital flows from South to North observed in recent years. The main conclusion that emerges from the analysis below is that *protectionism*, an increasingly likely political reaction in North, could exacerbate rather than alleviate these "imbalances" if financial factors are important determinants of trade patterns.[18]

4.1 A Dynamic Extension

Consider the following dynamic extension of our model, which essentially integrates the single-good framework of Caballero, Farhi and Gourinchas (2006) with the trade model in the previous sections.

Time evolves continuously. Infinitesimal agents are born at a rate ϕ per unit time and die at the same rate; population mass is constant and equal to L. All agents are endowed with one unit of labor services which they supply inelastically to the market.[19] Intertemporal preferences are such that agents save all their income and consume only when they die (exit).[20] Instantaneous utility at the time of death is given by (1). Physical capital is tradable and is the only store of value. We assume that the initial stock of capital is equal to K and we rule out any capital depreciation or accumulation.

Entrepreneurs are born as such, and at any given instant they constitute a share μ of the population. As in the static model, they naturally specialize in sector 1. Entrepreneurial rents are not capitalizable (i.e., they cannot be used as store of value).[21] Moreover, in the main text we assume that these rents are taxed away and distributed back to the population at large as a lump sum. The reason for this assumption is to avoid having to track the wealth dynamics of two different groups within each country and the feedback of these differential dynamics on factor prices. We show in Appendix A.1, where we develop the full model without taxation, that none of our main results in this section depends on this simplification.

At any point in time, factor prices are determined exactly as in the static model developed

[17] Since there is no concept of risk and hence of diversification in our model, we focus only on net but not gross capital flows.

[18] See, e.g., The Economist (2006) for a discussion of some of the factors behind the protectionist view, and multiple Greenspan speeches on the connection between global imbalances and trade imbalances. E.g., http://www.usatoday.com/money/economy/trade/2003-11-20-gspan-protectionism_x.htm

[19] To simplify matters we do not distinguish between workers and capitalists in this section. Our previous results on w, δ, and λ can be interpreted as applying to the different components of an agent's income.

[20] Caballero, Farhi and Gourinchas (2006) show that the crucial features of the equilibrium described below survive to more general overlapping generation structures, such as that in Blanchard (1985) and Weil (1987).

[21] This is consistent with these rents stemming from the human capital of entrepreneurs. Note also that this assumption is not inconsistent with entrepreneurs using their capital as collateral to borrow from uninformed investors in the "interim" periods.

above. Nevertheless, in this dynamic model physical capital plays a dual role as a productive factor and also as a store of value. To the extent that claims on this store of value are allowed to be traded across borders, this dynamic model generates an alternative source of capital flows across countries. Importantly, the key price that determines the direction of these capital flows is not the rental rate δ, but rather the interest rate r in each country before opening the capital account. This interest rate differs from the static marginal product of capital, δ, because the value of a unit of capital need not be one in equilibrium (since capital is fixed) and there could be expected capital gains or losses. We turn next to the determination of interest rates.

Let V_t^j denote the value of the stock of capital in country $j = N, S$ at any instant t. The return on holding K units of capital is equal to the dividend price ratio $\delta^j K / V_t^j$ plus the capital gain $\dot{V}_t^j / V_t^j$:

$$r_t^j V_t^j = \delta_t^j K + \dot{V}_t^j. \tag{22}$$

Let W_t^j denote the savings accumulated by agents in country j up to date t. Savings decrease with withdrawals (deaths), and increase with labor, entrepreneurial income and the return on accumulated savings:

$$\dot{W}_t^j = -\phi W_t^j + w_t^j L + \lambda_t^j \mu \theta^j K + r_t^j W_t^j. \tag{23}$$

With a closed capital account, it must be the case that savings equal to the value of the capital stock at all points in time:

$$W_t^j = V_t^j. \tag{24}$$

Replacing (24) into (22), and using (23), we have that

$$\phi W_t^j = Y_t^j,$$

where

$$Y_t^j \equiv \delta_t^j K + w_t^j L + \lambda_t^j \mu \theta^j K.$$

Factor prices are still determined by the static conditions in earlier sections, and hence they are time invariant. It follows that $\dot{W}_t^j = \dot{V}_t^j = 0$ and the equilibrium interest rate (also time invariant) is given by:

$$r^j = \phi \frac{\delta^j K}{Y^j}. \tag{25}$$

If the financial friction is not binding, it follows directly from the symmetric Cobb-Douglas assumption in (2) that $r^j = \phi\alpha$. This is an upper bound for the interest rate in the economies we consider.

Let us now reintroduce the binding financial friction. Consider first the case in which North and South are closed to international trade. Plugging equations (9), (10), and (12) into (25) yields

$$r_{aut}^j = \phi\alpha \frac{1-\eta}{1-\mu\theta^j}.$$

The autarkic interest rate is thus an *increasing* function of θ, which implies that South experiences a capital *outflow* if it integrates to global capital markets when trade frictions are large. This is the result highlighted by Caballero, Farhi and Gourinchas (2006).

The low interest rate in South reflects the limited availability of assets to satisfy the local store of value demand. The reason there are few assets is that the share of output received by uninformed capital, the only capitalizable income, is depressed by the financial friction which pushes uninformed capital toward the unconstrained sector and depresses its return.

We can contrast the autarky result with the polar opposite case where *trade is frictionless.* Plugging equations (14), (15), and (16) into (25) yields

$$r^j_{open} = \phi\alpha \frac{p^{1/\alpha}}{\mu\theta^j + \left(1 - \mu\theta^j\right) p^{1/\alpha}}, \tag{26}$$

which is now *decreasing* in θ. That is, South experiences capital *inflows* if it integrates to global capital markets.

The result that the interest rate is higher in South than in North is tightly related to our previous "overshooting" result regarding the rental rate of capital. Intuitively, by specializing in the unconstrained sector, uninformed capital works with a disproportionate amount of labor in economies with lower credit multipliers. As a result, a larger share of capital income is in the form of capitalizable "uninformed capital income" and the supply of store of value, relative to its demand, is higher. Conversely, by specializing in the financially dependent sector, a financially developed country raises the reward of entrepreneurs (who now employ more workers), thereby reducing the share of capitalizable income in total income.

As in the case of physical capital mobility, the crucial difference between the autarky case and the free trade case is that the "goods-market clearing effect" is operative in the former case, but not in the latter. We next turn to studying intermediate levels of openness, which corresponds to situations with varying incidence of the goods-market clearing effect.

4.2 An Application: Protectionism Backfires

The current "global imbalances" have rekindled protectionist proposals. The direct logic behind these proposals is that by raising trade barriers in North, the magnitude of trade surpluses in South must decline. We argue in this section that if the current scenario is an equilibrium response to heterogenous degrees of financial development across the world, protectionism may exacerbate rather than reduce the imbalances.

We illustrate the reason behind our warning by showing that the pre-integration North-South interest rate spread, which is the main factor behind the direction of capital flows in our model, rises with trade frictions.

Let us extend the interest rate expression in (26) to cases of intermediate levels of trade frictions. As in section 3.3, we consider situations in which sector 1's output can be freely tradable, while a fraction $\tau \in (0, 1)$ of sector 2's output melts in transit when shipped across countries. As a result, the relative price in South is $p^N(1-\tau)$ and the interest rate in each country becomes:

$$\begin{aligned} r^N &= \phi \frac{\alpha \left(p^N\right)^{1/\alpha}}{\mu\theta^N + \left(1-\mu\theta^N\right)\left(p^N\right)^{1/\alpha}}; \\ r^S &= \phi \frac{\alpha \left(p^N(1-\tau)\right)^{1/\alpha}}{\mu\theta^S + \left(1-\mu\theta^S\right)\left(p^N(1-\tau)\right)^{1/\alpha}}. \end{aligned}$$

It is clear from inspection that, for a given p^N, the difference $r^N - r^S$ is strictly increasing in τ. Furthermore, we have that:

Proposition 5 *There exists a unique level of trade frictions $\tilde{\tau} \in \left(0, 1 - p^S_{aut}/p^N\right)$ such that for $\tau < \tilde{\tau}$ we have $r^N < r^S$, while for $\tau > \tilde{\tau}$ we have $r^N > r^S$. Consequently, financial capital migrates South when $\tau < \tilde{\tau}$ and North if $\tau > \tilde{\tau}$.*

This result is analogous to Proposition 4, but it now applies to financial capital instead of physical capital.[22]

Suppose that the initial level of trade frictions is $\tau_0 \geq \tilde{\tau}$ so that $r^N \geq r^S$. Then financial integration leads to capital outflows from South to North, a situation that captures the current scenario between emerging Asia and the U.S. We now want to compare the impact of financial integration for different values of trade friction $\tau \geq \tilde{\tau}$. It is clear from the above discussion that the larger is τ, the larger is the gap $r^N - r^S$. We next show that a larger τ may also be associated with larger current account surpluses in South.

Notice that financial integration does not affect factor prices and thus the value of production in South. Hence, impact changes on the current account follow one-to-one from impact changes in consumption. In our dynamic model, consumption in any instant is simply given by ϕW^j_t, since a fraction ϕ of agents die and consume their wealth. How does financial integration affect wealth in South? Note that *before* opening the capital account we have

$$W^S_- = V^S_- = \frac{\delta^S K}{r^S}.$$

Right after opening up the capital account, the interest rate jumps from r^S to r^N and we have

$$W^S_+ = V^S_+ = \frac{\delta^S K}{r^N} < W^S_-.$$

In sum, financial integration leads to a fall in wealth in the South, to reduced consumption, and

[22] We can also show that $\tilde{\tau} \geq \bar{\tau}$. In words, the required level of trade openess to attract financial capital flows is lower than that required to attract physical capital flows. Hence, a liberalizing country should first experience financial capital inflows and only later physical capital inflows. Formally, this follows from the fact that interest rates are proportional to $\delta^j K/Y^j$. Hence, at $\tau = \tilde{\tau}$, we have that $r^S = r^N$ but still $\delta^S < \delta^N$, since income is lower in South.

to a current account surplus on impact. The fall in wealth is given by

$$\Delta W^S = W^S_- - W^S_+ = \frac{\delta^S K}{r^N}\left(\frac{r^N}{r^S} - 1\right).$$

An alternative way to interpret the result is that the ratio $q^S = V^S/K^S$, which measures the price of a unit of capital in South, falls on impact when South financially integrates with North. This decline in the value of domestic capital yields a negative wealth effect that reduces consumption in South and generates a current account surplus.

We can now compare the impact effect of financial integration for different values of τ. Notice that straightforward differentiation yields:

$$\frac{\partial \Delta W^S}{\partial \tau} = \frac{K}{r^N}\left(\frac{\partial \delta^S}{\partial \tau}\left(\frac{r^N}{r^S} - 1\right) + \delta^S \frac{\partial\left(r^N/r^S\right)}{\partial \tau}\right).$$

It is then apparent that for $\tau \approx \tilde{\tau}$ (i.e., $r^N \approx r^S$), the capital loss in South worsens with a rise in protectionism. This in turn exacerbates the trade surplus recorded in South following financial integration.[23] That is, *protectionism backfires* (if the goal is to reduce North's trade deficits).

In our derivations we have treated South as small relative to North, but it should be apparent that our substantive results do not depend on this assumption. The main significant difference is that, in the two-large region model, financial integration also reduces the interest rate in North, thus creating a positive wealth effect that induces North to increase consumption on impact and increase their trade deficit vis à vis South.

4.3 An Application and Extension: High Saving Rate in Regions of South

The implication that regions in South that are more open to trade are more prone to receive net capital inflows may appear as counterfactual when comparing Asia and Latin America. The economies in the former region are at least as open as those in the latter, but they typically run current account surpluses that are significantly larger than those of Latin American economies. However, there is no contradiction once one also considers that Asian economies have much higher saving rates.

Our dynamic model is flexible enough to accommodate such situations. In particular, suppose that South is split between high and low saving regions — for example, Asia and Latin America, respectively. Because consumption in any instant is equal to a fraction ϕ of wealth, a natural way to capture this different propensity to consume is to have

$$\phi^{S,Asia} < \phi^N < \phi^{S,LA}.$$

[23] Note that an increase in trade frictions may reduce the trade surplus in the South when the initial trade friction is already very significant. The reason for this result is that, in such case, δ^S is so depressed that W^S does not have much space to fall as a result of financial integration.

If all countries in South have identical financial markets, endowments, technology, and instantaneous utility functions at the time of death, then it follows that before opening the capital account we have

$$r^{S,Asia} = \frac{\phi^{S,Asia}}{\phi^{S,LA}} r^{S,LA} < r^{S,LA}.$$

Now if $\phi^{S,Asia}$ is sufficiently lower than ϕ^{N}, then it may well be the case that even if Asia is completely open to trade, we have that

$$\delta^{S,Asia} > \delta^{N}$$

but

$$r^{S,Asia} < r^{N}.$$

In words, although trade integration brings the marginal product of capital in Asia above that in North, the larger propensity to save in Asia makes them net exporters of financial capital in a world with financial integration. Similarly, even though limited trade integration might not increase the marginal product of capital in Latin America by much (and we might have $\delta^{S,LA} < \delta^{N}$), the lower propensity to save of Latin America makes them net importers of financial capital when the capital account is open (i.e., $r^{S,LA} > r^{N}$). More generally, high savings countries in South need to be more open to trade than low saving countries in order to experience *net* capital inflows.[24]

5 A Heckscher-Ohlin-Mundell Extension

Our benchmark model isolates the effects of cross-country and cross-sectoral heterogeneity in financial frictions on the structure of trade and capital flows. In this section, we introduce Heckscher-Ohlin determinants of international trade into the analysis. The purpose of this extension is twofold. On the one hand, we seek to explore the robustness of our results to more general specifications of preferences and technology. On the other hand, we want to study how the standard results of the Heckscher-Ohlin-Mundell model are modified by the presence of imperfect capital markets. For this reason, we focus on the range of parameter values for which the financial constraint binds.

As in the previous sections, we begin by developing a highly parameterized version of the model. In Appendix A.2, we develop a model with general functional forms, in the spirit of the classical treatments of the Heckscher-Ohlin-Mundell model.

5.1 Environment

The model is a simple extension of our benchmark static model. We allow production technologies to differ in (primitive) factor intensity and endow countries with different relative endowments (that

[24] Our model offers an alternative explanation for Latin America attracting larger net capital inflows than Asia despite being less open to trade. In particular, just as in the case of physical capital, the amount of trade integration needed to ensure net financial capital inflows into South is lower the lower is financial development in South. Hence, the observed patterns are also consistent with Latin America being less financially developed than Asia.

is, different aggregate capital-labor ratios). For simplicity, we continue to assume Cobb-Douglas preferences and technologies, but we now allow for a larger output elasticity of capital in sector 1:

$$X_i = Z\left(K_i\right)^{\alpha_i}\left(L_i\right)^{1-\alpha_i}, \ \ i = 1,2, \text{ with } \alpha_1 > \alpha_2.$$

In words, we assume that there is a positive cross-industry correlation between (primitive) capital intensity and frictions in financial contracting. This specification is consistent with available data.[25]

The frictionless, closed-economy equilibrium of this two-sector model is straightforward to characterize. For our purposes, it suffices to indicate at this point that the economy would allocate an amount

$$K_1^{FB} = \frac{\alpha_1 \eta}{\eta \alpha_1 + (1-\eta)\alpha_2} K$$

of capital to sector 1. For financial frictions to bind, we hence now require:

Assumption 1': $\mu\theta < \frac{\alpha_1 \eta}{\eta\alpha_1 + (1-\eta)\alpha_2}$.

5.2 Closed Economy Equilibrium

Under Assumption 1' the financial constraint binds and equalization of the value marginal product of labor imposes

$$(1-\alpha_1) Z \left(\frac{\mu\theta K}{L_1}\right)^{\alpha_1} = p(1-\alpha_2) Z \left(\frac{(1-\mu\theta) K}{L - L_1}\right)^{\alpha_2}.$$

We combine this condition with goods market clearing

$$(1-\eta) Z (\mu\theta K)^{\alpha_1} (L_1)^{1-\alpha_1} = p\eta Z \left((1-\mu\theta) K\right)^{\alpha_2} (L - L_1)^{1-\alpha_2},$$

to obtain

$$L_1 = \frac{(1-\alpha_1)\eta}{(1-\alpha_1)\eta + (1-\alpha_2)(1-\eta)} L = \psi_1^{aut} L \tag{27}$$

and

$$p = \frac{(1-\alpha_1)}{(1-\alpha_2)} \frac{\left(\frac{\mu\theta}{\psi_1^{aut}}\right)^{\alpha_1}}{\left(\frac{1-\mu\theta}{1-\psi_1^{aut}}\right)^{\alpha_2}} \left(\frac{K}{L}\right)^{\alpha_1 - \alpha_2}. \tag{28}$$

As in our benchmark model, the allocation of labor across sectors is identical to that in the case without financial frictions. Combined with the fact that the economy allocates an inefficiently large amount of capital to sector 2, we again obtain that good 2 is oversupplied and its relative price is depressed.

[25] The most widely used cross-industry measure of financial dependence is given by the share of capital expenditures not financed with cash flow from operations (see Rajan and Zingales, 1998). Manova (2007) reports a positive cross-sectoral correlation of 0.14 between capital intensity and external finance dependance. Importantly, this correlation is computed using U.S. data, for which actual capital intensities are more likely to be tightly related to output elasticities of capital. The fact that $\alpha_1 > \alpha_2$ is however perfectly consistent with financially dependent sectors operating at relatively low capital intensities *in financially underdeveloped* countries.

The result that the allocation of labor across sectors is invariant to the level of financial frictions depends on our assumption of Cobb-Douglas preferences and technology. Nevertheless, as shown in Appendix A.2, the result that the relative price p is increasing in θ holds for arbitrary neoclassical production functions and homothetic preferences.

An important difference between the present model and our benchmark one is that relative factor endowment differences generates cross-country variation in the relative price p. In particular, a labor abundant, financially underdeveloped South features a relatively lower p, not only because of financial frictions but also because sector 2 is labor intensive and autarky wages in labor abundant countries are, ceteris paribus, lower.[26]

We next turn to describing the equilibrium factor prices of this closed economy equilibrium. The rewards to labor and uninformed capital are pinned down by their marginal products in the unconstrained sector, which using (27) and (28) yields

$$w = (1 - \alpha_1) Z \left(\frac{\mu\theta}{\psi_1^{aut}} \frac{K}{L} \right)^{\alpha_1} \tag{29}$$

and

$$\delta = \alpha_2 \frac{\mu\theta (1-\eta)}{(1-\mu\theta)\eta} Z \left(\frac{\mu\theta}{\psi_1^{aut}} \frac{K}{L} \right)^{\alpha_1 - 1}. \tag{30}$$

As in our benchmark economy, both w and δ are increasing in financial development θ, but the effect on δ is disproportionate, in the sense that

$$\frac{w}{\delta} = \frac{(1-\alpha_1)\eta(1-\mu\theta)}{\alpha_2 (1-\eta) \psi_1^{aut}} \frac{K}{L}$$

is decreasing in θ. The intuition for these results is analogous to that in our benchmark economy.

Suppose now that the world consists of two economies, North and South, that differ not only in financial development, but also in their relative factor endowments. North features a larger value of θ and also a larger capital-labor ratio K/L. We consider first the case of limited trade in which countries can only trade in the numeraire sector.

Given limited trade, in which direction does physical capital flow? Our benchmark model suggests that the larger level of θ in North implies that $\delta^N > \delta^S$, and capital flows from South to North. The Heckscher-Ohlin model instead predicts that, in autarky, the lower K/L in South leads to $\delta^N < \delta^S$ and capital flows from North to South.

Since this extended model incorporates both effects, it is not surprising that the direction of

[26] This corresponds to the "price version" of the Heckscher-Ohlin theorem. As shown in Appendix A.2, however, for general production functions in the two sectors, this positive mapping between p and K/L may fail to hold whenever the elasticity of substitution between capital and labor is much smaller in the unconstrained sector than in the constrained sector. The condition we derive in the Appendix resembles that derived by Amano (1977) for the case of the specific-factors model.

capital flows is now ambiguous. To illustrate this, we can log-differentiate equation (30) to obtain

$$\hat{\delta} = \left(\alpha_1 + \frac{\mu\theta}{1-\mu\theta}\right)\hat{\theta} - (1-\alpha_1)\widehat{K/L},$$

where hats denote proportional differences. The first term reflects the effect identified in our benchmark model. The second term relates to the standard Heckscher-Ohlin effect, which is at the core of Mundell's prediction that trade frictions foster capital inflows into the capital-scarce South. We summarize our result as follows:

Proposition 6 *Suppose $\theta^N > \theta^S$ and $K^N/L^N > K^S/L^S$. Provided that differences in capital-labor ratios are small relative to differences in financial contractibility, with limited trade, capital flows from South to North.*

5.3 Open Economy Equilibrium

Consider now the case in which South is small and thus faces exogenous relative prices p. We again focus on the case in which North shares the same preferences and technologies as South and θ^N satisfies Assumption 1'. This ensures that South does not specialize completely in the unconstrained sector and allocates an amount $\mu\theta K$ of capital to sector 1.[27]

As in our benchmark model, the allocation of labor across sectors is now uniquely pinned down by the condition equating the value of the marginal product of labor in the two sectors:

$$(1-\alpha_1)\,Z\left(\frac{\mu\theta K}{L_1}\right)^{\alpha_1} = p\,(1-\alpha_2)\,Z\left(\frac{(1-\mu\theta)\,K}{L-L_1}\right)^{\alpha_2}. \quad (31)$$

Although equation (31) does not provide a closed form solution for L_1, it is straightforward to see that, just as in the benchmark economy, L_1 is decreasing in p and increasing in θ. When South opens up to trade with a North that pins down a higher relative price p, South specializes in the labor-intensive sector, where financial frictions are lower. Notice that North pins down a higher relative price p not only because of the effect isolated in the benchmark model, but also because its larger capital-labor ratio is associated with a larger price of the labor-intensive good.

Letting $\psi_1 \equiv L_1/L$, we can next write wages and the rental rate of uninformed capital as a function of this endogenous variable

$$w = (1-\alpha_1)\,Z\left(\frac{\mu\theta}{\psi_1}\frac{K}{L}\right)^{\alpha_1} \quad (32)$$

$$\delta = \alpha_2 Z p\left(\frac{(1-\mu\theta)}{1-\psi_1}\frac{K}{L}\right)^{\alpha_2-1}. \quad (33)$$

[27] If θ^N is large enough, then South specializes in sector 2 to the point at which financial constraints cease to bind. In such a case, the model behaves as the standard Heckscher-Ohlin model and, if K^S/L^S is large enough, factor price equalization attains. As we will see later, however, even in this case trade integration raises the Southern rental rate δ^S relative to the Northern one. This is in sharp contrast to the result obtained in the standard Heckscher-Ohlin model.

Because ψ_1 is decreasing in p, it follows that both w and δ are increasing functions of p, regardless of differences in factor intensity and factor abundance. This implies that as in the Heckscher-Ohlin model, trade integration raises wages (in terms of the numeraire) in the capital-scarce South. Nevertheless, contrary to the standard model, the real return to uninformed capital also goes up as a result of trade integration. Even more surprisingly, using (31), (32) and (33), the ratio w/δ can be written as

$$\frac{w}{\delta} = \frac{(1-\alpha_2)(1-\mu\theta)}{\alpha_2(1-\psi_1)}\frac{K}{L},$$

which is decreasing in p, since ψ_1 is decreasing in p. In words, although trade integration raises wages, it raises the rental rate of capital even more. A necessary implication of this result is that, with trade opening, Southern wages increase in terms of the numeraire, but decrease relative to sector 2's prices. Using Jones' (1965) hat algebra, we have $\hat{\delta} > \hat{p} > \hat{w} > 0$, where hats denote percentage changes. This contrasts with the ranking dictated by the Stolper-Samuelson theorem: $\hat{w} > \hat{p} > 0 > \hat{\delta}$. In summary, we have derived the following anti-Stolper-Samuelson proposition:

Proposition 7 (Anti-Stolper-Samuelson) *Regardless of differences in factor intensity and relative factor abundance, trade integration with a more financially developed and capital abundant North reduces the wage-rental ratio in South. As a result, the rental rate increases relative to the price of both sectors, while wages increase relative to the price of the import sector, but fall relative to the price of the export sector.*

The intuition for this result is analogous to that in the benchmark model. Regardless of relative factor intensities, as p rises, sector 1 releases labor but not capital to sector 2, so w/δ has to adjust downwards to decrease its capital intensity.

This result bears some resemblance to the result in a specific factors model in which capital is sector specific but labor can move across sectors. As is well understood, in that type of model, trade integration increases the real reward of the capital specific to that sector, while having an ambiguous effect on real wages.[28] In our model, uninformed capital is *not* sector-specific, but the rents obtained by informed capital *are* sector-specific and this explains the similar predictions that emerge in both models.

5.4 Direction of Capital Flows

So far we have focused on studying the effects of trade integration in South, which correspond to studying an increase in the relative price p. Next we explore the relative factor prices in North and South, from which we learn the (desired) direction of capital flows in the free trade equilibrium. This analysis amounts to characterizing the comparative statics with respect to θ and K/L, given that both North and South share the same relative price p and are identical in all other dimensions.

[28] As a matter of fact, in our log-linear model, we can show that the real wage, that is $w/p^{1-\eta}$, is nececessarily higher under free trade. But this result is functional-form specific.

Simple log-differentiation of equations (31), (32) and (33) delivers:

$$\hat{w} = \frac{\alpha_1 \alpha_2}{\alpha_1 + \alpha_2 \left(\frac{\psi_1}{1-\psi_1}\right)} \left[\left(\frac{\psi_1}{1-\psi_1} - \frac{\mu\theta}{1-\mu\theta} \right) \hat{\theta} + \left(\frac{1}{1-\psi_1} \right) \widehat{K/L} \right]$$

$$\hat{\delta} = -\frac{(1-\alpha_2)\,\alpha_1}{\alpha_1 + \alpha_2 \left(\frac{\psi_1}{1-\psi_1}\right)} \left[\left(\frac{\psi_1}{1-\psi_1} - \frac{\mu\theta}{1-\mu\theta} \right) \hat{\theta} + \left(\frac{1}{1-\psi_1} \right) \widehat{K/L} \right],$$

where remember that ψ_1 is the share of labor allocated to sector 1.

These equations illustrate that the country with the larger capital-labor ratio (North) features a relatively higher wage and lower rental rate of capital. This is consistent with the predictions of the Heckscher-Ohlin model *outside the factor price equalization set*.

Furthermore, provided that $\psi_1 > \mu\theta^j$ holds in both countries, the larger θ in North contributes further to ensuring that the rental rate in South settles at a higher level than that in North: $\delta^S > \delta^N$. In our benchmark model, this was the only effect at play. There, we had that $\psi_1 = \eta$ and $\eta > \mu\theta$ necessarily held in an economy where financial frictions bind. In our more general model, the condition $\psi_1 > \mu\theta$ may fail to hold if α_1 is sufficiently larger than α_2.[29]

Still, even when $\psi_1 < \mu\theta$, our analysis suggests that large enough differences in K/L always ensure that $\delta^S > \delta^N$. How large need differences in K/L be? Our exposition following Proposition 2 in section 2.5 suggested a simple (and in our view plausible) condition that ensures that $\delta^S > \delta^N$, namely that North operates sector 2's technology at a higher capital-labor ratio than South does.

5.5 Discussion

In our benchmark model, we derived the result that the difference $\delta^S - \delta^N$ is negative with limited trade but positive with free trade. Our extended analysis with Heckscher-Ohlin features illustrates that neither of these two statements holds for arbitrary capital-labor differences across countries and sectors.

Nevertheless, our model does show that if $\delta^S - \delta^N$ is positive with limited trade, it is *even larger* with free trade. In other words, the incentive for capital to flow towards the South is always enhanced by trade integration. Similarly, if $\delta^S - \delta^N$ is negative under free trade, it is more negative with limited trade, and hence the incentives for capital to outflow from South are reduced by trade integration. In sum, in this extended model it continues to be the case that trade and capital flows are *complements* rather than substitutes.

The key conditions that ensure this result are that (i) South features a depressed relative price p in the closed-economy equilibrium, and that (ii) in the free trade equilibrium, the rental rate of uninformed capital in South is increasing in the relative price p. We showed above that these two conditions are satisfied whenever preferences and technologies are Cobb-Douglas. In Appendix A.2, we show that condition (ii) continues to be satisfied for general neoclassical production functions

[29] In particular, $\psi_1 > \mu\theta$ fails if $\alpha_1 - \alpha_2$ is large enough to make sector 1 operate at a higher capital-labor ratio than sector 2.

and homothetic preferences. This is related to the "full" generality of our anti-Stolper-Samuelson result in Proposition 7. As for condition (i), we show in Appendix A.2. that it is also generally satisfied, except for situations in which the elasticity of substitution between capital and labor is much smaller in the unconstrained sector than in the constrained sector *and* North-South differences in capital abundance are large relative to differences in financial development.

Given these results, we conclude that our model delivers a robust complementarity between trade flows and capital mobility.

6 Final Remarks

The main message of this paper is that when variation in financial development and financial dependence are significant determinants of comparative advantage, trade and capital flows become complements in financially underdeveloped countries. This complementarity is in sharp contrast to the substitutability that arises in the standard Heckscher-Ohlin-Mundell framework, and has important practical implications. For example, it says that deepening trade liberalization in South raises its ability to attract foreign capital. At the global level, it implies that protectionist policies aimed at reducing the so called "global imbalances" may backfire and exacerbate them. And while we do not analyze the normative aspects of liberalization processes, our framework hints that it is important for developing economies to liberalize trade before the capital account, if capital outflows are to be averted.

Our complementarity result follows from the fact that trade liberalization allows an allocation of labor to sectors that is independent of local demand conditions. As a result, a financially underdeveloped country is able to allocate a disproportionate amount of workers in sectors in which financial frictions are less severe, thereby increasing the marginal product of capital. Although we initially derived this result for the case in which South is a small open economy and preferences and technologies are Cobb-Douglas, we later demonstrated that the result is general. In particular, in a world in which countries differ only in financial development and sectors differ only in financial dependence, trade integration necessarily reduces (and actually overturns) the gap between the real return to capital in North and South. Furthermore, even after introducing Heckscher-Ohlin determinants of trade, our complementarity result continues to hold under weak conditions.

In order to keep our analysis focused, we only allowed physical and financial capital to flow across borders. Our framework can however easily accommodate mobility of informed capital. Remember that in our benchmark model the shadow value of entrepreneurial capital λ is larger in South than in North, that is $\lambda^S > \lambda^N$. If we allowed them to move, Northern entrepreneurs might want to migrate to South to run projects there (and they would surely want to if they could borrow a multiple $\theta^N - 1$ of their endowment when producing in South). We leave this issue for future work but point at two immediate and related implications of allowing for this sort of mobility. First, in contrast to the case of uninformed capital, "informed capital" migrates to the import-competing, financially dependent sector in South rather than to its export sector. As a result, informed capital flows are trade-reducing rather than trade-enhancing. Second, trade integration reduces the gap in the value of λ across countries, and thus the incentive for informed capital to flow across countries are reduced by trade integration. These two effects jointly suggest that informed capital mobility and trade are substitutes rather than complements.

References

Aghion, Philippe, Abhijit Banerjee, and Thomas Piketty (1999), "Dualism and Macroeconomic Volatility," *Quarterly Journal of Economics*, Vol. 114, No. 4, pp. 1359-1397.

Amano, Akihiro (1977), "Specific Factors, Comparative Advantage and International Investment," *Economica*, Vol. 44, No. 174, pp. 131-144.

Aoki, Kosuke, Gianluca Benigno, and Nobuhiro Kiyotaki (2006), "Adjusting to Capital Account Liberalization," unpublished manuscript London School of Economics.

Bardhan, Pranab and Kenneth Kletzer (1987), "Credit Markets and Patterns of International Trade," *Journal of Development Economics*, Volume 27, Issues 1-2, pp. 57-70.

Beck, Thorsten (2002), "Financial Development and International Trade : Is There a Link?," *Journal of International Economics*, Vol. 57, Issue 1, pp. 107-131.

Blanchard, Olivier J. (1985), "Debt, Deficits, and Finite Horizons," *Journal of Political Economy*, Vol. 93, No. 2, pp. 223-247.

Boyd, John H. and Bruce D. Smith (1997), "Capital Market Imperfections, International Credit Markets and Nonconvergence," *Journal of Economic Theory*, 73:2 335-364.

Brecher, Richard A. and Ronald Findlay (1983), "Tariffs, Foreign Capital and National Welfare with Sector-Specific Factors," *Journal of International Economics*, Volume 14, Issues 3-4, pp. 277-288.

Caballero, Ricardo J., Emmanuel Farhi, and Pierre-Olivier Gourinchas (2006), "An Equilibrium Model of 'Global Imbalances' and Low Interest Rates," manuscript Massachusetts Institute of Technology.

Gertler, Mark and Kenneth S. Rogoff (1990), "North-South Lending and Endogenous Domestic Capital Market Inefficiencies," *Journal of Monetary Economics*, 26:2, pp. 245-266.

Jones, Ronald W. (1965), "The Structure of Simple General Equilibrium Models," *Journal of Political Economy*, 73, pp. 557-572.

Jones, Ronald W. (1971), "A Three-Factor Model in Theory, Trade, and History," in Bhagwati, et al., eds., Trade, Balance of Payments, and Growth: Essays in Honor of C. P. Kindleberger, Amsterdam: North-Holland.

Jones, Ronald W. (1989), "Co-movements in Relative Commodity Prices and International Capital Flows: A Simple Model," *Economic Inquiry*, Volume 27, Issue 1, pp. 131-41.

Ju, Jiandong and Shang-Jin Wei (2006), "Endowment Versus Finance: A Wooden Barrel Theory of International Trade," CEPR Discussion Paper 5109.

King, Robert G. and Ross Levine (1993), "Finance and Growth: Schumpeter Might be Right," *Quarterly Journal of Economics*, Vol. 108, No. 3, pp. 717-737.

Kraay, Aart, Norman Loayza, Luis Servén, and Jaume Ventura (2005), "Country Portfolios," *Journal of the European Economic Association*, 3:4, pp. 914-945.

Lucas, Robert (1990), "Why Doesn't Capital Flow from Rich to Poor Countries?" *American Economic Review*, 80:3, pp.92-96.

Manova, Kalina (2007), "Credit Constraints, Heterogeneous Firms and International Trade, " unpublished manuscript, Harvard University.

Markusen, James R. (1983), "Factor Movements and Commodity Trade as Complements," *Journal of International Economics*, Volume 14, Issues 3-4, pp. 341-356.

Matsuyama, Kiminori (2005), "Credit Market Imperfections and Patterns of International Trade and Capital Flows," *Journal of the European Economic Association*, Vol. 3, No. 2-3, pp. 714-723.

Mendoza, Enrique G., Vincenzo Quadrini, and José-Victor Rios-Rull (2007), "Financial Integration, Financial Deepness and Global Imbalances," NBER Working Paper No. 12909.

Mundell, Robert A. (1957), "International Trade and Factor Mobility," *American Economic Review*, Vol. 47, No. 3, pp. 321-335.

Neary, J. Peter (1995), "Factor Mobility and International Trade," *Canadian Journal of Economics* , Vol. 28, Special Issue, pp. S4-S23.

Rajan, Raghuram G., and Luigi Zingales (1995), "What Do We Know About Capital Structure? Some Evidence from International Data," *Journal of Finance*, 50:5, pp. 1421-1460.

Rajan, Raghuram G., and Luigi Zingales (1998), "Financial Dependence and Growth," *American Economic Review* 88:3, 559-586.

Reinhart, Carmen M. and Kenneth S. Rogoff (2004), "Serial Default and the "Paradox" of Rich to Poor Capital Flows," *American Economic Review*, 94:2, pp. 52-58.

Samuelson, Paul A. (1971), "Ohlin Was Right," *Swedish Journal of Economics*, Vol. 73, pp. 365-384.

Shleifer, Andrei and Robert W. Vishny (1997), "A Survey of Corporate Governance," *Journal of Finance*, Vol. 52, No. 2., pp. 737-783.

Shleifer, Andrei and Daniel Wolfenzon (2002), "Investor Protection and Equity Markets," *Journal of Financial Economics*, 66:1, pp. 3-27.

The Economist (2006), "More Pain than Gain." September 14th.

Tirole, Jean (2006), *The Theory of Corporate Finance*, Princeton: Princeton University Press.

Weil, Philippe (1989), "Overlapping Families of Infinitely-Lived Agents," *Journal of Public Economics*, Vol. 38, Issue 2, pp. 183-198.

Wynne, José (2005), "Wealth as a Determinant of Comparative Advantage," *American Economic Review*, 2005, Vol. 95, Issue 1, pp. 226-254.

Appendix

A. 1 The Dynamic Model without Lump-Sum Taxation

In the dynamic version of our model developed in the main text, we assumed that entrepreneurial rents were taxed away and distributed back in a lump-sum manner to the population at large. In this Appendix we relax this assumption and characterize the different wealth dynamics of agents born as entrepreneurs and as non-entrepreneurs. The main complication derives from the fact that the share of capital in the hands of entrepreneurs is no longer pinned down by the parameter μ, but is also a function of other equilibrium variables. As a result, this share differs in the closed-economy and free trade equilibria. In other words, trade integration leads to an endogenous relaxation or tightening of the financial constraint. Despite these complications, we show that our qualitative results on section 4 remain unaltered, and that Assumption 1 still suffices for the financial constraint to be binding.

As in the main text, we let V_t^j denote the value of the tradable stock of capital in country $j = N, S$ at any instant t and q_t^j is the price of a unit of this capital. The return on holding one unit of uninformed capital in country j again satisfies:

$$r_t^j q_t^j = \delta_t^j + \dot{q}_t^j. \tag{34}$$

Importantly, note that this characterizes the value of a unit of uninformed capital held by everybody (entrepreneurs and not). Capital is worth more to entrepreneurs since they obtain an excess return, but this excess return is non-tradable. Still, the higher income that entrepreneurs receive from capital raises asset demand and hence bids up the price of capital.

Let $W_t^{j,i}$ denote the savings accumulated by agents of type $i = e$ (entrepreneurs) and $i = u$ (uninformed) in country j up to date t. Savings decrease with withdrawals (deaths), and increase with labor, entrepreneurial income and the return on accumulated savings:

$$\dot{W}_t^{j,u} = -\phi W_t^{j,u} + (1-\mu) w_t^j L + r_t^j W_t^{j,u}. \tag{35}$$

$$\dot{W}_t^{j,e} = -\phi W_t^{j,e} + \mu w_t^j L + \lambda_t^j \theta^j K_t^e + r_t^j W_t^{j,e}. \tag{36}$$

with $K_t^e + K_t^u = K$.

With a closed capital account, it must be the case that savings equal the value of the capital stock at all times:

$$W_t^j = q_t^j K. \tag{37}$$

Replacing (37) into (34), and using the sum of (35) and (36), we have that

$$\phi W_t^j = Y_t^j \equiv \delta_t^j K + w_t^j L + \lambda_t^j \theta^j K_t^e.$$

We next explore the steady state of this model. While entrepreneurs obtain a higher income period by period, the finite-horizon nature of our model implies that the distribution of wealth converges to a non-degenerate steady state. From equations (35) and (36), together with $W_t^{j,e} = q_t^j K^e$, we have

$$W^{j,u} = \frac{(1-\mu) w^j}{\phi - r^j} \tag{38}$$

and

$$W^{j,e} = \frac{\mu w^j}{\phi - r^j - \lambda^j \theta^j / q^j} \tag{39}$$

Furthermore, as in the main text, the interest rate is given by

$$r^j = \phi \frac{\delta^j K}{Y^j}. \tag{40}$$

Notice that whenever $\lambda^j \rightarrow 0$, the share of wealth in the hands of entrepreneurs converges to μ, just as in the static model. With $\lambda^j > 0$, the higher entrepreneurial income translates into a steady state entrepreneurial share of wealth $\tilde{\mu}$ that is larger than μ. Importantly, this share $\tilde{\mu}$ is a function of factor prices (as indicated by equation (39)), and thus it will vary depending on whether the economy is open to international trade or not. Similarly, in the static model factor prices were affected by the share of wealth (capital) in the hands of entrepreneur. These interactions between equilibrium factor prices and the tightness of the financial constraint complicate the analysis, but as illustrated below the analysis remains tractable.

Closed Economy Equilibrium

Consider first the static closed economy equilibrium. From equations (38) and (39), and using the fact that $r_t^j q_t^j = \delta_t^j$ in steady state, the share of wealth (and capital) in the hands of entrepreneurs is given by

$$\tilde{\mu} = \frac{\left(\frac{\phi}{r} - 1\right)\mu}{\left(\frac{\phi}{r} - 1\right) - \frac{\lambda}{\delta}\theta\left(1 - \mu\right)}, \tag{41}$$

where we have dropped country superscripts and time subscripts for simplicity. It is clear that whenever $\lambda > 0$, we have $\tilde{\mu} > \mu$. This may suggest that Assumption 1 is no longer sufficient to ensure that financial constraints bind in the steady state. Note however that if we had $\tilde{\mu}\theta > \eta > \mu\theta$, then the first inequality would imply $\lambda = 0$ and $\tilde{\mu} = \mu$, thus contradicting the second inequality. Hence, we must have either $\mu\theta < \tilde{\mu}\theta < \eta$ or $\tilde{\mu}\theta = \mu\theta > \eta$. Assumption 1 then suffices to ensure that the first of these cases applies.

Next, from equations (10) and (12), we have that in the autarky equilibrium, the ratio λ/δ is given by

$$\frac{\lambda}{\delta} = \frac{\left(1 - \tilde{\mu}\theta\right)\eta}{\tilde{\mu}\theta\left(1 - \eta\right)} - 1, \tag{42}$$

where we have replaced μ with $\tilde{\mu}$, since the fraction of the capital stock in the hands of entrepreneurs is now given by $\tilde{\mu}$, not μ.

On the other hand, from equation (40), the ratio r/ϕ is given by $\delta^j K/Y^j$. Using equations (9), (10) and (12) with $\tilde{\mu}$ replacing μ, we obtain:

$$r_{autarky} = \phi\alpha\left(\frac{1-\eta}{1-\tilde{\mu}\theta}\right). \tag{43}$$

where again $\tilde{\mu}$ is replacing μ.

Plugging (42) and (43) into (41) then yields:

$$\tilde{\mu} = \frac{\left(\frac{\phi}{\alpha\phi\left(\frac{1-\eta}{1-\tilde{\mu}\theta}\right)} - 1\right)\mu}{\left(\frac{\phi}{\alpha\phi\left(\frac{1-\eta}{1-\tilde{\mu}\theta}\right)} - 1\right) - \theta\left(\frac{(1-\tilde{\mu}\theta)\eta}{\tilde{\mu}\theta(1-\eta)} - 1\right)(1-\mu)}, \tag{44}$$

which implicitly defines $\tilde{\mu}$ as a function of θ and other parameter values. This expression is cumbersome, but in order to study the effects of financial development θ on the variables of interest (wages, rental rates, interest rates...), it suffices to study how $\Lambda \equiv \tilde{\mu}\theta$ varies with θ.

Multiplying both sides of (44) by θ and rearranging we can implicitly define Λ as a function of θ.

$$\Lambda\left(1-\frac{\left(\frac{(1-\Lambda)\eta}{\Lambda(1-\eta)}-1\right)}{\left(\frac{1-\Lambda}{\alpha(1-\eta)}-1\right)}\theta\left(1-\mu\right)\right)=\mu\theta. \tag{45}$$

We next show that Λ is increasing in θ. Since the left-hand-side of (45) is decreasing in θ, while the right-hand-side is increasing in θ, it suffices to show that the left-hand-side of (45) is increasing in Λ. A few steps of algebra yield

$$\frac{\partial\left(\Lambda\left(1-\frac{\left(\frac{(1-\Lambda)\eta}{\Lambda(1-\eta)}-1\right)}{\left(\frac{1-\Lambda}{\alpha(1-\eta)}-1\right)}\theta\left(1-\mu\right)\right)\right)}{\partial\Lambda}=\frac{g\left(\Lambda\right)}{\left(\alpha\eta-\Lambda-\alpha+1\right)^{2}},$$

where

$$g\left(\Lambda\right)=\left(1-2\left(1-\alpha(1-\eta)\right)\Lambda+\Lambda^{2}+\alpha(1-\alpha)(1-\eta)(1-\mu)\theta-2\alpha(1-\eta)+\alpha^{2}(1-\eta)^{2}\right).$$

Hence we need only show that $g\left(\Lambda\right)>0$ for all Λ in the relevant range. But note that

$$g'\left(\Lambda\right)=-2\left(1-\alpha+\alpha\eta-\Lambda\right)<0,$$

since $\Lambda=\tilde{\mu}\theta<\eta$.[30] Hence, we need only show that $g\left(\Lambda\right)>0$ when evaluated at the highest possible value of Λ, which is η. But this follows from

$$g\left(\eta\right)=\left(1-\alpha\right)\left(1-\eta\right)\left(1-\eta+\theta\alpha-\alpha+\alpha\left(\eta-\theta\mu\right)\right)>0.$$

This proves that in the steady state of our model with endogenous tightness of the credit constraint, $\tilde{\mu}\theta$ is still necessarily an increasing function of θ. From inspection of the equilibrium values of the closed-economy equilibrium, we can immediately conclude that wages, the rental rate of uninformed capital and the interest rate are larger in a financial developed North than in a financial underdeveloped South. Hence, for large enough trade frictions it continues to be the case that there is an incentive for capital (both physical as well as financial) to flow out of South.

Free Trade Equilibrium

In the main text, we showed that these last conclusions are radically reversed whenever trade in goods is sufficiently free. We next show that this reversal continues to be the case in this more complicated dynamic model.

With free trade, the equilibrium steady state value of r and $\tilde{\mu}$ are still given by equations (40) and (41), but the equilibrium values of factor prices are now different functions of $\tilde{\mu}$. Using equations (14), (15) and (16), we have

$$\frac{\lambda}{\delta}=p^{-1/\alpha}-1$$

[30] We proved above that Assumption 1 is sufficient to ensure this.

and

$$r_{freetrade} = \phi\alpha\left(\frac{p^{1/\alpha}}{\tilde{\mu}\theta + (1-\tilde{\mu}\theta)\,p^{1/\alpha}}\right),$$

where again $\tilde{\mu}$ replaces μ.

Plugging these two expressions into (41) yields

$$\tilde{\mu} = \frac{\left(\frac{\phi}{\alpha\phi\left(\frac{p^{1/\alpha}}{\tilde{\mu}\theta+(1-\tilde{\mu}\theta)p^{1/\alpha}}\right)} - 1\right)\mu}{\left(\frac{\phi}{\alpha\phi\left(\frac{p^{1/\alpha}}{\tilde{\mu}\theta+(1-\tilde{\mu}\theta)p^{1/\alpha}}\right)} - 1\right) - \left(p^{-1/\alpha} - 1\right)\theta\,(1-\mu)},$$

from which we have that $\Lambda = \tilde{\mu}\theta$ must satisfy

$$\Lambda\left(1 - \left(\frac{p^{-1/\alpha} - 1}{\frac{\Lambda+(1-\Lambda)p^{1/\alpha}}{\alpha p^{1/\alpha}} - 1}\right)\theta\,(1-\mu)\right) = \mu\theta.$$

As in the closed economy equilibrium, to show that Λ is increasing in θ, it suffices to show that the left-hand-side of the above equation is increasing in Λ. But note that this is clearly true, since $\Lambda + (1-\Lambda)\,p^{1/\alpha}$ is increasing in Λ for $p < 1$. Hence, we again have that $\tilde{\mu}\theta$ is an increasing function of θ.

This result ensures that, in the free trade equilibrium, wages are increasing in θ, while the rental rate of uninformed capital and the interest rate are *decreasing* in θ. Hence the direction of both types of capital flows are from North to South, just as in the model with "exogenous" credit constraints.

A. 2 The Static Model with General Functional Forms

In this Appendix we extend the static model to general neoclassical production functions and general homothetic preferences. In particular, we assume that each country allows a representative consumer with identical homothetic preferences, by which we can express demand in sector 1 relative to demand in sector 2 as a function $\kappa(p)$ of the relative price p. We also assume that both countries have access to the same technologies to produce goods 1 and 2, and that these technologies feature constant returns to scale, continuously diminishing marginal products and no factor intensity reversals. Letting $k = K/L$, we denote output per worker under each of these technologies by $f_1(k)$ and $f_2(k)$.

Let us first consider the equilibrium of the closed economy. As in the main text, we assume that θ is low enough to ensure that the credit constraint binds and the amount of capital allocated to sector 1 is $K_1 = \mu\theta K$. The equilibrium conditions of this economy are:

$$\begin{aligned}
\psi_1 f_1\left(\frac{\mu\theta}{\psi_1}\frac{K}{L}\right) &= \kappa(p)(1-\psi_1)\,f_2\left(\frac{1-\mu\theta}{1-\psi_1}\frac{K}{L}\right)\\
f_1'\left(\frac{\mu\theta}{\psi_1}\frac{K}{L}\right) &= \delta + \lambda\\
f_1\left(\frac{\mu\theta}{\psi_1}\frac{K}{L}\right) - f_1'\left(\frac{\mu\theta}{\psi_1}\frac{K}{L}\right)\frac{\mu\theta}{\psi_1}\frac{K}{L} &= w\\
pf_2'\left(\frac{1-\mu\theta}{1-\psi_1}\frac{K}{L}\right) &= \delta\\
pf_2\left(\frac{1-\mu\theta}{1-\psi_1}\frac{K}{L}\right) - pf_2'\left(\frac{1-\mu\theta}{1-\psi_1}\frac{K}{L}\right)\frac{1-\mu\theta}{1-\psi_1}\frac{K}{L} &= w
\end{aligned} \tag{46}$$

The first condition ensures goods-market equilibrium. The next two conditions characterize optimality in sector 1, while the last two ones characterize optimal behavior in sector 2. Although it is impossible to solve for equilibrium prices and the allocation of labor to each sector as a function of parameters, we can learn a great deal about the characteristics of the equilibrium by using Jones' (1965) hat algebra approach.

Log-differentiating the above system (46) and after a few manipulations we obtain:

$$\begin{aligned}
\hat{\psi}_1 + \alpha_1 \left(\hat{\theta} - \hat{\psi}_1 + \hat{k}\right) &= -\frac{\psi_1}{(1-\psi_1)}\hat{\psi}_1 + \varepsilon\widehat{p} + \alpha_2 \left(-\frac{\mu\theta}{1-\mu\theta}\widehat{\theta} + \frac{\psi_1}{(1-\psi_1)}\hat{\psi}_1 + \hat{k}\right) \\
-\frac{(1-\alpha_1)}{\sigma_1}\left(\hat{\theta} - \hat{\psi}_1 + \hat{k}\right) &= \frac{\delta}{\delta+\lambda}\hat{\delta} + \frac{\lambda}{\delta+\lambda}\hat{\lambda} \\
0 &= (1-\alpha_1)\,\hat{w} + \alpha_1\left(\frac{\delta}{\delta+\lambda}\hat{\delta} + \frac{\lambda}{\delta+\lambda}\hat{\lambda}\right) \\
\hat{\delta} &= \widehat{p} - \frac{(1-\alpha_2)}{\sigma_2}\left(-\frac{\mu\theta}{1-\mu\theta}\widehat{\theta} + \frac{\psi_1}{(1-\psi_1)}\hat{\psi}_1 + \hat{k}\right) \\
\widehat{p} &= (1-\alpha_2)\,\hat{w} + \alpha_2\hat{\delta},
\end{aligned} \tag{47}$$

where hats denote percentage changes in the variables, and the following definitions have been used:

$$\begin{aligned}
\alpha_i &\equiv f_i'(k_i)\,k_i/f_i(k_i) \\
\sigma_i &\equiv \frac{\partial \ln k_i}{\partial \ln\left(\frac{f_i(k_i)-f_i'(k_i)k_i}{f_i'(k_i)}\right)} \\
\varepsilon &\equiv \kappa'(p)\,p/\kappa(p)
\end{aligned}$$

These correspond to sector i's elasticity of output with respect to capital, sector i's elasticity of substitution between capital and labor, and the elasticity of substitution in consumption between goods 1 and 2.

The system (47) can be solved to obtain $\hat{p}$, $\hat{w}$, $\hat{\delta}$, $\hat{\lambda}$, and $\hat{\psi}_1$ as a function of $\widehat{\theta}$ and $\hat{k}$. These expressions shed light on the cross-country variation in prices and the allocation of labor under autarky. We are particularly interested in exploring whether the relative price p is larger in North or South. After some fairly cumbersome algebra we obtain

$$\begin{aligned}
\hat{p} &= \frac{\frac{\left(1-\alpha_1+\frac{\psi_1}{(1-\psi_1)}(1-\alpha_2)\right)}{\left(1+\frac{\sigma_1\alpha_2}{\alpha_1\sigma_2}\frac{\psi_1}{(1-\psi_1)}\right)}\left(1+\frac{\sigma_1}{\alpha_1}\frac{\alpha_2}{\sigma_2}\frac{\mu\theta}{1-\mu\theta}\right) + \left(\alpha_1 + \alpha_2\frac{\mu\theta}{1-\mu\theta}\right)}{\varepsilon + \frac{\sigma_1}{\alpha_1}\frac{\left(1-\alpha_1+\frac{\psi_1}{(1-\psi_1)}(1-\alpha_2)\right)}{\left(1+\frac{\sigma_1\alpha_2}{\alpha_1\sigma_2}\frac{\psi_1}{(1-\psi_1)}\right)}}\widehat{\theta} \\
&\quad + \frac{\left(\alpha_1\sigma_2\,(1-\alpha_2) - (1-\alpha_1)\,\sigma_1\alpha_2\right)}{\left(\varepsilon + \frac{\sigma_1}{\alpha_1}\frac{\left(1-\alpha_1+\frac{\psi_1}{(1-\psi_1)}(1-\alpha_2)\right)}{\left(1+\frac{\sigma_1\alpha_2}{\alpha_1\sigma_2}\frac{\psi_1}{(1-\psi_1)}\right)}\right)\left(\alpha_1\sigma_2\,(1-\psi_1) + \psi_1\sigma_1\alpha_2\right)}\hat{k}
\end{aligned} \tag{48}$$

It is clear that, other things equal, the relative price p is larger in an economy with a higher degree of financial contractibility θ. This is the effect isolated by our benchmark model, and it is now apparent that it holds more generally. It is straightforward to show that, in the case symmetric productions functions, this immediately implies that $p < 1$ whenever financial constraints bind. The reason for this is that as θ rises, equilibrium values converge continuously to the allocations of an economy where financial constraints do not bind, and in the latter economy we must have $p = 1$.

Equation (48) also shed lights on the effects of a larger aggregate capital-labor ratios on the relative price p. In the Cobb-Douglas case we had a positive link between p and K/L. In the general case, this continues to be the case provided that

$$\alpha_1\sigma_2(1-\alpha_2) > (1-\alpha_1)\sigma_1\alpha_2. \tag{49}$$

In a frictionless economy, this condition would simply be $\alpha_1 > \alpha_2$, which is our assumption in the main text. Similarly, when $\sigma_1 = \sigma_2$ (which is satisfied in our Cobb-Douglas case), the condition $\alpha_1 > \alpha_2$ is again sufficient to ensure that p is increasing in K/L. When σ_2 is sufficiently low, however, it may be the case that p is decreasing in K/L. Intuitively, when capital and labor are very complementary in sector 2, an increase in the capital stock increases the allocation of labor to that sector almost proportionately (regardless of factor intensities), and thus expands production in sector 2 relative to production in sector 1.[31] It should be clear, however, that even when condition (49) fails to be satisfied, the relative price p continues to be lower in South whenever cross-country differences in θ are larger relative to cross-country differences in K/L.

We can now move to an analysis of the small open economy. Our goal here is to show that, for general technologies and preferences, the rental rate of uninformed capital is an increasing function of p. We again use Jones' (1965) hat algebra approach, this time ignoring the goods-market condition and treating p as parametric. This amounts to solving for $\hat{w}$, $\hat{\delta}$, $\hat{\lambda}$, and $\hat{\psi}_1$ as a function of $\hat{p}$, $\hat{\theta}$ and $\hat{k}$. We focus here on the value of $\hat{\delta}$:

$$\hat{\delta} = \frac{(\psi_1\sigma_1 + \alpha_1\sigma_2(1-\psi_1))}{(\alpha_1\sigma_2(1-\psi_1) + \psi_1\sigma_1\alpha_2)}\hat{p} - \frac{(\psi_1 - \theta\mu)\,\alpha_1(1-\alpha_2)}{(\alpha_1\sigma_2(1-\psi_1) + \psi_1\sigma_1\alpha_2)(1-\theta\mu)}\hat{\theta} - \frac{\alpha_1(1-\alpha_2)}{(\alpha_1\sigma_2(1-\psi_1) + \psi_1\sigma_1\alpha_2)}\hat{k}.$$

Notice that the rental rate δ is necessarily increasing in p. This confirms that it is generally the case that, provided that trade integration raises the relative price p in South, it also raises the real reward to uninformed capital. In fact, the coefficient of $\hat{p}$ is strictly larger than one (for $\alpha_2 < 1$), and thus δ/p is also increasing in the relative price p. In words, the return to uninformed capital increases in terms of both sectors' output.

As discussed in the main text, this rise in δ (and δ/p) is the key feature that leads to complementarity between trade flows and capital flows in the model. Whether the increase in δ is large enough to lead to $\delta^S > \delta^N$ with free trade depends again on whether relative factor endowment differences are large relative to factor intensity differences and differences in financial contractibility. As a matter of fact, the condition that ensures $\delta^S > \delta^N$ is completely analogous to that in the model with Cobb-Douglas functional forms, namely:

$$\left(\frac{\psi_1}{1-\psi_1} - \frac{\mu\theta}{1-\mu\theta}\right)\hat{\theta} + \left(\frac{1}{1-\psi_1}\right)\widehat{K/L} > 0.$$

Or, more simply, all that we require is that North operates sector 2's technology at a higher capital-labor ratio than South does.

It is straightforward to show that this condition will hold in the case of symmetric (neoclassical) production functions and no differences in K/L across countries. In such a case, the analog of equation (5) equating the value of the marginal product of labor across sectors is

$$F_L\left(\frac{\mu\theta^j K}{\psi_1^j L}\right) = pF_L\left(\frac{(1-\mu\theta^j)\,K}{\left(1-\psi_1^j\right)L}\right), \text{ for } j = N, S, \tag{50}$$

where $F_L(\cdot)$ denotes the marginal product of labor and $F_L'(\cdot) > 0$. As shown above, for general homothetic

[31] Our condition is closely related to Amano's (1977) analysis of a proportional increase in the endowment of *both* specific factors in the context of the specific-factors model.

preferences and symmetric production functions, it continues to be the case that $p < 1$ as long as the financial constraint binds in North. >From equation (50), this immediately implies that $\psi_1^j / \left(1 - \psi_1^j\right) > \mu\theta^j / \left(1 - \mu\theta^j\right)$, and thus $\delta^S > \delta^N$.

Finally, note too that in the case of symmetric technologies and equal aggregate capital-labor ratios, the last equation of the system in (47) immediately implies that $w^S < w^N$. This is because countries differ only in their θ's, and thus the sign of $dw/d\theta$ has to be the opposite of the sign of $d\delta/d\theta$. Manipulating the same system (47), one can also show that for the case of symmetric technologies (i.e., $\alpha_1 = \alpha_2$ and $\sigma_1 = \sigma_2$) we necessarily have that $\lambda^S > \lambda^N$ (details available upon request). This completes the proof that all the statements in Proposition 2 hold for general symmetric production technologies and no relative factor endowment differences across countries.