Centre for Economic Policy Research

BANCO DE ESPAÑA
Eurosistema

EUROPEAN SUMMER SYMPOSIUM IN INTERNATIONAL MACROECONOMICS (ESSIM) 2010

Hosted by
Banco de España

Tarragona, Spain; 25-28 May 2010

Industrial Structure and Financial Capital Flows

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First Draft: October 7, 2008
This Draft: May 10, 2010

Abstract

This paper provides a new theory of international capital flows. In a framework that integrates a factor-proportions paradigm of trade and financial asset trade, a novel force emerges: capital tends to flow towards countries that become more specialized in capital-intensive industries. This 'composition effect' competes with the standard force which channels capital towards where it is more scarce. If the composition effect dominates, capital flows away from the country hit by a positive labor force/technology shock—"a flow reversal". One implication is that rich countries' current account deficits may be a consequence of their shift towards capital-intensive industries.

JEL Classification: **F21, F32, F41**

Key Words: Globalization, capital flows, current account, asset prices, demographics, factor-proportions trade.

*I would like to thank Kenneth Rogoff for his continual guidance and support. I am grateful to Robert Barro, Emmanuel Farhi and Gita Gopinath for their invaluable advice. Professors Pol Antrás, John Campbell, Richard Cooper, Arnaud Costinot, Elhanan Helpman, Nathan Nunn, and Harvard International Economics Workshop and Macroeconomics workshop participants offered helpful comments. I thank Gianluca Benigno, Stéphane Guibaud, Kai Guo, Ethan Ilzetzki, Oleg Itskhoki, Karthik Kalyanaraman, Jean Lee, Hélène Rey, Dan Sacks, and Alwyn Young, and in particlar Florent Ségonne. I thank the NBER Aging and Health fellowship for financial support.

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1 Introduction

Commodity trade and financial capital flows have both played primary roles in the process of globalization. They are often termed as "the two engines of integration". Until now, little has been studied on how they interact. The conventional separation of models of international macroeconomics and trade theory ignores the impact of macroeconomic dynamics on the structure of trade and the aggregate feedback effects of trade patterns. This paper demonstrates that this interaction can become crucial in determining the global allocation of financial capital and the behavior of asset prices, shedding new light on widely-debated issues of global imbalances.

The main purpose of this paper is to develop a stochastic, general-equilibrium framework that integrates trade and financial capital flows, allowing for their interplay. With only basic ingredients, it derives new and often surprising results on how the global equilibrium responds to a variety of shocks and structural changes. In contrast to standard frameworks, a permanent labor-force or labor productivity boom in a country can induce a capital *outflow* from that country. Trade and financial liberalization can cause capital to flow from developing countries to advanced economies. The underlying mechanism hinges on a new force driving international capital flows: financial capital tends to flow towards economies that become more specialized in capital-intensive sectors (a composition effect). Simultaneously present is the standard, "convergence effect" which channels capital towards the location where the effective capital-labor ratio is lower. These two forces can become competing, and the direction of capital flows depends on which of the two effects dominates.

Two salient international developments of the past few decades have been globalization and the rapid labor force and labor productivity growth in emerging markets.[1] The implication of these changes, as predicted by the standard international-macroeconomic framework, is that South should be net importers of capital because of the higher investment opportunities it offers. Yet patterns in the data show exactly the opposite.

The implicit assumption, however, is that countries cannot engage in intra-temporal, commodity trade but only in intertemporal trade. This assumption becomes untenable when global forces such as those of the recent decades fundamentally alter a country's comparative advantage, and consequently, its structure of trade.[2] How does the change in specialization

[1]Freeman (2004) estimates that higher population growth in developing countries, and the integration of China, India, and ex-Soviet bloc increased the labor force in developing countries from 680 million workers in 1990 (before the integration of these countries) to 2.23 billion workers in 2000, of which these countries contributed 1.38 billion. This is referred to as the "Great Doubling" of the world labor force. Herd and Dougherty (2007) estimates that India's labor productivity grew by 4.36% over the period 1990-99, and 3.76% over 2000-05. In China, labor productivity grew by 8.66% over 1990-99, and 7.67% over 1999-2005.

[2]Further evidence is provided by Romalis (2004), which finds that countries tend to capture larger shares of world production and trade of commodities that require more intensive use of their abundant factors, and

patterns in turn affect capital flows? An integrated framework which permits this very interaction can make markedly different predictions on capital flows from the standard model. A country which becomes relatively capital abundant,[3] and subsequently shifts resources from labor-intensive industries to capital-intensive industries, sees a rise in the *share* of capital-intensive goods in total domestic output and hence a rise in its investment share of output. The other country, which has become more labor-intensive, sees the opposite. So, while on the one hand, the standard, "convergence" force exerts its impact by drawing capital away from industrialized 'North' to emerging 'South' (where the capital-labor ratio is lower), this force is offset by the "composition" effect, which raises North's demand for capital and tends to draw capital towards North. If sectors are sufficiently different so that specialization patterns are pronounced enough, the composition effect dominates, causing a "reverse capital flow"(from South to North); investment comoves across countries, and asset prices rise globally rather than just locally in South. The prediction, thus, of the emerging periphery running a current account surplus and the industrialized core running a deficit is more consistent with the data than that of the standard model in which the "convergence" effect is the only impetus to capital flows and predicts just the opposite.

The framework developed in this paper is a stochastic, two country, overlapping generations model with production and capital accumulation, based on the closed-economy, one-good framework in Abel (2003).[4] I incorporate multiple sectors that differ in factor intensity to capture factor-endowment trade and allow for financial capital to flow across borders. The key difference between this model and a dynamic Hecksher-Ohlin model is the existence of capital adjustment costs, which endogenously determine the price of capital, and also serve to pin down the capital stock in a world of factor price equalization.[5] The framework is analytically tractable despite the numerous features that are embedded in this model. Semi-closed form or full closed-form solutions obtained in different cases make trans-

that countries that rapidly accumulate a factor see their production and export structures systematically shift towards industries that intensively use that factor. Discussions on why earlier works failed to find factor content of trade can be found in the works of Donald R. Davis et al.(1997), Davis and David E. Weinstein (2001a), and Alexander Wolfson (1999).

[3]The notion of 'capital abundance' still exists despite the fact that capital is internationally mobile. Here, since capital stock is fixed for one period, a labor force increase in one country causes its aggregate capital-labor ratio to fall.

[4]Abel (2003) develops a closed-economy, one-sector overlapping-generations model with capital adjustment costs to analyze the effect of a baby boom on stock prices and capital accumulation.

[5]In a Hecksher-Ohlin world with factor price equalization, capital earns the same returns everywhere and can be located anywhere. One conventional way to pin down the capital stock at the country level is to impose balanced trade (that capital needs to stay within borders). In this case, North's increase in the demand for capital must be met entirely domestically, through sectoral reallocation and savings. But rather than imposing the unrealistic assumption of financial autarky, another way to pin down the path of capital while allowing for both trade and financial openness is to introduce adjustment costs to capital, which temporarily breaks FPE. Further discussions on adjustment costs can be found in Section 4.3.

parent the underlying mechanisms that are key to understanding the new results.

In this integrated framework, the standard neoclassical case becomes only one of two special cases. When there is a single sector, or when there are multiple sectors but feature no differences in factor intensities, only the convergence effect is present. A second special case, in which the most labor-intensive sector uses only labor as an input to production, isolates the composition effect and illustrates a scenario in which factor price equalization leads investment and asset prices to always comove across countries. The more general case is the one in which the convergence effect and the composition effect coexist and primitive parameters determine the relative strength of the two. The last two cases are analyzed separately and brought into sharp contrast with the first.

The framework can be easily extended and provides a rich setting for analyzing a host of issues. One important prediction is that even if two countries have the *same* returns to capital prior to opening up their economies, net capital flows are not necessarily precluded once they integrate. A rich country which features a higher total factor productivity, and therefore a higher capital-labor ratio, exports capital-intensive goods when opening up to trade. Insofar as countries' industrial structures change, the composition effect causes rich countries to experience a net capital *inflow*. Further, the sequencing of trade and financial liberalization have different implications for developing countries. While simultaneous liberalization may lead to a capital outflow in South, and an asset price drop, trade liberalization without financial liberalization will prevent such an outflow and lead to an asset price boom.

Beyond its predictions for global imbalances, the framework can also shed light on the widely-debated "asset meltdown hypothesis". While some believe that the "age wave" hitting industrialized countries will precipitate a large drop in asset prices as post-war baby boomers start selling assets for retirement consumption to a smaller young cohort, the predictions of the framework suggest that the fast-growing and young developing countries can potentially emerge as a remedy. Higher demand for industrialized countries' assets from developing countries, as industrial countries become more specialized in capital-intensive sectors, will help sustain their asset prices despite the imminent reduction of their labor force. Yet, allowing for the trade channel of adjustment is key.

Some simple illustrations of the potential channels of interaction between trade and capital flows in a two-country, two-sector framework has already been explored in earlier works such as Mundell (1957). In that framework, trade and capital mobility are substitutes: a reduction in trade impediments reduces the incentives for capital to flow from [6]. . In this framework, the opposite result occurs: an increase in trade flows encourages capital flow

[6]Mundell illustrates the case where... our framework A labor-intensive country which imposes a tariff on the capital-intensive goods will see an increase in the price of the cpaital intensive good, and

reversals—away from the labor-intensive country to the capital intensive country. The key difference, aside from the general-equilibrium, dynamic quantitative aspect, is While the underlying intuition whereby a country that shifts production towards capital intensive sectors experiences an increase in the demand for capital, Mundell focuses on the implication of an increase in tariffs on factor location. The main difference, other than from a dynamic point of view, is the framework focuses on shocsk to labor productivity/ labor force. In this sense, since the demand for capital rises in both countries, the direction of capital flows is unclear. We also generate the result that capital flows can be reversed, and that greater trade stimulates greater reversal of capital flows. The closest framework to ours is the one-good or two-good stochastic growth models of large open economies (Backus, Kehoe and Kydland (1992), (1994)), from which the key point of departure is the assumption of factor-intensity differences across sectors, intended to capture factor-endowment trade. The overlapping generations structure featured in the model is analytically convenient although not essential.[7] Two-sector, two-country models which which feature factor-proportions type of trade usually assume that capital cannot flow across countries. Examples include Beaudry and Collard (2004), Ventura (1997), Atkeson and Kehoe (2000), Mundell (1957), Mussa (1978), and Neary (1978), among others.

In spirit, this paper is closer to a few recent papers that also highlight the interaction between trade and capital flows, such as Antrás and Caballero (2007), Ghironi and Melitz (2005), Cuñat and Maffezzoli (2004), and Ju and Wei (2006).[8] The main point of this paper, in contrast to the others, is that specialization patterns alone can alter the nature of financial flows.

Finally, on explaining global imbalances, in particular the net flow of capital from South to North, this paper proposes an alternative view highlighting the importance of trade and specialization, in contrast to others works, such as Caballero, Farhi, and Gourinchas (2008) and Mendoza, Quadrini, and Rios-Rull (2007), that put financial-market heterogeneity between the two regions at center stage.

[7]A technical appendix showing similar results in a representative-agent model is available upon request.

[8]Cuñat and Maffezzoli (2004) examine the business cycle properties generated by a multi-sector stochastic two country growth model and show that its predictions of the trade balance and terms of trade are more consistent with empirical facts than in the one-sector model. This paper differs from theirs both in terms of the formalization of the model and in terms of purpose. In this model, closed-form and semi-closed form solutions are obtainable, explicitly demonstrating the countervailing forces of the convergence effect and the composition effect in shaping international capital flows and asset prices. This paper also focuses on shocks that change countries' comparative advantage, and links it to current debates on global imbalances. Ju and Wei (2006) highlights the interaction between labor market rigidities and trade as an impetus to capital flows, while Antrás and Caballero (2007) highlight the interaction between financial heterogeneity and trade. In terms of its formalization, this framework differs from both papers in that the present setting is a stochastic general-equilibrium global model that jointly determines and quantifies the full path of capital, asset prices, and global imbalances.

The rest of the paper is organized as follows. The multiple-sector framework is described in Section 2. A special case that isolates the composition effect and gives rise to a closed-form solution characterizing the evolution of capital and the price of capital is presented in Section 3. Section 4 presents numerical results of the general case in which the composition effect and the convergence effect coexist, and discusses the conditions under which the composition effect dominates. Additional implications of the framework are taken up in Section 5. Section 6 concludes.

2 The Model Description

Consider a world with two countries, Home (h) and Foreign (f), each characterized by an overlapping generations economy in which consumers live for two periods. Each consumer supplies one unit of labor when young and does not work when old. Each country's production technology produces the same types of intermediate goods $i = 1..,m$, which are traded freely and costlessly, and are conveniently indexed by their capital intensity, $\alpha_1 < \alpha_2... < \alpha_i... < \alpha_m$. Intermediate goods are combined to produce a composite good that is used for consumption and investment. Preferences and production technologies are assumed to have the same structure and parameter values across countries. However, the technologies differ in two aspects: in each country, the labor input consists only of domestic labor, and intermediate-goods-producing firms are subject to country-specific productivity and labor force shocks. Henceforward, j denotes countries and i denotes sectors.

2.1 Production Technologies

The production technology, identical in each country, uses capital and labor to produce an intermediate good. Let Y_{it}^j be the gross production of an intermediate good i in country j:

$$Y_{it}^j = \left(K_{i,t}^j\right)^{\alpha_i}\left(A_t^j N_{it}^j\right)^{1-\alpha_i}, \quad (1)$$

where $0 < \alpha_i < 1$ for any i. K_{it}^j is j's aggregate capital stock in sector i at the beginning of period t, and N_{it}^j is the aggregate input of labor employed in sector i, at t. A_t^j represents the country-specific labor productivity, and follows

$$\ln A_t^j = \ln A_{t-1}^j + \epsilon_{At}^j$$

where the growth rate of labor productivity, ϵ_{At}^{j}, is an i.i.d. random variable. A high realization of ϵ_{At}^{j} represents a productivity boom in country j.

The intermediate goods produced by the production technology is combined to form a unit of a composite good, used for both consumption an investment, which takes the form

$$I_{it}^{j} = \left[\sum_{k=1}^{m} \gamma_i^{\frac{1}{\theta}} \left(i_{ki,t}^{j} \right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

where $\sum_{i=1}^{m} \gamma_i = 1$, and $\theta > 0$. $i_{ki,t}^{j}$ is the amount of good k used for investment in the i'th sector of country j.

Assuming that there are no barriers to international trade, the law of one price holds for all intermediate goods, and there is one international price associated with each good i, denoted as p_{it}. That preferences are symmetric across countries implies that the associated investment price index in any country is the same, and is given by

$$P_t = \left[\sum_{i=1}^{m} \gamma_i p_{it}^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{2}$$

The price of the composite good, P, is normalized to 1.

The capital used in producing good i in country j is augmented by investment goods, I_{it}^{j} and the current capital stock K_{it}^{j}. The law of motion for capital stock is given by $K_{i,t+1}^{j} = G(K_{it}^{j}, I_{it}^{j})$ where $G(K_{it}^{j}, I_{it}^{j})$ is nondecreasing and linearly homogeneous in K_{it}^{j} and I_{it}^{j}. Convex adjustment costs are represented by the restriction $\frac{\partial^2 G^j}{\partial {I^j}_{it}^2} < 0$. Following Abel (2003), I take a log-linear specification of $G(K_{it}^{j}, I_{it}^{j})$:

$$K_{i,t+1}^{j} = a \left(I_{it}^{j} \right)^{\phi} \left(K_{it}^{j} \right)^{1-\phi}, \tag{3}$$

where $0 \leqslant \phi \leqslant 1$ and $a > 0$. As in Abel (2003), this log-linear capital accumulation equation becomes the one in the neo-classical growth model with complete depreciation in each period if $\phi = 1$ and $a = 1$. If $\phi = 0$ and $a = 1$, it becomes the case of the Lucas-tree asset pricing model in which the capital stock is constant. It can be shown that, compared to the standard capital accumulation equation with adjustment costs:

$$K_{i,t+1} = (1-\delta)K_{it} + I_{it} - \frac{b}{2} \left(\frac{I_{it}}{K_{it}} - \delta \right)^2 K_{it}, \tag{4}$$

the log-linear model and the standard model are equivalent up to the second order if $a = \phi^{-\phi}$, $\delta = \phi$, and $b = \frac{1-\phi}{\phi}$. The purpose of adopting the log-linear specification is to derive an analytical solution for the equilibrium price and quantity of capital, presented in Section 3. Subsequent quantitative analyses in Section 4 adopt the standard capital accumulation equation 4.

Let q_{it}^{j} be the price of capital in sector i and country j. It is the price, in terms of the consumption and investment good, of acquiring one unit of capital at the end of period t to be carried into period $t+1$. Thus, the price is the additional I_{it}^{j} needed to augment $K_{i,t+1}^{j}$ by one unit, that is, $\left(\partial K_{i,t+1}^{j} / \partial I_{it}^{j}\right)^{-1}$. From Eq. 3, this implies that

$$q_{it}^{j} = \frac{1}{a\phi}\left(\frac{I_{it}^{j}}{K_{it}^{j}}\right)^{1-\phi}. \tag{5}$$

If $0 < \phi < 1$, then q_{it}^{j} is increasing in sector i's investment-capital ratio, I_{it}^{j}/K_{it}^{j}.

The value, in terms of the composite good, of the aggregate capital stock in sector i to be carried into period $t+1$ is $q_{it}^{j}K_{i,t+1}^{j}$, which, by Eq. 5 and Eq. 3 implies that

$$q_{it}^{j}K_{i,t+1}^{j} = \frac{I_{it}^{j}}{\phi}. \tag{6}$$

Effectively, $I_{i}^{j}(s^t)$ units of the composite good is transformed into $q_{i}^{j}(s^t)K_{i}^{j}(s^t)$ units worth of capital stock in sector i in period t.

Factor markets are competitive so that each factor, capital and labor, earns its marginal product. The wage rate per unit of labor in sector i in country j is

$$w_{it}^{j} = (1-\alpha_i)p_{it}\frac{Y_{it}^{j}}{N_{it}^{j}}. \tag{7}$$

Since labor is perfectly mobile across sectors within any country j, the wage rate in each sector i in any period t, w_{it}^{j}, is equal to the country-specific wage rate w_{t}^{j}.

Following Abel (2003), the total rental to capital in any period can be interpreted as the sum of the rentals of capital earned in the intermediate-production process, and in the capital adjustment process, where capital also contributes to lower installation costs next period. The rental earned in period t by the capital stock in sector i and country j is $\alpha_i p_{it}\frac{Y_{it}^{j}}{K_{it}^{j}}$. The rental earned in the capital adjustment process at time t is the marginal contribution of capital in augmenting capital stock for use in the following period, $\frac{dK_{t+1}}{dK_t}$, multiplied by the relative price of capital q_{it}. It follows from Eq. 3 and Eq. 5 that this rental is equal to

$\frac{1-\phi}{\phi}\frac{I_t}{K_t}$. The rate of return to capital of sector i in country j during period t is thus the sum of these two rentals, divided by the price at which it was purchased in the previous period, $q_{i,t-1}$, which gives[9]

$$R_{it}^j = \frac{\alpha_i p_{it}\frac{Y_{it}^j}{K_{it}^j} + \frac{1-\phi}{\phi}\frac{I_{it}^j}{K_{it}^j}}{q_{i,t-1}}. \tag{8}$$

2.2 Consumers

At the beginning of period t, a measure N_t^j of consumers are born in country j, where N_t^j follows a geometric random walk:

$$lnN_t^j = lnN_{t-1}^j + \epsilon_{N,t}^j,$$

with $\epsilon_{N,t}^j$ being an i.i.d. random variable that is independent of $\epsilon_{A,t}^j$ at all leads and lags. A high realization of $\epsilon_{N,t}^j$ represents a labor force boom in country j.

Consumers in both Home and Foreign have the same preferences, which are defined over an aggregate consumption index, C^j. The consumption index of country j in any period t is given by

$$C_t^j = \left[\sum_{i=1}^m \gamma_i^{\frac{1}{\theta}} \left(c_{it}^j\right)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{9}$$

where c_{it}^j is the aggregate consumption demand for good i in j. Since the composite good used for consumption is the same composite good used for investment, the consumer price index is given by Eq. 2.

In period t, a young consumer at Home inelastically supplies one unit of labor and earns the competitive wage w_t^h, which is used for consumption $c_t^{y,h}$, and for purchasing capital. Let $k_{i,t+1}^{h,j}$ be the amount of capital that a young consumer in Home buys in sector i from

[9]When combined with the consumer's problem in Section2.2, the rate of return to capital can also be understood from the point of view of an old consumer who purchased the capital stock in the previous period and is going to sell it to the young consumers in the current period. The rate of return to capital is thus the sum of the dividend income $p_{it}Y_{it} - w_{it}N_{it} - I_{it}^j$ and the market value of capital stock from selling it to the younger consumer in period t, $q_{it}^j K_{i,t+1}^j$, divided by the market value of capital stock when purchased in ther previous period, $q_{i,t-1}K_{it}$. The rate of return, using Eq. 6, implies that

$$R_{it}^j = \frac{p_{it}Y_{it}^j - w_{it}^j N_{it}^j - I_{it}^j + q_{it}^j K_{i,t+1}^j}{q_{i,t-1}^j K_{it}^j} = \frac{\alpha_i p_{it} Y_{it}^j + \frac{1-\phi}{\phi} I_{it}^j}{q_{i,t-1}^j K_{it}^j}$$

is equivalent to Eq.8.

country j, at a price q_{it}^j per unit, at the end of period t to be carried into period $t+1$. A Home, young consumer's consumption and purchases of capital satisfy

$$c_t^{y,h} = w_t^h - \sum_{j=h,f} \sum_{i=1}^{m} q_{it}^j k_{i,t+1}^{h,j}. \tag{10}$$

Assume that consumers do not have bequest motives, and therefore consume all available resources when they are old. The consumption of an old, Home consumer in period $t+1$, denoted as $c_{t+1}^{o,h}$, is entirely financed by capital so that

$$c_{t+1}^{o,h} = \sum_{j=h,f} \sum_{i=1}^{m} R_{i,t+1}^j q_{it}^j k_{i,t+1}^{h,j}. \tag{11}$$

A Home consumer born in the beginning of period t maximizes its lifetime utility of consumption

$$u(c_t^{y,h}) + \beta \mathbb{E}_t \left[u(c_{t+1}^{o,h}) \right] \tag{12}$$

where β denotes the discount factor, and satifies $0 < \beta < 1$. $c_t^{y,j}$ denotes the consumption of a young consumer in j in period t, and $c_{t+1}^{o,j}$ denotes the consumption by an old consumer in j in period $t+1$. A similar set of equations hold for the Foreign country.

2.3 Market Clearing

The intermediate goods markets clear when global demand of any good i equals its global supply. Let Y_{it}^g denote the global output of good i,where $Y_{it}^g \equiv \sum_{j=h,f} Y_{it}^j$. Let c_{it}^j be country j's consumption demand of good i as in Eq. 9, and $i_{ki,t}^j$ its investment demand of good i in each sector k as in Eq. 2. Market clearing for each good i requires that

$$Y_{it}^g = \sum_{j=h,f} c_{it}^j + \sum_{j=h,f} \sum_{k=1}^{m} i_{ki,t}^j, \tag{13}$$

for all $i = 1..,m$. The consumption demand, c_{it}^j, associated with the CES composite index given by Eq. 2 is

$$c_{it}^j = \gamma_i \left(\frac{p_{it}}{P_t} \right)^{-\theta} C_t^j.$$

The consumption index, C_t^j is the total consumption of all consumers in country j in period t, so that $C_t^j = c_t^{y,j} \cdot N_t^j + c_t^{o,j} \cdot N_{t-1}^j$. If $\theta = 1$, consumers devote a constant share γ_i of total spending to good i. Likewise, country j's demand for good i used for investment in any sector k is

$$i^j_{ki,t} = \gamma_i \left(\frac{p_{it}}{P_t}\right)^{-\theta} I^j_{it}.$$

Denoting country j's aggregate investment in period t as I^j_t, it must be that $\sum_{i=1}^m I^j_{it} = I^j_t$. Replacing these expressions for c^j_{it} and I^j_{ki} into Eq.13, noting that the price index P is normalized to 1, yields the relative price of any two intermediate goods i and k:

$$\frac{p_{it}}{p_{kt}} = \left(\frac{\gamma_i}{\gamma_k}\frac{Y^g_{kt}}{Y^g_{it}}\right)^{\frac{1}{\theta}}. \tag{14}$$

The relative price of any two goods falls with an elasticity $1/\phi$ with respect to an increase in the relative output of the two goods. When $\theta = 1$, relative output changes are completely offset by relative price changes so that the nominal values of output remain constant across sectors.[10]

Lastly, domestic labor markets clear when

$$\sum_{i=1}^m N^j_{it} = N^j_t$$

for any j.

The value of world output at t, denoted as Y^g_t, is used for two purposes: consumption and capital formation. Let I^g_t be the aggregate amount of world investment, in period t, such that $I^g_t = \sum_j I^j_t$. The world resource constraint requires that

$$Y^g_t \equiv \sum_{i=1}^m p_{it} Y^g_{it} = C^{y,g}_t + C^{o,g}_t + I^g_t. \tag{15}$$

2.4 Equilibrium

A semi-closed-form solution of the equilibrium of the economy follows when relying on three simplifying assumptions, summarized below:

Assumption 1 *The elasticity of substitution among intermediate goods, θ, is 1*

Assumption 2 *Consumers have logarithmic preferences, so that $\rho = 1$*

Assumption 3 *The capital-adjustment technology is log-linear, as in Eq. 3*

[10] When $\theta = 1$, the value of output in any industry i is a constant fraction γ_i of the total value of world output, so that $p_{it}Y^g_{it} = \gamma_i \sum_i p_{it} Y^g_{it}$.

Assumptions 2 simplifies the consumption/saving problem and implies that private saving does not depend on the real rate of return. Severing the link in which the rate of return affects capital accumulation allows for analytical expressions for the optimal level of consumption in each country. When assumptions of 1 and 3 are combined with assumption 2, the global aggregate investment-output ratio and the global industry-level investment-output ratio are both constants. Relying on these results, the evolution of the capital stock in each sector i in any country j, is characterized by one key variable—the present discounted value of the expected share of good i produced domestically. Without these assumptions, neither the semi-closed form solution in the general case nor the full closed-form solution in the special case, presented in Section 3, is possible. In later sections all of these assumptions are relaxed, and it is shown that none are crucial for the main results of interest.

Assuming that consumers have logarithmic utility, the optimal consumption of a young consumer in period t is a constant fraction of the present value of lifetime resources, which, in this setting, is simply the wage income earned by the young. The optimal consumption of a young consumer in j is therefore

$$c_t^{y,j} = \frac{1}{1+\beta} w_t^j, \tag{16}$$

Let $C_t^{y,j}$ be the aggregate consumption of the young cohort, where $C_t^{y,j} \equiv N_t^j c_t^{y,j}$. Aggregating this across countries implies that the world consumption of the young in period t, $C_t^{g,y} \equiv \sum_j C_t^{y,j}$, is a constant fraction of world labor income, $W_t^g \equiv \sum_j w_t^j N_t^j$. With a unitary elasticity of substitution (Assumption 1), W_t^g accounts for the constant share s_l of world GDP, with $s_l \equiv \sum_i \gamma_i(1-\alpha_i)$. It can be interpreted as a 'weighted-average' labor share, the weights being the share of expenditure in good i in total spending, γ_i. Let s_k denote the weighted-average capital share, so that $s_k = 1 - s_l = \sum_i \gamma_i \alpha_i$. It follows that that the global investment-GDP ratio is a constant:[11]

$$\frac{I_t^g}{Y_t^g} = \psi s_l, \tag{17}$$

where $\psi = \frac{\phi\beta}{1+\beta}$, and $Y_t^g \equiv \sum_i p_{it} Y_{it}^g$.

How is world investment allocated across industries and countries? To determine global investment at the industry level, let $I_{it}^g = \mu_{it} I_t^g$ so that μ_{it} represents the share of industry i's

[11] Aggregating Eq. 10 across countries gives $C_t^{y,g} = W_t^g - \sum_j \sum_i q_{it}^j K_{i,t+1}^j$, where $K_{i,t+1}^j = k_{i,t+1}^{h,j} N_{t+1}^h + k_{i,t+1}^{f,j} N_{t+1}^f$ is the total amount of financial capital claimed by the world on j's ith sector. Then, setting the expression for optimal aggregate consumption of the young, Eq. 16, to the left hand side of the above equation, while using the fact that $q_{it}^j K_{i,t+1}^j = I_{it}^j/\phi$ from Eq. 5, yields the investment-GDP ration in Eq. 17.

investment in aggregate investment, and let $I_{it}^h = \eta_{it} I_{it}^g$ so that η_{it} represents Home's share of global investment in sector i. Investment in any sector i, in any country h, f, can thus be written as

$$I_{it}^h = \mu_{it}\eta_{it} I_t^g \quad (18)$$

$$I_{it}^f = \mu_{it}(1-\eta_{it}) I_t^g. \quad (19)$$

It can be shown that

Lemma 1

$$\mu_{it} = \frac{\gamma_i \alpha_i}{\sum_{k=1}^m \gamma_k \alpha_k} \qquad \forall t \quad (20)$$

The share of global investment allocated to industry i depends γ_i and the capital intensity of that sector, α_i. The greater the "effective capital share" in industry i, $\gamma_i \alpha_i$, relative to the weighted-average capital share $\sum_{k=1}^m \gamma_k \alpha_k$, the larger the share of global investment apportioned to industry i. That μ_i is a constant hinges on the assumption of unitary elasticity of substitution θ, the case in which the relative values of output across industries is constant, implied by Eq. 14. The share of world resources allocated to any industry i, including employment allocations N_{it}^g,[12] and investment allocations I_{it}^g, thus remain constant across industries, despite stochastic shocks in the labor force and labor productivity.

The *country-share* of global investment in any industry i, η_{it}, is the key variable to determining the evolution of a country's aggregate capital stock and aggregate investment. This share can be written explicitly as

$$\eta_{it} = (1-\lambda) \sum_{k=0}^{\infty} \lambda^k E_t \left(\frac{Y_{i,t+k+1}^h}{Y_{i,t+k+1}^g} \right), \quad (21)$$

where $\lambda = \frac{\frac{\beta(1-\phi)}{1+\beta}}{\frac{1-s_l}{s_l} + \frac{\beta(1-\phi)}{1+\beta}} < 1$ is the discount factor of Home's future share of output in industry i. This expression says that higher expected share of Home's production of good i amounts to a higher share of investment in i allocated to Home. In the absence of adjustment costs where $\phi = 1$, η_{it} does not depend on future output after date $t+1$, so that the investment in sector i is solely determined by its expected share of output of good i at $t+1$.

[12] The share of world employment in sector i in total global employment is $\frac{\gamma_i(1-\alpha_i)}{\sum_i \gamma_i(1-\alpha_i)}$, the 'effective labor share' of industry i relative to the weighted-average labor share. This follows from the wage equalization condition across sectors, within a country for any two sectors i and k: $(1-\alpha_i)p_{it}Y_{it}/N_{it} = (1-\alpha_k)p_{kt}Y_{kt}/N_{kt}$. Aggregating this equation across countries and using the fact that $p_{it}Y_{it} = \gamma_i Y_t^g$ for any sector i, the ratio of N_{it}^g and N_{kt}^g is the ratios of the effective share of labor $\frac{\gamma_i(1-\alpha_i)}{\gamma_k(1-\alpha_k)}$.

Home's share of global investment can be written as $I_t^h = \eta_t I_t^g$, where, summing Eq. 18 across industries, gives

$$\eta_t \equiv \sum_{i=1}^{m} \mu_i \eta_{it} \tag{22}$$

$$= \sum_{i=1}^{m} \frac{\gamma_i \alpha_i}{s_k} \eta_{it}, \tag{23}$$

where the second line uses Eq. 20 and s_k is the weighted-average capital share. Investment in any country j is not only associated with the size of its expected relative production, captured by η_{it}, but also with its *composition* of production, where more weight (higher α_i) is put on the expected share of future capital-intensive-goods production, and less weight is put on its expected share of labor-intensive-goods production.

By contrast, in the one-sector model, η_t is Home's expected, present-discounted value of its share of the only good produced globally (Eq. 21 without subscripts i). A positive, permanent, technology or labor force shock in Foreign, which effectively increases Foreign's share of global production, causes a large drop in Home's share of investment, η_t.

In any period t, the total net foreign assets of Home, denoted as NFA_t is the value of Home's claims on foreigners less the value of foreigner's claim on home:

$$NFA_t \equiv q_t^f k_{t+1}^{h,f} \cdot N_t^h - q_t^h k_{t+1}^{f,h} \cdot N_t^f$$

The current account of Home in period t, denoted as CA_t^h, is by definition the change in net foreign assets, so that when combined with the young consumer's budget constraint, Eq. 10, gives[13]

$$CA \equiv \Delta NFA_t = S_t^y - q_t^h K_{t+1}^h - (S_{t-1}^y - q_{t-1}^h K_t^h),$$

where S_t^y denotes the aggregate savings of the young in period t and $K_{t+1}^h = \sum_{j=h,f} k_{t+1}^{j,h} \cdot N_t^j$ is the world claim on Home's capital stock at t.

Finally, Eq. 18, 20, and 21, combined with the evolution of the capital stock, given in Eq. 3, yields the solution to the equilibrium of this economy.

[13]From the young consumer's budget constraint Eq. 10, the aggregate value of the claim of Home's young consumers on foreigner's capital stock can be written as $S_t^y - q_t k_{t+1t}^{hh\ h}$. Observing that $q_t k_{t+1}^{h,h} \cdot N_t^h + q_t^h k_{t+1}^{f,h} \cdot N_t^f = q_t^h K_{t+1}^h$, the derivation for the current account follows.

3 The Composition Effect

This section presents a special case in which the standard "convergence effect" is shut off and the "composition effect" operates in isolation. In general, analytical solutions are not obtainable in two-country stochastic growth models, and analyses are generally restricted to numerical simulations. In this case, a closed-form solution for the price and quantity of capital arises when relying on the additional assumption

Assumption 4 $\alpha_1 = 0$.

In this case, the most labor-intensive sector, sector 1, uses only labor as an input and no capital in the production technology for good 1. With this assumption, the wage in any region j (normalized by its TFP) is pinned down by the price of the most labor-intensive good, $w_t^j/A_t^j = p_{1t}$. Since intermediate goods' prices are equalized through trade, conditional wage equalization, $w_t^h/w_t^f = A_t^h/A_t^f$, holds in any period t, despite stochastic shocks. It follows that

$$\tilde{k}_{it}^h = \tilde{k}_{it}^f \tag{24}$$

for all $i > 1$, where $\tilde{k}_{it}^j = \frac{K_{it}^j}{A_t^j N_{it}^j}$ is 'j's effective capital-labor ratio in sector i. Labor reallocation across sectors alone is sufficient to equalize effective-capital labor ratios in each sector, across countries. The force of convergence that tends to equalize capital-effective labor ratios across countries is effectively shut off, isolating the composition channel.

Consider a high $\epsilon_{N,t}^f$ (labor force boom) or $\epsilon_{A,t}^f$ (productivity boom) in Foreign. In order to equalize wages across sectors, Foreign expands relatively more the labor-intensive sectors. The rise in the world supply of labor-intensive goods relative to that of capital-intensive goods puts downward pressure on the relative price of labor intensive goods. For what range of goods do prices fall or rise? It can be shown that

$$\hat{p_k} \leq 0 \quad \Leftrightarrow \quad s_k \equiv \alpha_k \leq \sum_i \gamma_i \alpha_i$$

where $\hat{p_k}$ denotes the percentage change of the price of good k (proof in Appendix B). Prices rises for sectors with capital shares greater than the weighted-average capital share.

In response to greater profitability of capital-intensive sectors, Home responds by drawing labor out of the first sector and reallocating it towards capital-intensive sectors. Domestic labor reallocation ensures that $\tilde{k}_i$, for all $i \neq 1$, is equalized across countries in every period.[14]

[14]The implicit condition is that both countries produce all goods. Appendix B shows a sufficient condition for which all goods are produced by both countries. Intuitively, the size of sector 1 needs to be large enough

Determining Home's investment response to a boom in Foreign's labor force or labor productivity in period t amounts to knowing the share of Home's investment in global investment η_t, given by Eq. 21 and Eq. 18. With Assumption 1-4, η_{it}, the country-sector share of global sectoral investment is a constant and thus η_t, the country-share of global aggregate investment, is also constant over time, given by the following proposition:

Proposition 1 *With Assumptions* $1-4$, $\eta_{it} = \frac{K_{i0}^h}{K_{i0}^g}$ *for all* t.

The share of Home's investment in any industry i, η_{it}, is a constant and is equal to its initial share of world capital in that sector.

Proof. To prove that $\eta_{it} = \frac{K_{i0}^h}{K_{i0}^g}$, guess that $\frac{K_{it}^h}{K_{it}^g} = \eta_{it}$, and show that $\eta_{it} = \eta_{i0}$ is a solution to a contraction mapping, consisting of Eq. 21 and the production technologies, Eq. 1 and 3. By the contraction mapping theorem, it is the unique solution. Appendix B provides details to the full proof. ■

Commodity trade (of goods with different factor intensities) brings about the equalization of sectoral capital-effective labor ratios across countries at all points in time, through industrial rearrangement. This ensures that the rental earned from the production technology, $\alpha_i p_i \tilde{k}_i^{j,\alpha_i - 1}$, which *rises* in both countries,[15] is equalized at all times. How does Foreign invest its marginal unit of savings? It will allocate it to *both* countries, rather than just locally. Adjustment costs merely pin down the amount of savings apportioned to each country. If countries were initially symmetric, one half of Foreign's additional savings would be allocated to Home, the remaining half invested domestically. If however, Home started out with a higher initial aggregate capital stock, K_0^h, the sum of all initial capital stock in each industry i, K_{i0}^h, the marginal adjustment costs paid to augmenting capital stock, in any sector, would be lower at Home. Home thus commands a greater share of global savings, the constant of proportionality being the share of Home's initial capital stock in global initial capital stock. Note that the result that Foreign allocates part of its savings to Home stems from their ability to trade multiple goods, and not from adjustment costs. In the one-sector model with adjustment costs, Foreign not only allocates its domestic savings locally but also imports capital from Home, as shown later on.[16]

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and the shock small enough so that both countries are required to produce the good.

[15] Rentals rise for all sectors except the labor-intensive one because of an increase in employment in all sectors but the first sector, and/or an increase in the relative price p_i. Proof in Appendix.

[16] Adjustment costs are proportional to $\frac{I_i^j}{K_i^j}$, which, when equalized, implies that the aggregate investment ratio of countries are equal to its initial capital stock ratio.

3.1 Aggregate Savings and Investment

Summing investment, given by Eq. 18, across sectors, and using Proposition 1, country j's aggregate investment at t becomes

$$I_t^j = \sum_i \mu_i \eta_{i0}^j \psi s_l Y_t^g, \tag{25}$$

where $\psi = \phi\beta/(1+\beta)$, s_l is the weighted-average labor share, and μ_i is given by Lemma 1. A high $\epsilon_{A,t}^j$ or $\epsilon_{N,t}^j$ which raises world output, Y_t^g, raises investment globally, and in such a way that more investment is allocated to country j that has a higher initial, weighted-average capital share, $\sum_i \mu_i \eta_{i0}^j$. In this special case with international trade linkages, investment comoves.

A graphical exposition offers some basic intuition to these results. Let $\tilde{k}_t^j = \sum_i K_{it}^j/(A_t^j N_t^j)$ be the aggregate, effective capital-labor ratio in country j in period t, $\tilde{k}_t^g = \sum_i \sum_j K_{it}^j / \left(\sum_j A_t^j N_t^j\right)$ be the world effective capital-labor ratio, and let $Y_t^j = \sum p_{it} Y_{it}^j$ denote j's domestic nominal output at t. One can write j's aggregate investment-to-output ratio at t as a function of its relative, aggregate capital-labor ratio, denoted as $\kappa_t^j = \tilde{k}_t^j / \tilde{k}_t^g$:[17]

$$\mathcal{I}(\kappa_t^j) \equiv \frac{I_t^j}{Y_t^j} = \frac{\psi s_l}{\frac{s_l}{\kappa_t^j} + 1}. \tag{26}$$

Country j's share of output allocated to investment, in period t, rises with its relative aggregate capital-effective-labor ratio at t. A high $\epsilon_{N,t}^f$ or $\epsilon_{A,t}^f$ that raises the effective labor force in Foreign in period t, $A_t^f N_t^f$, relative to that of Home raises Home's relative aggregate capital-effective-labor ratio, κ_t^h, since capital is predetermined and therefore fixed at t. Greater comparative advantage in capital bids Home to specialize more in capital-intensive sectors, which raises the relative share of output allocated to investment and reduces the share of output allocated to labor income. As in the top panel of Figure 1, the investment-to-output curve is upward sloping.

Analogously, savings-to-output ratio in j can be written as

$$\mathcal{S}(\kappa_t^j) = \psi \left(1 - \frac{1}{\frac{s_l}{\kappa_t^j} + 1}\right), \tag{27}$$

[17] $p_{it} Y_{it}^j$ can be expressed as $\gamma_i Y_t^g \frac{Y_{it}^j}{Y_{it}^g}$. Since $Y_{it}^j / Y_{it}^g = K_{it}^j / K_{it}^g = \tilde{N}_{it}^j / \tilde{N}_{it}^g = \eta_{i0}^j$, and domestic GDP $Y_t^j = \sum_i p_i Y_i^j = \sum_{i \neq 1} \gamma_i \eta_{i0}^j + \gamma_1 \frac{\tilde{N}_1^j}{N_1^g}$. Wage equalization across sectors in j, $(1-\alpha_i) p_{it} Y_{it}^j / N_{it}^j = A_t^j N_{1t}^j$ $\forall$ $i \neq 1$, implies $\tilde{N}_{it}^j = (1-\alpha_i)\gamma_i/\gamma_1 \eta_{i0}^j \tilde{N}_1^g$ where $i \neq 1$. Country j's domestic to world GDP can be expressed as $Y_t^j = \left(\frac{s_l}{\kappa_t^j} + 1\right) \sum_i \mu_i \eta_{i0}^j Y_t^g$, which, combined with Eq. 25 yields Eq. 26, where $\mathcal{I}(\kappa_t^j) \equiv I_t^j / Y_t^j$.

and is downward sloping because greater specialization in labor-intensive goods in any country raises the share of output allocated to wage income, while reducing the share of output allocated to investment needs. A country's supply of savings depends on its capacity to generate labor income, in this OLG setup. If a country's production structure is heavily tilted towards capital-intensive industries, the labor share of domestic output is inevitably small, and so is the supply of savings. On the other hand, a country which has a production structure bent towards labor-intensive sectors is able to generate a large share of wage income relative to output, and has a high capacity to save.

The $\mathcal{I}(\kappa_t^j)$ and $\mathcal{S}(\kappa_t^j)$ schedules intersect at the point where countries' capital-labor ratios are equalized–the point at which domestic savings is just enough to serve its domestic investment needs, and no net capital flows needs to occur between countries. A positive shock that reduces j's relative capital-labor ratio at t, leads to a compositional shift that causes its supply of savings to rise by more than its investment demand, the difference of which shows up as a net capital outflow.

Similarly, one can graph the savings and investment curves in the one sector model. In this case, the investment-GDP curve is downward sloping, as drawn in the second panel of Figure 1. Lower capital-effective-labor ratios in any country j requires greater investment in j so that this ratio eventually converges across countries. On the other hand, the savings rate is a constant when Assumptions 1 (log utility) and 2 ($\theta = 1$) are made. In contrast to the multi-sector model, j experiences a net capital inflow as its capital-labor ratio falls.

These two figures depict the savings-investment relationship when the composition effect and the convergence effect are each respectively isolated. The striking difference is the slope of the investment demand curve, which is negative in the one-sector case but positive in the multi-sector case. In the general case, where both composition and convergence effects coexist, the investment-output curve lies somewhere in between—and becomes positively sloped when the composition effect is stronger and negatively sloped when the convergence effect is stronger. The main action comes from investment demand and not from the supply of savings, the reason for which the OLG structure is non-essential. Important factors governing the relative strength of the two effects are explored in Section 4.3.

3.2 The Price and Quantity of Capital

The evolution of the effective, aggregate capital-labor ratio in region j is characterized by:

$$ln(\tilde{k}_{t+1}^j) = ln\Theta + +(1-\phi s_l)ln(\tilde{k}_t^j) + \phi s_l ln\left(\sum_i \mu_i \eta_{i0}^j\right) + \phi s_l \left(ln\tilde{N}_t^g - ln\tilde{N}_t^j\right) - (\epsilon_{N,t+1}^j + \epsilon_{A,t+1}^j) \quad (28)$$

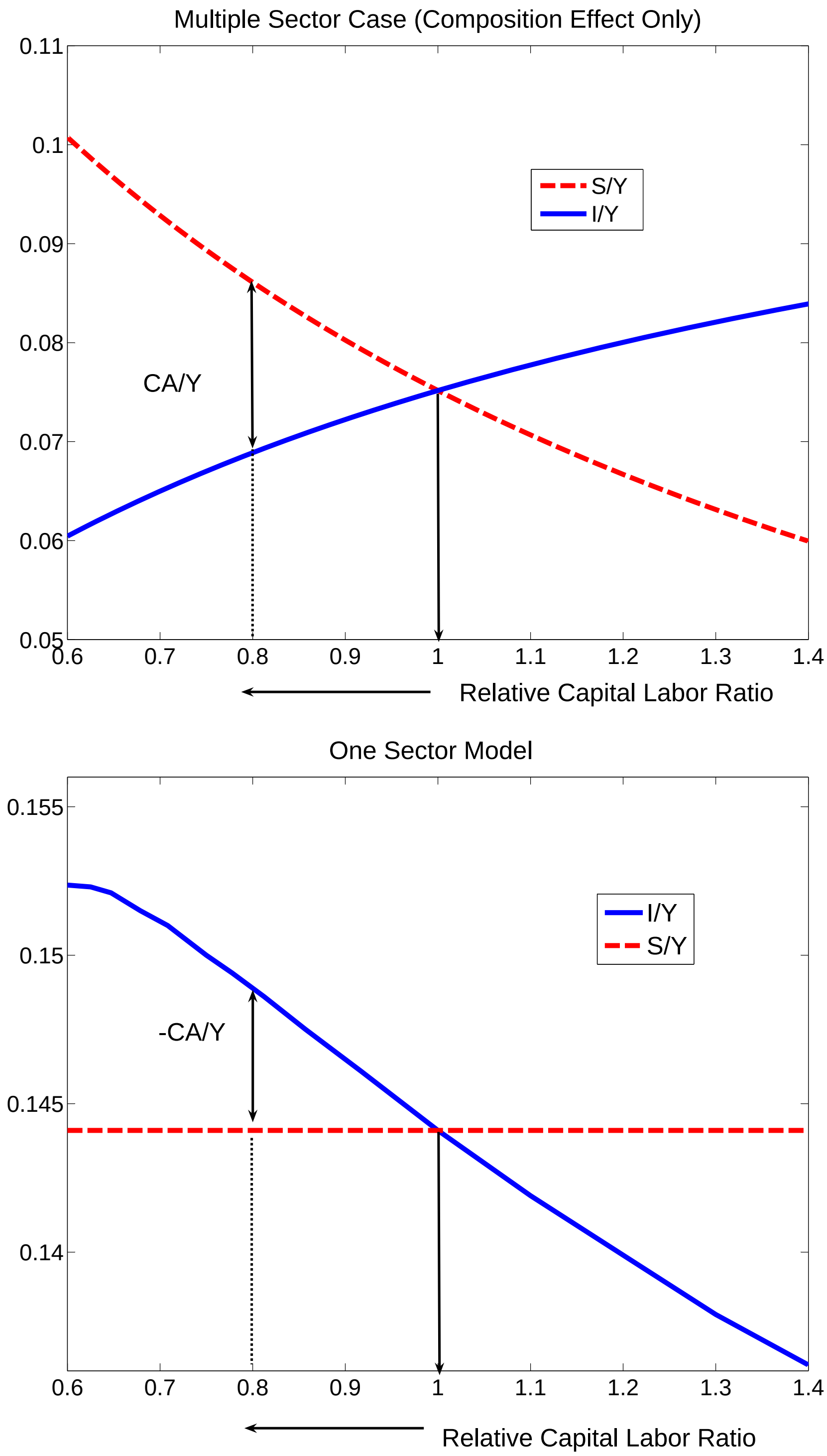

Figure 1: Savings/GDP and Investment/GDP ratio as a function of κ_t^j, $\frac{\tilde{k}^j}{\tilde{k}^g}$. The first panel shows the multiple sector case, based on closed-form solutions. It assumes that $\alpha_1 = 0, \alpha_2 = 0.3, \alpha_3 = 0.5, \alpha_4 = 0.9$, $\gamma_i = 0.25$ for all i. The second panel shows the simulated results of the one sector case, based on Eq. 21 when $i = 1$; $\alpha_1 = 0.3$. In both cases, $\beta = 0.7$ and $\phi = 0.5$.

where Θ is a constant.[18] This implies the following propositions:

Proposition 2 *(Path Dependence) The evolution of the* $\tilde{k}_t^j$ *depends on j's initial weighted-average capital-intensity,* $\sum_i \mu_i \eta_{i0}^j$*; the higher the initial weighted-average capital intensity in j, the higher the effective capital-labor ratio in j at every point of the transitional path.*

The country with the higher initial capital intensity commands lower marginal adjustment cost paid on investment in that country, and thus occupies a higher share of world investment.

The aggregate price of capital q_t^j in j is defined as the weighted average of the price of capital in each sector $i \neq 1$, the weights being the capital share of that industry in total capital stock of region j, $\frac{K_i^j}{K^j}$. The logarithm of the price of capital in sector i in j evolves according to:

$$lnq_{it}^j = (1-\phi s_l)lnq_{i,t-1}^j + (1-\phi)s_l(ln\tilde{N}_t^g - ln\tilde{N}_{t-1}^g) - ln\Theta_i,$$

where Θ_i is a sector-specific constant. This leads to the following proposition:

Proposition 3 *(Price of capital)* q_t^j *in any region j is an increasing function of a positive labor force or labor productivity shock if* $\phi < 1$*, and follows a stationary process if* $0 < \phi < 1$*.*

Proposition 3 provides conditions under which the price of capital in both countries rises in response to a labor force boom or a positive shock to labor productivity in any region. If $\phi = 1$, the case of complete depreciation, the price of capital is constant and equal to $1/a$. In the more interesting case where $\phi < 1$, the price of capital at Home rises in response to a high $\epsilon_{N,t}^f$ or $\epsilon_{A,t}^f$. If capital can be accumulated ($\phi > 0$), then the price of capital is stationary. However, if capital stock is fixed over time ($\phi = 0$), as in the Lucas-tree model, the price of capital is non-stationary. By contrast, in the one sector case, the price of capital tends to *fall* at Home when $\phi < 1$, as investment flows abroad to take advantage of higher investment opportunities.

Proposition 4 *Country j's stock market-capitalization to domestic GDP ratio at t,* $\frac{\sum_{i\neq 1} q_{it}^j K_{i,t+1}^j}{Y_t^j}$ *is increasing in j's relative capital-labor ratio,* $\tilde{k}_t^j/\tilde{k}_t^g$*.*

Using $q_{it}^j K_{i,t+1}^j = (1/\phi)I_{it}^j$, this result immediately follows from Eq. 26.[19]

Corollary 5 *The ratio of sector i's stock market-capitalization to domestic GDP, in any country j, is increasing in* $\alpha_i\gamma_i$*, and* η_{i0}*.*

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[18] $\Theta = a(\psi s_l/s_k \prod \gamma_i^{\gamma_i}(\alpha_i\gamma_i)^{\alpha_i\gamma_i}[(1-\alpha_i)\gamma_i]^{1-\alpha_i\gamma_i})^{\phi}$

[19] In the one-sector, closed-economy framework of Abel (2003), the stock market-capitalization to domestic GDP ratio is a constant in the long run.

Proposition 4 indicates that the smaller the comparative advantage in labor of Home, the higher its aggregate stock-market value to GDP ratio. This result is consistent with the sharp rise in the value of stocks in the 1990's in the U.S. On the other hand, Corollary 5 says that the stock market value of sector i depends on its effective capital-intensity, $\alpha_i\gamma_i$, and the expected share of global output it produces, η_{i0}.

Aggregate investment is the economic channel through which a labor force boom or a productivity shock affects the price of capital. The high level of aggregate investment relative to the capital stock in t, which is predetermined, drives up the price of capital along the upward-sloping supply curve of capital, Eq. 5, in both countries.

4 The Competing Forces of the "Convergence" and "Composition" Effects

The previous special case, which isolates the composition effect, leads to factor price equalization after one period, despite the existence of adjustment costs. Investment and asset prices always comove across countries. However, FPE no longer holds in a case where all sectors use both capital and labor as inputs to technology, except in the steady state. The convergence and the composition effect coexist and are competing. Which effect dominates depends on whether factor intensities are sufficiently different so that specialization patterns are pronounced enough to induce a large composition effect. If the composition effect dominates, the previous qualitative results on asset prices and financial flows are preserved. The following quantitative exercise first assumes a two-sector structure before discussing how a many-sector setting differs.

4.1 General Capital Adjustment Function and Parameter Values

The drawback of the log-linear capital adjustment function is that depreciation and adjustment costs, both of which are captured by the parameter ϕ, cannot be separated. Therefore, I henceforward adopt a standard capital-adjustment model in the quantitative exercises (see footnote 7 for equivalence between the two models).

A realistic calibration of a two-period model clearly has its limitations. If one period is interpreted to be 20 years, then adjustment costs are inevitably going to be very small, if paid evenly over time.[20] Capital adjustment costs are widely used in international RBC models but there is no consensus on the calibration strategy to parameterize them.[21] The strategy adopted in this model is to take a standard adjustment cost parameter value, $b = 1$, based on an annual frequency, and compute the amount of capital adjustment that takes place over twenty years. The parameter b is then chosen, in a twenty year period model, so that the same amount of capital adjustment takes place as in the annual frequency model over the same time horizon. Admittedly, no calibration technique of the adjustment cost parameters will be entirely satisfactory, although it can be shown that the qualitative results are insensitive to the size of the adjustment costs, and that the quantitative results are driven to a much larger extent by factor intensity differences than by adjustment costs. Section 4.3 reports a sensitivity analysis. The discount factor β is set to 0.45 to match the initial steady-state annual real interest rate of 4%.

The baseline model takes the benchmark case of Cobb-Douglas preferences, i.e. $\theta = 1$. In this case, γ_i's are equal to the share of sector i in the world's total value added, in an integrated equilibrium. Estimates of factor intensity shares and γ_i's are provided in Cuñat and Maffezoli (2004). Using OECD Annual National Accounts Detailed Table, they aggregate the value of 28 sectors across 24 OECD countries, and calculate the share of each sector in total OECD value added. γ_i's are then calibrated to match these observed shares. Since $1 - \alpha_i$ is just the sector's labor share in value added, one can use data on compensations of employees to compute the sectoral labor share. Assuming that production technologies are identical across countries, the labor share across sectors is taken from U.S. data.[22] I aggregate the 28 sectors into one labor-intensive sector and one capital-intensive sector, of which the capital shares are respectively denoted as α^l and α^c. I rank the sectors by their capital intensity and assume that the first 14 sectors are labor-intensive, and the second half capital intensive. The share of the labor-intensive sector in total value added, γ, is then chosen such that $\gamma = \sum_{i=1}^{14} \gamma_i$. α^l and α^c are calibrated to match the weighted mean of the capital share of the 28 sectors, $\bar{s_k} = \sum_{i=1}^{28} \gamma_i \alpha_i = 0.36$, and the weighted variance, $\sum_i \gamma_i (\alpha_i - \bar{s_k})^2$ (the important of which will become evident), which is 0.04 as measured from the 28-sectors data. The resulting parametrization is $\gamma = 0.61$, $\alpha^l = 0.11$, and $\alpha^c = 0.52$.

Although the key results of interest pertain to symmetric countries as well as asymmet-

[20] Assuming the existence of some adjustment costs, albeit small in size, is necessary since zero adjustment costs would automatically lead us to the case of indeterminacy of capital stock at the country level.

[21] For example, Baxter and Crucini (1993) calibrates the elasticity of investment relative to Tobin's q to match investment variability in industrial countries. Chari, Kehoe, and McGrattan (2000) calibrates the parameter to match the relative variability of consumption to output. Kehoe and Perri (2002) targets the variability of investment.

[22] Internationally comparable estimates for all sectors and all countries are available only for 1995 and 1996. They assume that factor intensities have not changed significantly over time.

ric countries, the exercise is done for countries that are meant to mimic a developing and a developed country. I assume that the only difference between the two countries is their initial capital-labor ratios. These values are taken from Hall and Jones (1999). As a whole, developed countries' capital-labor ratio is about 6 times as large as that of developing countries in 1988.

4.2 Impulse Response

I consider an experiment in which the effective labor force in South doubles permanently and unexpectedly. Since capital is fixed for one period, South allocates a greater fraction of labor to the labor-intensive sector, in order to equalize wages. The higher world supply of the labor-intensive good causes its price p^l to fall, and the price of the capital-intensive good p^c to rise. North shifts resources to the capital-intensive sector, in response to its greater profitability. While returns to capital rise in both sectors in South, the rate of return to capital rises in the capital-intensive sector in North, its export sector, and falls in its import competing sector. The real wage is depressed in South as a result of a greater supply of labor. In North, the real wage rises with respect to purchases of the import good but falls with respect to purchases of the export good, so that the overall effect is ambiguous. For reasonable parameter values, it tends to fall in North.[23]

The first set of panels in Figure 2 displays the response of key variables. The vertical axis represents the level of each variable normalized by its initial value. The horizontal axis represents generations. Investment comoves as South partly finances North's investment in the capital-intensive sector. The rise in investment in North and the fall in its savings (as a result of declining wages) lead to a current account deficit. Higher investment in both countries bid up the aggregate price of capital globally. However, the price of capital behaves differently across sectors in each country: while the price of capital rises in both sectors in South, the price of capital falls in the labor-intensive industry in North as a result of the downsizing of that sector. North sees an initial trade deficit, due to the increase in investment, and ultimately, a permanent trade surplus as it pays capital gains and interest income abroad.

The second set of panels in Figure 2 juxtaposes the response of North in the one-sector and two-sector case, and brings the two cases into sharp contrast. In the benchmark one-sector case, North's GDP, investment and price of capital fall as capital flows from North to South to take advantage of the latter's higher returns. Intuitively, since only one capital-

[23] The impact effect on goods and factor prices are shown analytically in Appendix A.1.

to-labor ratio is consistent with the steady state in the one-sector case, an increase in labor in South implies an equivalent scaling up of capital in South in the long run. Since capital accumulation takes time, in the presence of adjustment costs, North initially finances some of South's investment, and runs a current account surplus. It runs a trade deficit to finance higher consumption in North, while South runs an initial trade surplus. In the long run, trade is balanced between the two countries.

4.3 When does the composition effect dominate?

When the convergence effect and the composition effect are competing, the result that investment and asset price comove, while capital flows are "reversed" relies on the composition effect outweighing the convergence effect. The composition effect is strong when specialization patterns are pronounced, and the extent of specialization depends on factor intensity differences across sectors. In the limit where factor intensities converge to the same level, the multi-sector model yields qualitatively similar results to a one-sector model, and the convergence effect is isolated. As factor intensities become more disparate, the composition effect becomes stronger. So how different do factor intensities have to be in order for the composition effect to prevail?

In a multiple-sector setting, a measure of the dispersion of factor intensities is the weighted variance of α_i, with weights γ_i capturing the effective size of the sector:

$$\sum_{i=1}^{m}(\alpha_i - \bar{s_k})^2\gamma_i$$

Estimated from the OECD data with 28 sectors, the weighted mean of capital intensity, $\bar{s_k}$, is 0.36, and the weighted variance is 0.04. Figure 3 shows the results of the response of North's investment, at the time of the shock, for various values of the dispersion of factor intensities in a five-sector case. The experiment that holds fixed the weighted mean while increasing the weighted variance shows that North's investment rises with the dispersion of factor intensities.[24] The cutoff weighted-variance, above which North's investment rises and below which North's investment falls, is less than 0.02. This cutoff weighted-variance is naturally also the point at which the price of capital turns from negative to positive,

[24] Parameters α_i's and γ_i's are chosen so that $\bar{s_k} = 0.36$, $\sum_{i=1}^{m}(\alpha_i - \bar{s_k})^2\gamma_i = 0.04$, and $\sum_i \gamma_{i=1}^{m} = 1$. Note that there is one extra degree of freedom in choosing parameters to satisfy a constant weighted mean and weighted variance, so that there is no unique correspondence between North's investment level and the weighted variance. For this reason, only a linear regression line of the simulated responses is plotted, in order to illustrate the positive relationship between the dispersion of factor intensity and investment in North.

and the current account turns from surplus to deficit. This shows that as factor intensities become more similar, the convergence effect dominates, causing investment to fall in North, and the qualitative results converge to those of the one-sector case. The more different are factor intensities, the more pronounced are specialization patterns, and the stronger is the composition effect.

Other parameters

Adjustment costs change the quantitative response of asset prices and the current account although not their qualitative predictions.[25] Table 2 shows that increasing the size of adjustment costs causes a higher jump in the price of capital at Home, and induces a smaller current account deficit as the amount of desired investment falls. Qualitatively, the price of capital always rises and the current account always falls for Home, so long as factor intensities are sufficiently different. Moreover, the magnitudes of the current account's responses are to a much larger extent governed by factor intensity differences than by the change in the size of the adjustment costs, as can be seen from the various interactions between the values of b and α^c/α^l.[26]

The impact of adjustment costs on the current account is different in the one-sector case. While higher adjustment costs lead to a smaller current account deficit in North in the two-sector case, it leads to a greater current account surplus in North in the one sector case. The reason is that rather than bearing all of the cost of adjusting capital, South imports capital from North, who is paid a higher price of capital in return.

Further, the results are not very sensitive to the coefficient of relative risk aversion and the elasticity of substitution. None of these parameters, except for the factor intensity ratio, matter qualitatively for the main result at hand. The current account pattern of North running a deficit and South a surplus, along with investment comovement and asset price comovement are solely governed by the dispersion of capital intensities, which determines the strength of the composition effect, and the existence of *some* adjustment costs.

[25]Adjustment costs are crucial to the extent that they pin down the path of capital at the country level, in a world of FPE. They provide a scope for international capital flows to meet the rise in investment demand in the country which shifts resources to capital-intensive sectors. But whether the rise in investment needs is met domestically or from capital inflows depends on the sizes of inter-sectoral versus international adjustment costs. In the extreme case where the former approaches infinity, inter-sectoral reallocation of capital satisfies investment demands. In the other extreme case where the latter approaches infinity, capital inflows from abroad meet investment needs. This model considers the intermediary case where international adjustment costs and inter-sectoral adjustment costs are the same, so that both domestic reallocation and international capital flows play a role.

[26]In the two-sector case, a straightforward way to guage factor intensity differences is simply the ratio of the capital shares in the capital-intensive and labor-intensive sectors, here denoted as α^c/α^l.

5 Applications and Discussions

The integrated framework developed in this paper is able to deliver a number of new predictions for a host of issues. Although a thorough treatment of various applications to the framework is beyond the scope of this paper, this section points to a few important predictions that emerge.

5.1 Globalization and the "Lucas Paradox" Revisited

As originally pointed out by Lucas (1990), large differences in capital-labor ratios may not imply vast differences in the marginal product of capital (MPK), as poor countries also have lower endowments of factors complementary with physical capital, such as human capital and total factor productivity. This has been attributed to be a main reason explaining why very little capital flows from rich to poor countries.

Over the past decade, a more puzzling phenomenon has emerged: not only has there been very little capital flowing from rich to poor countries, but flows have been entirely reversed. If MPK's are indeed similar, this pattern of "reversal" cannot be reconciled in a standard neoclassical model. Extant theories that feature contracting imperfections, or models with incomplete markets limit the flows but do not reverse these flows from poor to rich countries (Ohanian and Wright (2007)). But dispensing with the standard assumption that inherently different trading economies can only produce the same, single good (with rich countries only producing more of it) can go a long way in reconciling with patterns of flows in the data, without the need to appeal to some type of friction. The following numerical experiment illustrates how trade and specialization patterns can cause capital to flow 'upstream' in the event of a globalization shock (from autarky to full trade and financial integration). An important prediction is that we cannot use the similarity in MPK's across countries to infer that there will be little financial capital movements across regions when they integrate.

Assume that two countries are initially in autarky. The difference between the industrialized North (country n) and the emerging South (country s) is that North features a higher total factor productivity (TFP). The autarkic equilibrium (described in Appendix A) is one in which goods and factor prices are determined by their respective aggregate capital-labor ratio:

$$p_k^{j,aut} \propto (\frac{K^j}{N^j})^{\sum_i \alpha_i\gamma_i - \alpha_k} \quad (29)$$

$$w^{j,aut} \propto A^j(\frac{K^j}{N^j})^{\sum_i \alpha_i\gamma_i} \quad (30)$$

$$R_k^{j,aut} \propto A^j(\frac{K^j}{N^j})^{\sum_i \alpha_i\gamma_i - 1} \quad (31)$$

In the initial steady state, returns are pinned down by preferences, which are equalized across countries. Thus, a higher TFP in North than in South, $A^n > A^s$, implies a higher capital-labor ratio in North (shown in Appendix A). According to Eq. 29, capital-abundant North features a lower relative price of capital-intensive goods: $(\frac{p_k}{p_i})^{n,aut} < (\frac{p_k}{p_i})^{s,aut}$ for any good $k > i$. Since the international price of good i once countries open up to trade is just the weighted average of the autarky prices in the two regions, North will see an increase in the price of all goods i such that $p_i^{n,aut} < p_i^{s,aut}$, or in other words, all goods $i \geq k$ such that

$$\alpha_k \geq \sum_i \alpha_i\gamma_i,$$

and South will see an increase in the price of goods $i < k$.[27] As a consequence, North becomes more specialized in capital-intensive goods and South in labor-intensive goods.

Trade liberalization causes wages to rise in South and to fall in North, in the two-sector case (analyzed in Appendix A.2). Since wage income accrues to the young consumers, who are the savers in the economy, aggregate savings rises in South. Insofar as countries shift their industrial structure in response of trade liberalization, South sees a reduction in its supply of capital relative to its demand for capital. In this case, the convergence force remains dormant (since initial returns were equalized), and simultaneous trade and financial liberalization therefore leads to a unambiguous net capital inflow in North, by the composition effect.[28]

Trade and specialization patterns can cause the respective marginal product of capital to diverge as a consequence of industrial restructuring. Therefore, the similarity in the rates of return to capital prior to financial liberalization is not enough to draw the conclusion that net capital flows will be precluded. However, an additional implication is that the sequencing of liberalization can also have differential impact on developing countries. Simultaneous liberalization may lead to a capital outflow in South, and an asset price drop, but trade liberalization without financial liberalization will prevent such an outflow and lead to an asset

[27] If $(\frac{K}{N})^n > (\frac{K}{N})^s$, $p_x^n < p_x^s$ iff $\sum \alpha_i\gamma_i - \alpha_k > 0$.
[28] Numerical results in the two-sector case are available upon request.

price boom. The reason is that a rise in wage income in South, as a consequence of trade liberalization, raises aggregate savings. Since aggregate savings need to contemporaneously equal aggregate investment with financial autarky, higher aggregate investment drives up the price of capital.

5.2 Demographic Divergence and Asset Prices

This framework can also be applied to address the looming "age wave" of industrialized countries that has garnered much attention from policy makers and academics alike. Just as some believe that the post-war baby boom and its flow of private savings had fueled the stock market and sent stock prices soaring in the past two decades, others fear that the imminent "age wave" that is hitting the industrialized countries will precipitate an "asset meltdown" as baby boomers start selling their large quantities of stocks for retirement consumption to a much smaller group of young cohort. Abel (2003), among others, shows that a baby boom causes an initial increase in the price of capital, followed by a fall.

Yet, the opposite demographic trend is occurring in developing countries. According to U.N. demographic projections (World Population Prospects: the 2008 Revision), demographic trends have diverged between industrialized countries and emerging markets since the mid-1980s, and is likely to continue for the next few decades. The share of working age population, population aged between 15-59, has increased from 54.3% in 1980 to a projected figure of more than 62% in 2030 for low and middle-income countries, in contrast to the decrease from 62% in 1980 to a projected 55% in 2030 for advanced economies. For Jeremy Siegel, in popular press, the far younger, and rapidly growing developing world can emerge as a solution to the "age wave crisis", as they procure the purchasing power needed to purchase assets from the developed world. Closer scrutiny of this argument under the discipline of a neoclassical framework suggests that this is untenable. If anything, faster labor force or productivity growth in emerging market would only cause their savings to stay mostly locally, where marginal product of capital and investment demand is high. It will likely generate further drops in asset prices in industrialized countries if investment takes place abroad. Yet, in a world where comparative advantage determines the structure of trade, and financial capital moves freely, higher labor force and/or labor productivity growth in emerging markets can potentially help sustain asset prices in an aging North.

One caveat is that labor force booms arising from demographic trends are to some extent anticipated. In reality labor-force booms are neither completely unexpected (demographic trends are predictable up to a certain point) nor completely anticipated (migration, female labor force participation, labor force reforms), but lie somewhere in between. Figure 4 shows results from the extreme case in which a labor force boom is perfectly anticipated, and contrasts the predictions of a one-sector case and a two-sector case scenario. The overall qualitative result on asset prices and capital flows is maintained in the anticipated case, for the periods after the shock, although its quantitative effect is tempered. The contrast remains sharp with the one-sector case, whereby the price of capital and investment falls and mean reverts for North, and the rise in asset prices is entirely accrued to Southern consumers, rather than shared across countries.[29]

5.3 Protectionism

The previous results rely on an environment where goods market and financial markets are both perfectly integrated. However, either trade autarky or financial autarky can lead to vastly different predictions for the current account and asset prices. Consider the following results:

Result 1: If countries can engage in free goods trade but financial capital is not allowed to flow across borders (i.e. if trade has to be balanced), then a positive labor force or productivity shock in South will cause the price of capital to rise in South, and to fall in North.

This result comes from the fact that aggregate savings must equal aggregate domestic investment in the absence of international movement of financial capital. As North shifts to capital-intensive sectors, the reduced demand for domestic labor can cause wages to fall in North (shown in Appendix A.2). Since aggregate savings derive from wage income, aggregate investment falls and puts downward pressure on the price of capital in North. This implies that protectionist policies in North can exacerbate the consequences of its shrinking labor force.

Result 2: If financial capital can flow across borders but countries cannot engage in free trade in goods, South's price of capital will rise while North's price of capital will fall as a consequence of a positive labor force or productivity shock in South.

[29] Initially, before the shock occurs, South starts accumulating capital a few periods ahead in expectation of a labor force boom at $t = 4$, since capital can only be gradually adjusted in the presence of adjustment costs. However, at the time of the shock $t = 4$, South still expands disproportionately more its labor-intensive sector, since capital is fixed for one period, and to equalize wages across sectors involve allocating more labor to labor-intensive ones. The composition effect is still present although tempered.

With the trade channel entirely shut off, a positive labor force or productivity shock in South will cause no changes in the patterns of specialization, and hence no impetus for capital flows induced by changes in industrial structure. Capital will flow from North to South to capture higher investment opportunities, leading to a decline in the price of capital in North.

6 Final Remarks

International commodity trade and asset trade are inherently intertwined processes of globalization, yet the workhorse international-macro model has neglected to analyze them jointly. The capital-intensity of a country's export and production structure affects its demand for financial capital, and financial capital inflows into a country can affect its extent of specialization in capital-intensive industries. This interaction is key in determining global allocations of capital and the behavior of asset prices. A simple and yet more realistic enrichment of the standard model to include multiple sectors thus compels us to reassess the way a variety of shocks impinge on the world economy.

In the framework that I develop, a novel force that coexists with the convergence force in shaping global capital flows emerges: capital tends to flow towards countries that become more specialized in capital-intensive sectors. This implies that the integration of developing South and industrialized North, or faster labor force/productivity growth in the former can lead to capital flows from South to North. This stands in sharp contrast to the prediction of the standard one-sector model, and is consistent with the existing global current account patterns.

The interaction between goods trade and asset trade is worthy of further investigation. For example, a natural implication of the framework is that trade liberalization and financial asset liberalization have differential impact on emerging market's asset prices. Whereas simultaneous trade and financial liberalization may cause asset prices to fall in emerging markets, for the reason that capital flows towards North where the capital-intensity of production is higher, trade liberalization alone can cause a rise in asset prices in emerging markets through its positive impact on wages and aggregate savings.

Looking towards the future, emerging markets' lagging demographic transitions combined with faster productivity growth can emerge as a potential remedy to the age mismatch of the industrialized economies. Higher global demand for North's assets as it becomes more capital-intensive can help sustain asset prices despite the imminent reduction of its labor force. Yet this outcome depends critically on the extent of financial and trade integration of world economies. Impediments to the free flow of goods and capital among countries, along with rising protectionism in certain parts of the world, will inevitably curtail the ability to share these shocks on a global level. But if we believe that greater interdependence is the direction towards which the world is heading, all the more important is a synthesized framework that takes into account a comprehensive set of forces that shape our global economy.

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A Appendix: Initial Equilibrium

The Open Economy: Assuming $\theta = 1$, the integrated equilibrium is one in which a constant fraction of world resources is spent in each sector: $\tilde{N}_i^g = \frac{\gamma_i(1-\alpha_i)}{s_l}\tilde{N}^g$ and$K_i^g = \frac{\gamma_i\alpha_i}{s_k}K^g$, where $s_k = \sum_i \alpha_i\gamma_i$, and $s_l = 1 - s_k$. In the open-economy steady state, goods price and factor prices are independent of domestic factor endowments and determined entirely by world endowments: $\frac{p_i}{p_j} \propto \left(\frac{K^g}{\tilde{N}^g}\right)^{\alpha_j-\alpha_i}$ where $\tilde{N}_i^g = A^n N_i^n + A^s N_i^s$. Factor prices are given by: $w \propto A\left(\frac{K^g}{\tilde{N}^g}\right)^{\sum \alpha_i\gamma_i}$, $R \propto \left(\frac{K^g}{\tilde{N}^g}\right)^{\sum \alpha_i\gamma_i - 1}$.

Autarky: Assume that North and South differ by total factor productivity, $A^s < A^n$, and are initially in autarky. The autarkic equilibrium is one in which the equalization of factor prices across sectors, together with the goods market clearing condition, give rise to the result that a constant fraction of resources is spent on each sector $N_i = \frac{\gamma_i(1-\alpha_i)}{s_l}N$, and $K_i = \frac{\gamma_i\alpha_i}{s_k}K$, and where the absolute price of any good k is $p_k \propto \left(\frac{K}{N}\right)^{\sum_i \alpha_i\gamma_i - \alpha_k}$.[30] Similarly, $w \propto A\left(\frac{K}{N}\right)^{\sum_i \alpha_i\gamma_i}$, $R \propto A\left(\frac{K}{N}\right)^{\sum_i \alpha_i\gamma_i - 1}$.[31] International goods prices after opening up to trade is the weighted average of the autarky prices in each country, and therefore trade liberalization raises all prices of goods k in North such that $\alpha_k > \sum_i \alpha_i\gamma_i$.

A.1 Key Derivations

Proof of Lemma 1:

With Assumption 2 (log utility), the optimal consumption for any young consumer in j is

$$c_t^{y,j} = \frac{1}{1+\beta}w_t^j. \tag{32}$$

When aggregating the above expression and summing across countries to get aggregate global consumption of the young, $C_t^{y,g} = \sum_j c_t^{y,j} N_t^j$ and plugging into the young consumer's budget constraint, Eq. 10, gives world investment

$$I_t^g = \frac{\phi\beta}{1+\beta}W_t^g = \frac{\phi\beta}{1+\beta}s_l Y_t^g \tag{33}$$

[30] Using the price index $1 = \prod_i p_i^{\gamma_i}$ and the relative price formula $\frac{p_i}{p_j} = \frac{\gamma_i}{\gamma_j}\frac{Y_j}{Y_i}$ for any i and j, we find the absolute price for any good k, $p_k = \prod_i (\frac{\gamma_k}{\gamma_i}\frac{Y_i}{Y_k})^{\gamma_i}$. This leads to Eq. 29, where more precisely, $p_k = (s_l/s_k)^{s_k-\alpha_k}\prod_i(\gamma_k/\gamma_i)^{-\gamma_i}(\alpha_i\gamma_i)^{\alpha_i\gamma_i}[(1-\alpha_i)\gamma_i]^{(1-\alpha_i)\gamma_i}\,(K/N)^{\sum_i \alpha_i\gamma_i-\alpha_k}$.

[31] More precisely, $w = M{s_l}^{-s_l}{s_k}^{-s_k}{\alpha_k}^{\alpha_k}(1-\alpha_k)^{1-\alpha_k}A(K/N)^{s_k}$, and $R = M(s_k/s_l)^{s_k-1}{\alpha_k}^{\alpha_k}(1-\alpha_k)^{1-\alpha_k}A(K/N)^{s_k-1}$.

where $I_t^g = \sum_j \sum_i I_{it}^j$ and $W_t^g = \sum_j w_t^j N_t^j$, and Y_t^g denotes world nominal output, $\sum_i p_{it} Y_{it}^g$. The share of wage income in total world nominal output is denoted as s_l where $s_l = \sum_i \gamma_i (1-\alpha_i)$.[32] With markets being effectively complete, we have the efficient allocation condition

$$\frac{C_t^y}{C_t^{y,g}} = \frac{C_{t+1}^o}{C_{t+1}^{o,g}} \tag{34}$$

where $C_t^{y,j} = c_t^{y,j} N_t^j$ and $C_t^{o,j} = c_t^{o,j} N_t^j$. Aggregating the budget constraint Eq. 11 and summing across countries gives

$$C_{t+1}^{o,g} = \left(s_k + \frac{(1-\phi)\beta}{1+\beta} s_l \right) Y_t^g, \tag{35}$$

where $s_k = 1 - s_l$ and is the share of capital income in world output. Plugging this expression, along with the total world consumption of the young into the standard Euler equation associated with a Home's agents' household's problem,

$$u'(c_t^{y,h}) = \mathbb{E}_t \left[u'(c_{t+1}^{o,j}) R_{i,t+1}^j \right] \tag{36}$$

for any $i = 1...m$ gives

$$1 = \left[\frac{\frac{\phi\beta}{1+\beta} W_t^g}{\sum_i p_{i,t+1} Y_{i,t+1}^g \left(s_k + \frac{(1-\phi)\beta}{1+\beta} s_l \right)} \frac{\alpha_i p_{i,t+1} Y_{i,t+1}^j + \frac{1-\phi}{\phi} I_{i,t+1}^j}{I_{it}^j} \right] \tag{37}$$

where $c_t^{y,h}/c_{t+1}^{o,h}$ is replaced by $C_t^{y,g}/C_{t+1}^{o,g}$ from Eq.34. Using the notation $I_{it}^j = \mu_{it}\eta_{it} I_t^g$ and Eq. 33 , the above expression becomes

$$\mu_{it}\eta_{it} = \mathbb{E}_t \left[\frac{\alpha_i \gamma_i}{s_k + \frac{(1-\phi)\beta}{1+\beta} s_l} \frac{Y_{i,t+1}^h}{Y_{i,t+1}^g} + \frac{\frac{(1-\phi)\beta}{1+\beta} s_l}{s_k + \frac{(1-\phi)\beta}{1+\beta} s_l} \mu_{i,t+1}\eta_{i,t+1} \right] \tag{38}$$

$$= \mathbb{E}_t \left[\lambda_i \frac{Y_{i,t+1}^h}{Y_{i,t+1}^g} + \lambda \mu_{i,t+1}\eta_{i,t+1} \right], \tag{39}$$

where $\sum_i \lambda_i = 1 - \lambda$. Summing the above equation across countries gives

$$\mu_{it} = \lambda_i + \lambda \mathbb{E}_t [\mu_{i,t+1}] \tag{40}$$

[32]The assumption of $\theta = 1$ implies that $p_i Y_i^g = \gamma_i \sum_i p_i Y_i^g$. Therefore, global wage income as a share of world nominal output $W^g / \sum_i p_i Y_i^g$ where $W^g = (1-\alpha_i) p_i Y_i^g$ is therefore the share $s_l \equiv \gamma_i (1-\alpha_i)$. Analogously, the share of capital income is $\sum_i \alpha_i p_i Y_i^g$ is $s_k = \sum_i \gamma_i \alpha_i = 1 - s_l$.

which implies that μ_i is a constant. Since $\mu_i = \frac{\lambda_i}{1-\lambda}$, it must be that

$$\mu_i = \frac{\alpha_i \gamma_i}{\sum_i \alpha_i \gamma_i}.$$

Dividing μ_i on both sides of Eq. 38, while using $\mu = \frac{\lambda_i}{1-\lambda}$ yields

$$\eta_{it} = (1-\lambda)\mathbb{E}_t\left[\frac{Y^h_{i,t+1}}{Y^g_{i,t+1}}\right] + \lambda \mathbb{E}_t[\eta_{i,t+1}] \quad (41)$$

$$= (1-\lambda)\sum_{k=0}^{\infty} \lambda^k \mathbb{E}_t\left[\frac{Y^h_{i,t+k+1}}{Y^g_{i,t+k+1}}\right] \quad (42)$$

which corresponds to Eq. 21.

A.2 Factor and Goods Prices

A high $\epsilon^f_{N,t}$: The impact effect of a labor force boom in Foreign on factor and goods prices can be analyzed analytically in the case of $\theta = 1$ in the two-sector case. Denoting hat variables as percentage changes, we have, in any country j:

$$\hat{w^j_1} = \hat{p_1} - \alpha_1 \hat{N^j_1} \quad (43)$$

$$\hat{w^j_2} = \hat{p_2} - \alpha_2 \hat{N^j_2} \quad (44)$$

$$\hat{R^j_1} = \hat{p_1} + (1-\alpha_1)\hat{N^j_1} \quad (45)$$

$$\hat{R^j_2} = \hat{p_2} + (1-\alpha_2)(\hat{N^j_2}), \quad (46)$$

where we assume that $\epsilon^j_{A,t} = 0$ for all j. Capital is predetermined and therefore a fixed factor in period t. Since $\hat{p_2} > 0$ and $\hat{p_1} > 0$ following a high a labor force boom in Foreign, only one configuration of the change in goods and factor prices is possible:

$$\hat{R^h_2} > \hat{p_2} > \hat{w^h} ?0 > \hat{p_1} > \hat{R}_1 \quad (47)$$

$$\hat{R^f_1} > \hat{R^f_2} > \hat{p_2} > 0 > \hat{p_1} > \hat{w^f}. \quad (48)$$

To determine wage behavior at home, first observe that wage equalization within a country at any point in time implies $\hat{w_1} = \hat{w_2}$, which, in conjunction to the condition that $\gamma\hat{p_1} + (1-\gamma)\hat{p_2} = 0$, implies that $\hat{w_2} = (\gamma-1)\alpha_2(\hat{N}_2) - \gamma\alpha_1\hat{N}_1$. The condition that determines whether wages rise or fall in Home amounts to:

$$\hat{w_t^h} < 0 \Leftrightarrow \frac{N^h_{1,t-1}}{N^h_{2,t-1}} < \frac{\gamma}{1-\gamma}\frac{\alpha_1}{\alpha_2} \tag{49}$$

For standard parameter values, wages tend to fall at Home while it falls unambiguously in Foreign.

A Globalization Shock: A similar analysis shows that in response to a globalization shock:

$$\hat{R_2^h} > \hat{p_2} > 0 > \hat{w_1^h}, \hat{w_2^h} > \hat{p_1} > \hat{R_1^h} \tag{50}$$

$$\hat{R_1^f} > \hat{p_1} > \hat{w_1^s}, \hat{w_2^s} > 0 > \hat{p_2} > \hat{R_2^s} \tag{51}$$

where wages falls unambiguously in North, since condition 49 is satisfied in the closed-economy equilibrium, where $\frac{N_1^h}{N_2^h} = \frac{\gamma(1-\alpha_1)}{(1-\gamma)(1-\alpha_2)}$ (from Appendix A).

B Special Case: A Closed-Form Solution

Proof of Proposition 1:

Proof. Guess that $\frac{K_{it}^h}{K_{it}^g} = \eta_{it}$, and using $K_{i,t+1} = aI_{it}^{\phi}K_{it}^{1-\phi}$, $\frac{I_{it}^h}{I_{it}^f} = \frac{\eta_{it}}{(1-\eta_{it})}$ by construction, $\frac{Y_{i,t+1}^h}{Y_{i,t+1}^g} = \frac{K_{i,t+1}^h}{K_{i,t+1}^g} = \frac{1}{1+\frac{K_{i,t+1}^f}{K_{i,t+1}^h}} = \frac{1}{1+\frac{(1-\eta_{it})^{\phi}}{\eta_{it}^{\phi}}\frac{(K_{it}^f)^{1-\phi}}{(K_{it}^h)^{1-\phi}}} = \eta_{it}$. This shows that if $\frac{K_{it}^h}{K_{it}^g} = \eta_{it}$, we naturally have $\frac{K_{i,t+1}^h}{K_{i,t+1}^g} = \eta_{it}$. By induction, $\frac{K_{i,t+m+1}^h}{K_{i,t+m+1}^g} = \eta_{i,t+m} = \eta_{i,t+m-1} = ... = \eta_{i0}$, for any $k \geq 0$, so that $\frac{Y_{i,t+m+1}^h}{Y_{i,t+m+1}^g} = \eta_{i0}\ \forall k \geq 0$.

This implies that: $\eta_{it} = \lambda \sum_{m=0}^{\infty}(1-\lambda)^k E_t[\frac{K_{i,t+m+1}^h}{K_{i,t+m+1}^g}] = \lambda \sum_{m=0}^{\infty}(1-\lambda)^m E_t[\eta_{i0}] = \eta_{i0}$, which proves that the guess $\eta_{it} = \eta_{i0}$ is a solution that satisfies the contraction mapping. ■

A Sufficient condition for diversification in production: The assumption of Cobb-Douglas demand preferences implies that the output of good 1, $Y_1^{g\prime}$, rises in response to a labor force boom or a TFP shock, since $Y_i^{g\prime} = \gamma_i (Y_i^g)'$ for all i, where "′" denotes variables after the shock. This implies that

$$N_1^{h\prime} + N_1^{f\prime} > N_1^h + N_1^f. \tag{52}$$

Since wages fall at Home, from above, we know that (i): $\Delta\tilde{k}_i^j < 0 \forall i \neq 1$, and (ii): $\Delta\tilde{N}_1^h <$

Table 1: Parameters for Simulation

Benchmark Parameter Values		
Preferences	$\beta = 0.45$	$\gamma = 0.61$
	$\rho = 1$	$\theta = 1$
Technology	$\alpha^l = 0.52$	$\alpha^c = 0.11$
	$b = 0.2$	

$0, \Delta\tilde{N_1^f} > 0, \Delta\tilde{N_i^j} < 0 \ \ \forall i \neq 1$. For non-specialization to occur, it must be that both countries produce the most labor-intensive good, good 1, so that$N_1^{s\prime} - N_1^s < \epsilon$, $N_1^{n\prime} > 0$. From Eq. 52,$N_1^{f\prime} - N_1^f < \epsilon \Leftrightarrow N_1^h - N_1^{h\prime} < N_1^{f\prime} - N_1^f < \epsilon$, which implies $N_1^{h\prime} > N_1 - \epsilon$. A sufficient condition for which $N_1^{h\prime} > 0$, and hence, diversification in production, is therefore

$$\epsilon < N_1^h.$$

C Tables and Figures

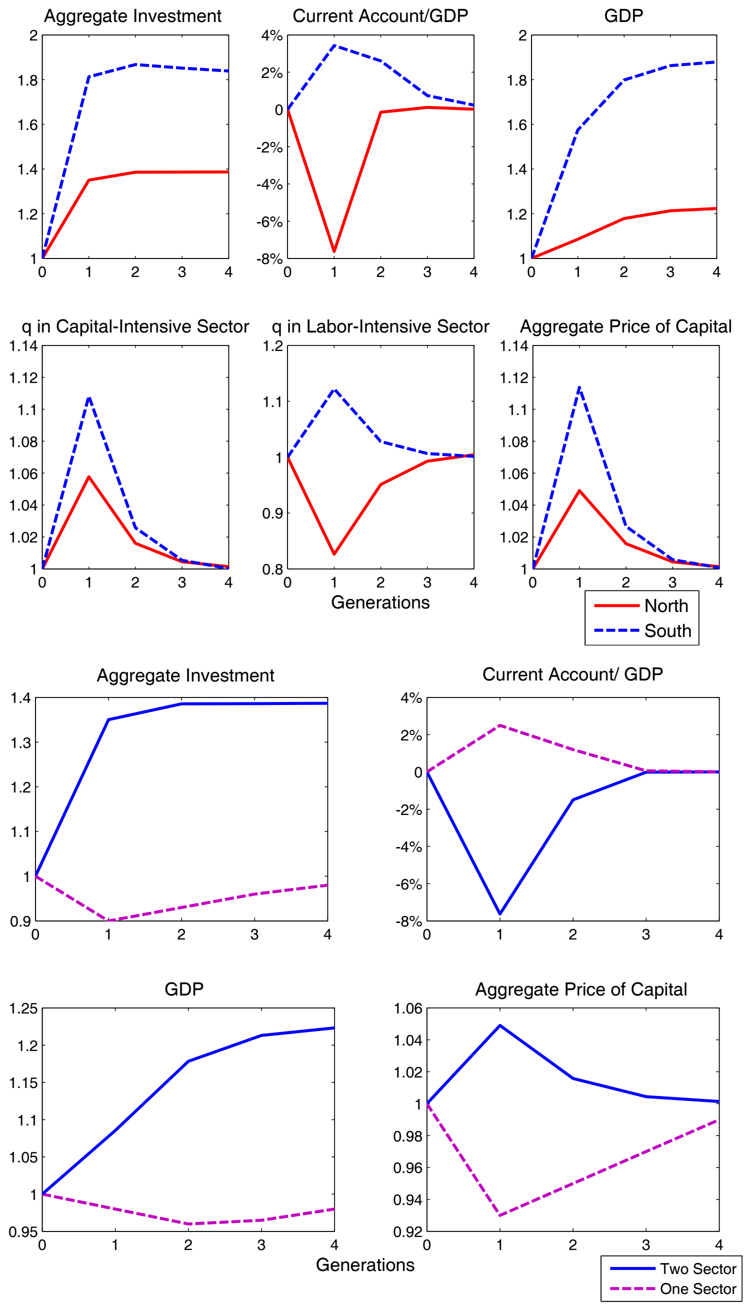

Figure 2: The response to an unexpected doubling of the labor force in South (Foreign) in period 1. The first set of panels displays the behavior of key variables in the two countries; the second set of panels contrasts the behavior of North (Home) in the one sector case and the two sector.

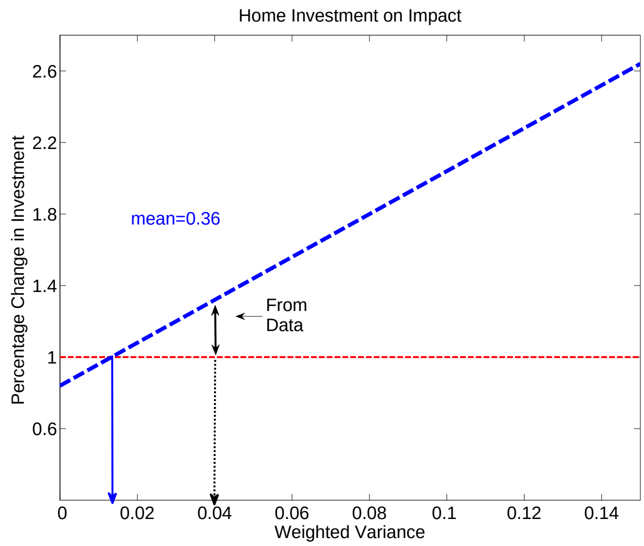

Figure 3: This graph shows North's (Home's) response to an unexpected doubling of South's (Foreign's)labor force in a 5 sector model, holding constant the weighted-mean $\sum_i \alpha_i \gamma_i$, at 0.36, while varying the weighted variance $\sum_i (\alpha_i - 0.36)^2 \gamma_i$.

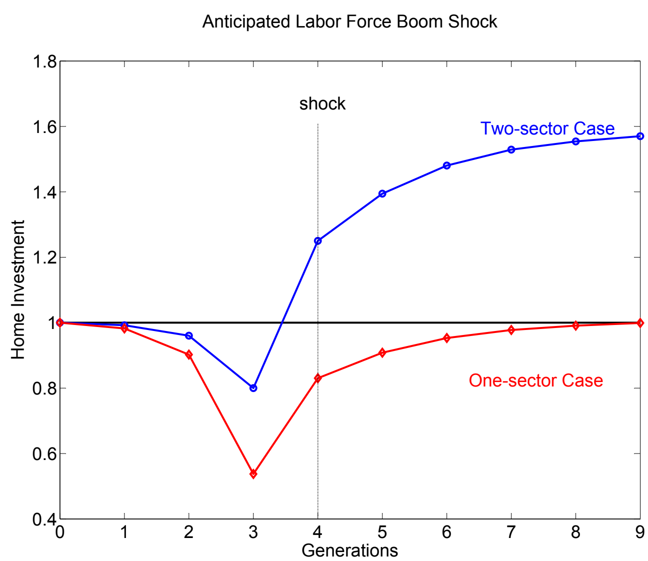

Figure 4: This figure contrasts the response of investment in North (Home) to an anticipated labor force boom in period 4, in the one sector vs. the two-sector case.

Table 2: Sensitivity Anaysis

Sensitivity to the Adjustment Cost Parameter and Factor Intensities				
Two-Sector	**CA**: T=1	**q**:	T=1	T=5
(1) Varying Adjustment Costs				
b=0.05	-8.37%		2.96%	0
b= 0.1	-8%		5.04%	0
b= 0.3	-7.04%		9.41%	0.31%
b= 0.5	-6.43%		11.27%	1.12%
(2) Varying Factor Intensity				
$\alpha^c/\alpha^l = 1$	0.1%		-0.1%	0
$\alpha^c/\alpha^l = 3$	-4.84%		5.88%	0.1%
$\alpha^c/\alpha^l = 9$	-5.06%		6.08%	0.47%
(3) Interaction				
High b and high α^c/α^l	-7.57%		16.75%	4.04%
low b and high α^c/α^l	-9.10%		5.45%	0
high b and low α^c/α^l	-2.95%		5.97%	2.85%
(4) Elasticity of Substitution				
$\theta = 0.8$	-5.77%		6.29%	0.1%
$\theta = 4$	-6.31%		6.41%	0.08%
(5) Risk Aversion				
$\rho = 0.8$	-6.33%		6.71%	0.17%
$\rho = 2$	-4.56%		4.4%	0.44%
One-Sector				
b=0.1	0.01%		-0.3%	0
b= 0.3	0.02%		-1%	0
b= 0.5	1.22%		-4%	0

Response of North's (Home's) current account and the price of capital at different horizons; shock occurs at $T = 1$. The first set of results varies b from 0.05 to 0.5, while holding constant other parameters, in Table 1; The second set of results holds constant all parameters in Table 1 except the factor intensity ratio, α^c/α^l; The levels of α^c and α^l are obtained by fixing the weighted mean $\gamma\alpha^1 + (1-\gamma)\alpha^c = 0.36$ and setting their ratio to each of the values above; The third set of results explores interactions between b and α^c/α^l.