Industrial Structure and Financial Capital Flows*

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Abstract

Factor-proportions trade and financial asset trade are both integral parts of globalization, yet little has been studied on their interplay. In a framework that integrates these two paradigms of trade, a new force driving international capital flows emerges: capital tends to flow towards countries that become more specialized in capital-intensive industries (a composition effect). This force competes with the “neoclassical force” which channels capital towards the location where it is more scarce, in response to shocks such as globalization, country-specific labor force or labor productivity shocks. If the composition effect dominates, capital flows away from the country hit by the positive shock—“a flow reversal”—and asset prices rise globally rather than locally. Two implications arise: rich countries’ current account deficits may be a consequence of their shifting towards capital-intensive industries; young and fast growing developing countries may help sustain asset prices in an aging industrialized world. Predictions of the current account and specialization patterns are shown to be consistent with the data.

JEL Classification: F21, F32, F41

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

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1 Introduction

Commodity trade and financial capital flows have both played primal roles in the process of globalization, yet there has been little focus on how they interact. A key insight of the neoclassical trade theory is that factor endowments form a basis for trade, and countries tend to specialize in industries that require intensive use of their abundant factor. While specialization patterns are well understood, much less is known about how they affect financial capital flows. The simple notion that the capital-intensity of a country’s export and production structure may be interrelated with its demand for global financial capital suggests that goods trade and capital flows be analyzed jointly. Yet the convention has been to keep them largely separate in the literatures of international trade and international macroeconomics. This paper demonstrates that their interaction can become crucial, and sheds light on widely-debated issues of global imbalances and asset prices. In particular, trade and specialization may cause financial capital to flow from developing countries to industrialized countries, and lead to a global comovement in investment and asset prices.

In investigating how factor-endowment-based trade and financial asset trade interact, this paper develops a framework that integrates these two paradigms of trade. With only basic ingredients, new results emerge and are often surprising. Accompanying the shift in the composition of countries’ production and export structure towards sectors that intensively use their abundant factor is a change in the relative demand and supply of capital. Countries that become more specialized in capital-intensive goods see a concurrent rise in their demand for capital relative to their domestic supply, and those that become more specialized in labor-intensive sectors see the opposite. A new driving force of international capital flows thus emerges: financial capital tends to flow towards countries more specialized in capital-intensive industries (a composition effect). Simultaneously present is the standard, “neoclassical effect” (a slight abuse of terminology) that channels capital towards the location where the effective capital-labor ratio is lower. These two forces can become competing, and the direction of international capital flows and the behavior of asset prices are ultimately determined by which of the two effects dominates.

A framework that allows for the interplay between factor-proportions trade and financial capital flows therefore potentially changes the way we think about the macroeconomic impact of certain global shocks. Indeed, two pronounced international developments of the past few decades have been the rapid trade and financial integration of developed and developing countries, and their vastly uneven growth in the effective labor force. Faster population growth in developing countries, including the massive rural migration of Chinese workers to the productive urban economy, combined with faster labor productivity growth in developing countries, contributed to a rapid growth in the labor force.

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.

2 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. These estimates are consistent with those provided by numerous other studies.
increase in the size of the effective labor force in emerging markets.

How does faster labor and productivity growth in emerging markets affect world capital flows and asset prices? According to the one-sector neoclassical model, the emerging South, with a permanently higher effective labor force, offers higher investment opportunities and should experience a net capital inflow (the “neoclassical” effect). Yet this relies on the assumption that countries cannot engage in commodity trade, an assumption which is no longer innocuous when countries’ comparative advantage are fundamentally altered. That factor proportions is a strong determinant of trade has been most recently, further demonstrated 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 that countries that rapidly accumulate a factor see their production and export structures systematically shift towards industries that intensively use that factor.

Thus, relying on the premise that factor endowment differences form a basis for world trade, an integrated framework of trade and capital flows can make opposite predictions from the standard model. When South becomes relatively more labor abundant and consequently more specialized in labor-intensive goods, its demand for capital rises by less than it would have otherwise in the one-sector case. So while on the one hand, the neoclassical force exerts its impact by drawing capital away from North to South (where the capital-labor ratio is lower), this force is offset by the composition effect, which reduces South’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 neoclassical effect is the only impetus to capital flows and predicts just the opposite.

The framework developed in this paper provides a rich setting for analyzing a host of widely-discussed issues, delivering new results and certain policy implications. 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 timing 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.

The framework developed in this paper is a stochastic, two country, Diamond-version overlapping generations model with production and capital accumulation, based on the closed-economy, one-good framework in Abel (2003)\textsuperscript{3} 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\textsuperscript{4}. Despite the numerous features that are embedded in this model, it remains to be highly tractable, and the new underlying mechanisms are made transparent through either the semi-closed form or full closed-form solutions obtained in the various cases.

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 neoclassical 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 one in which the neoclassical 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 to the first.

The main difference between this economy and the majority of either one-good or two-good stochastic growth models of large open economies (Backus, Kehoe and Kydland (1992), (1994)), 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. In contrast to two-sector models that do feature factor-proportions trade, such as Ventura (1997), Atkeson and Kehoe (2002), among others, the main difference is that this model does not make the assumption that capital needs to stay within borders (that trade is balanced).

In spirit, this paper is closer to a few recent papers that also highlight the interaction between trade and capital flows, such as Cuñat and Maffezzoli (2004), Ju and Wei (2006), and Antrás and Caballero (2007). The main point of this paper, in contrast to the others, is that specialization patterns alone can alter the nature of financial flows\textsuperscript{5}. Finally, on explaining global imbalances, in

\textsuperscript{3}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.

\textsuperscript{4}In a Hecksher-Ohlin world with factor price equalization, capital earns the same returns everywhere and can be located anywhere. Adjustment costs serve to temporarily break FPE and pin down the path of capital.

\textsuperscript{5}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 neoclassical effect and the composition effect in shaping
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 heterogeneity between the two regions at center stage.

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 neoclassical 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 provides some supportive empirical evidence on the relationship between specialization and the current account deficit, and Section 7 concludes.

2 The Model Description

Consider a world with two countries, a Home (H) and a Foreign (F), each characterized by an overlapping generations economy in which consumers live for two periods. The countries produce the same type of intermediate goods $i = 1 \ldots m$, which are traded freely and costlessly, and are conveniently indexed by their capital intensity, $\alpha_1 < \alpha_2 \ldots < \alpha_i \ldots < \alpha_m$. Intermediate goods are combined to produce a final good, which 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 Demographics, preferences and technologies

In each period $t$, the world economy experiences one of finitely many events $s_t$. Denote $s^t = (s_0, \ldots, s_t)$ the history of events up through and including period $t$. The probability at date 0 of any particular history $s^t$ is given by $\pi(s^t)$. In the beginning of period $t$, $N^j(s^t)$ young workers arrive in country $j$. They inelastically supply one unit of labor in youth, and none when old in the next period. The measure of young consumers, $N^j(s^t)$, is assumed to follow a geometric random walk:

$$\ln N^j(s^t) = \ln N^j(s^{t-1}) + \epsilon^j_N(s^t)$$
where \( \epsilon_N(s^t) \) represents a random labor force growth rate which is \( iid \). A high \( \epsilon_N^j(s^t) \) represents a labor force boom.

Each consumer in country \( j \) admits preferences of the form

\[
u(c^j(s^t)) = \frac{(c^j(s^t))^{1-\rho}}{1-\rho}
\]

where \( c^j(s^t) \) denotes the consumption by a consumer in \( j \). Intermediate goods are aggregated by a constant elasticity of substitution, \( \theta \), to form a unit of consumption good and a unit of investment good. For any consumer in \( j \),

\[
c^j(s^t) = \left[ \sum_{i=1}^{m} \gamma_i c^j_i(s^t)^{\theta-1} \right]^{\frac{1}{\theta}}
\]

where \( \sum_i \gamma_i = 1 \). \( c^j_i(s^t) \) denotes the consumption demand of a \( j \) consumer for good \( i \).

Perfectly-competitive firms use domestic labor, supplied by the young consumers, and capital to produce an intermediate good \( i \) in country \( j \):

\[
Y^j_i(s^t) = K^j_i(s^{t-1})^{\alpha_i} \left( A^j(s^t) N^j_i(s^t) \right)^{1-\alpha_i}
\]

where \( 0 < \alpha_i < 1 \) for any \( i \). \( K^j_i(s^t) \) is \( j \)'s aggregate capital stock in sector \( i \), and \( N^j_i(s^t) \) is its aggregate input of labor employed in sector \( i \), at \( s^t \). \( A^j(s^t) \) represents the country-specific labor productivity, and follows

\[
\ln A^j(s^t) = \ln A^j(s^{t-1}) + \epsilon^j_A(s^t)
\]

where the growth rate of labor productivity, \( \epsilon^j_A(s^t) \), is \( iid \) and is independent of \( \epsilon_N(s^t) \), a random labor force growth rate.

The capital used in producing good \( i \) is augmented by investment goods, \( I_i(s^t) \), and current capital stock. The law of motion for capital stock in \( i \) is given by \( K^j_i(s^t) = G(K^j_i(s^{t-1}), I^j_i(s^t)) \) where \( I^j_i(s^t) \) is the aggregate investment in sector \( i \) in country \( j \) at \( s^t \). \( G(K^j_i(s^t), I^j_i(s^t)) \) is linearly homogeneous in \( K^j_i(s^t) \) and \( I^j_i(s^t) \), and there are convex adjustment costs, which satisfy \( \frac{d^2G}{d^2I_i(s^t)} < 0 \).

Following Abel (2003), I take a log-linear specification of \( G(K^j_i(s^t), I^j_i(s^t)) \):

\[
K^j_i(s^t) = a \left( I^j_i(s^t) \right)^{\phi} \left( K^j_i(s^{t-1}) \right)^{1-\phi},
\]
where \( 0 \leq \phi \leq 1 \).\(^6\) The purpose of this assumption is to derive analytical solutions for the equilibrium price and quantity of capital.\(^7\)

### 2.2 Consumers

In the first period, a young consumer in the Home country inelastically supplies one unit of labor and earns the competitive wage \( w^h(s^t) \), which is used for consumption \( c^h_y(s^t) \), for purchasing state-contingent securities, \( b^h(s^{t+1}) \), at the corresponding state-contingent price \( Q(s^{t+1}) \), and for purchasing capital. Let \( k^{h,j}(s^t) \) be the amount of capital that a young consumer in Home buys in sector \( i \) from country \( j \), at a price \( q^j_i(s^t) \) per unit, at the end of period \( t \) to be carried into period \( t+1 \). A Home young consumer’s budget constraint is therefore:

\[
c^h_y(s^t) = w^h(s^t) - \sum_{j=h,f} \sum_{i=1}^m q^j_i(s^t)k^{h,j}(s^t) - \sum_{s^{t+1}|s^t} Q(s^{t+1})b^h(s^{t+1}).
\]

Assume that consumers do not have bequest motives, and therefore consume all available resources when they are old. The budget constraint for a Home’s old consumer is

\[
c^h_o(s^{t+1}) = \sum_{j=h,f} \sum_{i=1}^m R^j_i(s^{t+1})q^j_i(s^t)k^{h,j}(s^t) + b^h(s^{t+1})
\]

where \( R^j_i(s^{t+1}) \) is the rate of return on capital earned in sector \( i \) in country \( j \).

A consumer in Home maximize its lifetime utility of consumption

\[
U = u(c^j_y(s^t)) + \beta \sum_{s^{t+1}|s^t} \pi(s^{t+1})u(c^j_o(s^{t+1}))
\]

where \( \beta \) denotes the discount factor, \( c^j_y(s^t) \) denotes the consumption of a young consumer in \( j \) in period \( t \), and \( c^j_o(s^{t+1}) \) denotes the consumption by an old consumer in \( j \) in period \( t+1 \).\(^8\) A similar set of equations hold for consumers in Foreign.

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\(^6\)As shown in Abel (2003), if \( \phi = 1 \) and \( a = 1 \), the capital accumulation equation becomes the one in the neoclassical growth model with complete depreciation in each period; if \( \phi = 0 \) and \( a = 1 \), this becomes the case of the Lucas-tree asset pricing model in which the capital stock is constant.

\(^7\)In comparing the log-linear model with a standard capital adjustment technology:

\[
K_i(s^t) = (1 - \delta)K_i(s^{t-1}) + I_i(s^t) - \frac{b}{2} \frac{I_i(s^t)}{K_i(s^{t-1})} - \delta^2 K_i(s^{t-1}),
\]

it can be shown that the two models are equivalent up to the second order if and only if \( a = \phi^{-\phi}, \delta = \phi, b = \frac{1 - \phi}{\phi} \).

\(^8\)The first order condition of the consumer’s problem is \( Q(s^{t+1}|s^t) = \beta \pi(s^{t+1}|s^t)u_c(c^j_o(s^{t+1}))/u_c(c^j_y(s^t)) \). The Euler equation associated with any asset \( i \) in any country \( j \) is \( u_c(c^j_i(s^t)) = \beta \sum_{s^{t+1}|s^t} \pi(s^{t+1})u_c(c^j_i(s^{t+1}))R^j_i(s^{t+1}) \) where \( u_c(s^t) \) denotes the derivative of the utility function with respect to consumption.
2.3 Firms

Firms are perfectly competitive, and choose inputs \( K_i^j(s^t), N_i^j(s^t) \), and investment \( I_i^j(s^t) \) to solve

\[
\max_{t=0}^{\infty} \sum_{s^t} Q(s^t)[p_i(s^t)Y_i^j(s^t) - w_i^j(s^t)N_i^j(s^t) - I_i^j(s^t)]
\]

subject to \(^1\) and \(^2\) where \( p_i(s^t) \) is the international price of good \( i \), since the law of one price applies to the freely-traded intermediate goods. \( w_i^j(s^t) \) is the real wage paid in sector \( i \) in country \( j \) at \( s^t \).

The price of capital, \( q_i^j(s^t) \), is given by the first order condition for \( I_i^j(s^t) \). It is the price of acquiring one unit of capital in sector \( i \) and country \( j \) (in terms of the consumption good) at the end of period \( t \) to be carried into the the next period. This price is the amount that \( I_i^j(s^t) \) needs to be increased to increase \( K_i^j(s^t) \) by one unit, that is, \( \left( dK_i^j(s^t)/dI_i^j(s^t) \right)^{-1} \). This implies that

\[
q_i^j(s^t) = \frac{1}{\alpha^t} \left( \frac{I_i^j(s^t)}{K_i^j(s^{t-1})} \right)^{1-\phi}.
\] (5)

If \( 0 < \phi < 1 \), then \( q_i^j \) is increasing in the investment-capital ratio, \( I_i^j(s^t)/K_i^j(s^t) \), of any sector \( i \).

In a perfectly-competitive environment, factors are paid their marginal products. Capital in any sector \( i \) in any country \( j \), is productive both in the intermediate goods technology and also in contributing to lowering adjustment costs next period. The total rate of return to capital is therefore the sum of capital’s marginal product in the intermediate goods technology, multiplied by the price of the intermediate good, and its marginal contribution to lowering adjustment costs next period—discounted by the price at which a unit of capital was purchased last period, \( q_i^j(s^{t-1}) \). The first order condition with respect to \( K_i^j(s^t) \), for any \( i \) in \( j \), in conjunction to the optimal conditions of the consumer’s problem defines the rate of return\(^9\)

\[
R_i^j(s^t) = \frac{\alpha_i p_i(s^t)Y_i^j(s^t)}{K_i^j(s^{t-1})} + \frac{1-\phi}{\phi} \frac{I_i^j(s^t)}{K_i^j(s^{t-1})} q_i^j(s^{t-1}).
\] (6)

Labor earns its marginal product. The wage rate per unit of labor is given by the first order condition with respect to \( N_i^j(s^t) \):

\[
w_i^j(s^t) = (1 - \alpha_i)p_i(s^t) \frac{Y_i^j(s^t)}{N_i^j(s^t)}.
\] (7)

\(^9\)The first order condition of the firm’s problem with respect to \( K_i^j(s^t) \) is

\[
1 = \sum_{s^{t+1}} Q(s^{t+1}|s^t) \left( \frac{p_i(s^t) dY_i^j(s^{t+1})}{dK_i^j(s^t)} + \frac{dI_i^j(s^{t+1})}{dK_i^j(s^t)} \right) / \left( \frac{dK_i^j(s^t)}{dK_i^j(s^{t-1})} \right),
\]

which, combined with the first order conditions from the consumer’s problem given in Footnote \(^8\) yields Eq. \(^8\).
2.4 Market Clearing

The intermediate goods markets clear when global demand of any good $i$ equals its global supply:

$$Y^g_i(s^t) = \sum_{j=h,f} c^j_i(s^t) + \sum_{j=h,f} \sum_{k=1}^m I^j_{ki}(s^t), \quad (8)$$

for all $i = 1...m$. Superscripts $g$ will henceforward represent global variables. $c^j_i(s^t)$ is $j$’s consumption demand of good $i$, and $I^j_{ki}(s^t)$ is its investment demand of good $i$ in each sector $k$.

Domestic labor markets clear when

$$\sum_{i=1}^m N^j_i(s^t) = N^j(s^t)$$

for all $j$. And market clearing for state-contingent securities require that, for every $s^t$,

$$b^h(s^t) + b^f(s^t) = 0.$$

The law of one price implies that consumers in each country face the same international prices $p_i$, for all $i$, which, in conjunction to the assumption of identical preferences across countries, imply that both region’s aggregate price index is equalized. The price index that corresponds to CES preferences is

$$P = \left[ \sum_{i=1}^m \gamma_i p_i^1 - \theta \right]^{\frac{1}{1-\theta}}. \quad (9)$$

$P$ is normalized to 1. The relative price of any two intermediate goods $i$ and $k$ is determined by the relative world supply of the two goods:

$$\frac{p_i(s^t)}{p_k(s^t)} = \left( \frac{\gamma_i Y^g_k(s^t)}{\gamma_k Y^g_i(s^t)} \right)^\frac{1}{\theta}. \quad (10)$$

2.5 Equilibrium

The competitive equilibrium of the world economy consists of a sequence of prices $[p_i(s^t), R^j_i(s^t), w^j_i(s^t)]$, and employment and capital allocations $[N^j_i(s^t), K^j_i(s^t)]$ such that consumers and firms in $j$ optimize and markets clear. In what follows, the semi-closed form solution of the equilibrium relies on three simplifying assumptions, summarized below:

**Assumption 1** Preferences are Cobb-Douglas ($\theta = 1$)

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10The demands for consumption and investment goods implied by a CES demand function are $c^j_i = \gamma(p_{Pr}^{-\theta})^{-\frac{1}{\theta}} C^j$ and $I^j_{ki} = \gamma(p_{Pr}^{-\theta})^{-\frac{1}{\theta}} I^j_k$, for all $s^t$, where $P$ is the domestic price index.

11Using consumption and investment demands of any $i$ and $k$, plugging into Eq. [8] yields the relative price of $i$ and $k$. 
Assumption 2  Consumers have logarithmic preferences ($\rho = 1$)

Assumption 3  The capital-adjustment technology is log-linear

Assumptions 2 simplifies the consumption/saving problem so that private saving does not depend on the real rate of return. Without assumption 2, optimal consumption in this two-country investment model cannot be characterized analytically, and therefore neither are optimal investment and capital. When assumptions of 1 and 3 are combined with assumptions 2, the global aggregate investment-output ratio and the global industry-level investment-output ratio are both constants. Relying on these results, capital accumulation in each sector $i$ in any country $j$, is characterized by one key variable—the present discounted value of the expected future share of output of $i$ produced domestically. Although no closed-form solution is available in general, the system of equations form a contraction mapping that leads to a simple numerical algorithm, described in Appendix [C.2] A full closed-form solution of the equilibrium exists for a special case, presented in Section [3]. Without these assumptions, neither the semi-closed form solution in the general case nor the full closed-form solution in the special case 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 model is simply the wage income earned by the young. For notational simplicity, I will henceforward suppress the notation $s_t$ and denote period $t$ as subscript $t$. The aggregate consumption of the young cohort, $C_{yt}^j = N_{yt}^j c_{yt}^j$, is\(^{12}\)

$$C_{yt}^j = \frac{1}{1 + \beta} W_t^j,$$

(11)

where $W_t^j = \sum_i w_t^i N_{yt}^i$ denotes the aggregate wage in $j$.

At the world level, consumption of the young is a constant fraction of labor income, which, by the assumption of Cobb-Douglas preferences, occupies a share $s_l = 1 - \sum_i \alpha_i \gamma_i$ of world GDP, denoted as $Y^g_t$, and $Y^g_t = \sum_i p_i Y^g_i$. The result that global investment is a constant fraction of global output immediately follows\(^ {13}\)

$$I^g_t = \psi s_l Y^g_t$$

(12)

where $\psi = \frac{\phi \beta}{1 + \beta}$ and $I^g_t = \sum_j \sum_{i=1}^m I_i^g$.

To determine investment at the industry level, let $I^g_{it} = \mu_{it} I^g_t$ so that $\mu_{it}$ represents the share

\(^{12}\)Substituting 4 into 3 and aggregating, and using Eq. 6 and the first order conditions of the consumer’s problem yields Eq. 11

\(^{13}\)Aggregating Eq. 3 across countries gives $C_{yt}^{g,q} = W_t^q - \sum_{i=1}^m q_{it}^h K_{it+1}^H - \sum_{i=1}^m q_{it}^f K_{it+1}^F$, where $K_{it+1}^H = k_{it+1}^H, k_{it+1}^F + k_{it+1}^F, r_{it+1}$ is the total amount of financial capital claimed by the world on $j$. Then, setting the expression for optimal aggregate consumption of the young to the left hand side of the equation, Eq. 11 while using the fact that $q_{it}^h K_{it+1}^H = I_{it}^h/\phi$ from Eq. 5 gives Eq. 12.
of industry $i$’s investment in aggregate investment, and $I_{ht}^I = \eta_{ht} I_{ht}^0$ so that $\eta_{ht}$ 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

$$I_{ht}^i = \mu_{it} \eta_{ht} \psi_s I_t^g$$

(13)

$$I_{ft}^I = \mu_{it} (1 - \eta_{ht}) \psi_s I_t^g.$$  

(14)

It can be shown that

Lemma 1

$$\mu_{it} = \sum_i \alpha_i \gamma_i \forall t$$

(15)

Proof. See Appendix C.2

Total global investment in $i$, $I_{gt}^I$, is a constant fraction of global output, and is increasing in its capital share $\alpha_i$, and the preference for that industry’s good, $\gamma_i$. The reason that industry-specific shocks do not come into play in determining industry-level investment is that the assumption of Cobb-Douglas preferences (Assumption 1) implies that any movements in relative prices are offset by changes in output, so that nominal output remains unchanged. This eliminates the need for resource allocation across industries.

Deriving the full solution to the economy’s equilibrium amounts to solving for the crucial variable $\eta_{ht}$, the country-share of investment in sector $i$. Relying on the three simplifying assumptions (1-3), this share can be written explicitly as

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

(16)

where $\lambda = \frac{\beta(1-\phi)}{\beta(1-\phi) + \delta} < 1$. $I_{ht}^I$ is thus determined by Home’s expected, present-discounted value of the share of its future output in good $i$, the discount factor $\lambda$ depending on the size of adjustment costs. In the absence of adjustment costs, $\phi = 1$, future output after date $t + 1$ does not matter, and investment in sector $i$ is determined by its expected share of output of good $i$ at $t + 1$. The higher the adjustment cost (lower $\phi$), the higher the discount factor $\lambda (\lambda'(\phi) < 0)$, and the greater the desire to smooth investment over time.

Finally, Equations 13, 14, 15, and 16 combined with the evolution of the capital stock, in $j = h, f$:

$$K_{i,t+1}^j = aI_{ht}^I \phi K_{it}^{j, 1-\phi}$$

Using the Euler equation, $u'(c_t) = E_t [\beta u'(c_{t+1}) R_{t+1}]$, and the risk sharing condition, $\frac{\psi_s}{\gamma_{yt+1}} = \frac{\psi_s}{\gamma_{yt}}$, while plugging in optimal consumption of the young, from Eq. 11 and the old, given in the Appendix C.2 yields $\eta_{ht} = (1 - \lambda) + \lambda E_t \left[ \frac{Y_{ht}^{g} i, t+1}{Y_{ht}^{g} i, t+1} \right]$ where $\lambda = \frac{\beta(1-\phi)}{\beta(1-\phi) + \delta}$. Iterating forward yields Eq. 16.
Investment in Home

<table>
<thead>
<tr>
<th></th>
<th>$\alpha = 0.3$</th>
<th>$\alpha_1 = 0.1$, $\alpha_2 = 0.5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{\eta}_i$</td>
<td>$-11.13%$</td>
<td>$-12.46%$, $-1.4%$</td>
</tr>
<tr>
<td>$\hat{\eta}$</td>
<td>$-3.24%$</td>
<td></td>
</tr>
<tr>
<td>$\hat{Y}^g$</td>
<td>$+10%$</td>
<td>$+6.86%$</td>
</tr>
<tr>
<td>$\hat{I}^h$</td>
<td>$-1.13%$</td>
<td>$+3.62%$</td>
</tr>
</tbody>
</table>

Table 1: Impact Effect of an unexpected 20% labor force boom in Foreign; $\hat{I}^h_t = \hat{\eta}_t + \hat{Y}^g_t$; $\gamma_i = 0.5$.

together pin down a unique path of capital, and yield the full solution to the equilibrium of this economy.

### 2.6 An Illustration of the Composition Effect

To see the effect of composition (of production) on a country’s investment demand, write aggregate investment at Home as $I^h_t = \eta_t \psi s_t Y^g_t$, where

$$\eta_t = \sum_{i=1}^{m} \mu_i \eta_{it}$$  \hspace{1cm} (17)

represents its weighted average share of global production, with the weights $\mu_i = \frac{\alpha_i \gamma_i}{\sum_{i=1}^{m} \alpha_i \gamma_i}$ increasing in $\alpha_i$ and $\gamma_i$. Evidently, more weight is put on the capital-intensive sectors when determining a country’s investment share. By contrast, in a one-sector model, since only one good is produced, a positive technology or labor force shock in Foreign causes a large drop in the present-discounted expected value of Home’s share of global output, and consequently its share of investment. But when there are compositional shifts, less weight is put on the sectors that contract in Home (labor-intensive sector) and more weight is put on the sectors that expand (capital-intensive sectors). In the end, the weighted average share of investment $\eta_t$ falls by significantly less than it would have had in the one-sector case.

To illustrate this point more concretely, Table 1 gives the percentage changes in $\eta_t$ and $I^h_t$ in response to 20% labor force shock abroad for a one sector and a two-sector example. While Home’s share of expected production of any good $i$ falls unilaterally ($\eta_i$ is negative for all $i$), for the reason that Foreign’s relative size in the world has increased, this share falls by much more for the labor-intensive sector than for the capital-intensive sector ($-12.46\%$ vs $-1.4\%$). Thus, the weighted-average expected share of future output falls significantly less in the two-sector case compared to the one-sector case($-3.24\%$ vs. $-11.13\%$ ), making the overall change in investment at Home positive rather than negative ($3.62\%$ vs $-1.13\%$).
2.7 The Initial Steady State

Assuming that initial capital-labor ratios across countries are not too different so that economies are within the cone of diversification, countries diversify in production, and conditional FPE holds in the deterministic steady state. The trading equilibrium yields the same resource allocations and prices as the world’s integrated equilibrium, in which both goods and factors are perfectly mobile internationally. The equilibrium is one in which a constant fraction of world resources is spent in each sector:

\[
\tilde{N}_i^g = \frac{(1 - \alpha_i)\gamma_i}{s_l} \tilde{N}_g
\]

and

\[
K_i^g = \frac{\alpha_i\gamma_i}{s_k} K^g
\]

where \(\tilde{N}_i^g = \sum_j \tilde{N}_j^g\) represents effective world labor supply in sector \(i\). In this equilibrium, there is a multiplicity of steady states, arising from the fact that an infinite number of allocations of capital across countries is consistent with factor price equalization (conditional on technology). However, the existence of adjustment costs pins down a unique path of capital, so that given initial conditions \(K_0^j/N_0^j\), the transitional dynamics leads the system to a unique steady state.\(^\text{15}\) In this economy, conditional FPE does not hold in the transition to the steady state, but is attained only in the long run.

3 The Composition Effect

In general, analytical solutions are not obtainable in the two-country stochastic models with investment and adjustment costs, and analyses are generally restricted to numerical simulations. When incorporating multiple sectors with differing factor intensities, the special case in which the most labor-intensive sector uses only labor as an input to production effectively shuts off the neoclassical force, and isolates the composition channel of adjustment. Consequently, a closed-form solution for the price and quantity of capital arises. The special case requires the additional assumption that:

**Assumption 4** \(\alpha_1 = 0\).

With this assumption, the wage in any region \(j\) is given by the wage paid in the first sector, \(w_{it} = A_{it}^1 p_{1t}\). Since intermediate goods’ prices are equalized through trade, conditional wage equalization, \(w_{it}^h/w_{it}^f = A_{it}^h/A_{it}^f\), holds in any period \(t\) and state \(s^t\), despite stochastic shocks. It follows that

\[
\tilde{k}_{it}^h = \tilde{k}_{it}^f
\]

where \(\tilde{k}_{it}^j = K_{it}^j/\Lambda_i^j N_{it}^j\) is the effective capital-labor ratio in sector \(i\). Labor reallocates across sectors to equalize effective-capital labor ratios in each sector, across countries.

\(^{15}\)A more detailed discussion can be found in Cuñat and Maffezzoli (2004), which also introduce adjustment costs to pin down the capital stock in a world of FPE. An alternative is to assume that countries start out from autarky (described in Appendix B), where capital stock at the country-level is pinned down, and the equilibrium is unique.
Consider a high $\epsilon_{N,t}$ (labor force boom) or $\epsilon_{A,t}$ (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

$$\hat{p}_k \leq 0 \iff \alpha_k \leq \sum_i \alpha_i \gamma_i$$

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, the weights $\gamma_i$ being the effective size of the sector.

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 $\hat{k}_i$, for all $i \neq 1$, is equalized across countries in every period. Of course, this relies on the condition that both countries produce the most labor-intensive good. 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 and the shock small enough so that both countries are required to produce the good.

The market share of region $j$’s production in sector $i$ is pinned down by its share of capital stock in sector $i$, since $Y_{jt}^j/Y_{gt}^j = K_{jt}^j/K_{gt}^j$ follows from Eq. 18. It is thus the case that Home’s share of investment in $i$, $\eta_{it}$, using Eq. 16, becomes

$$\eta_{it} = \lambda \sum_{k=0}^{\infty} (1 - \lambda)^k E_t \left[ \frac{K_{jt+k+1}^h}{K_{jt+k+1}^g} \right].$$  \hfill (19)

**Proposition 1** With Assumptions 1 – 4, $\eta_{it} = \frac{K_{jt}^h}{K_{jt}^g}$.

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

**Proof.** To prove that $\eta_{it} = \frac{K_{jt}^h}{K_{jt}^g}$, guess that $\frac{K_{jt}^h}{K_{jt}^g} = \eta_{it}$, and show that $\eta_{it} = \eta_{i0}$ is a solution to a contraction mapping, consisting of Eq. 19 and the Cobb-Douglas production technologies, Eq. 1 and 2. By the contraction mapping theorem, it is the unique solution. Appendix B provides details to the full proof.

The intuition of this result is that commodity trade (of goods with different factor intensities) brings about the equalization of sectoral capital-labor ratios across countries at all points in time, through industrial rearrangement. This ensures that the marginal product of capital from the production side, $\alpha_i p_i k_i^{\alpha_i - 1}$, is equalized at all times. Therefore, in investing the marginal unit of savings, Foreign allocates it to both countries, and in such a way that marginal adjustment costs paid in sector $i$ and country $j$, proportion to $\frac{I_j}{K_j}$, are equalized. The standard neoclassical force that tends to equalize sectoral capital-labor ratios is effectively shut down, isolating the compo-
sition channel of adjustment. Despite adjustment costs, factor price equalization is attained one period after the shock. The investment ratio across regions in each sector will depend on their initial capital stock ratio in that sector, making this economy path dependent.

### 3.1 Aggregate Savings and Investment

Summing investment, given by Eq. (13) across sectors, and using Proposition 1, country $j$’s aggregate investment at $t$ becomes

$$I^j_t = \sum_i \mu_i \eta^j_0 \psi s_t Y^g_t,$$

where $\psi = \phi \beta / (1 + \beta)$, $s_t = 1 - \sum \alpha_i \gamma_i$ and $\mu_i$ is given by Lemma 1. A high $\epsilon^j_{A,t}$ or $\epsilon^j_{N,t}$ which raises world GDP raises investment globally, and in such a way that more investment is allocated to country $j$ that has a higher initial, weighted-average capital-intensity, $\sum \mu_i \eta^j_0$. In this special case with international trade linkages, investment comoves.

A graphical exposition offers some basic intuition to these results. Relying on the closed-form solution, one can write $j$’s domestic output to world output, $Y^j_t / Y^g_t$, denoted as $f$, as a function of its relative capital-labor ratio $t$, $\kappa^j_t = \tilde{k}^j_t / \tilde{k}^g_t$.

$$f(\kappa^j_t) = \left( \frac{s_t}{\kappa^j_t} + 1 \right) \left( \sum_i \mu_i \eta^j_0 \right)$$

Aggregate savings-to-output ratio in $j$ can be written as

$$S(\kappa^j_t) = \psi \left( 1 - \frac{1}{\frac{s_t}{\kappa^j_t} + 1} \right).$$

Analogously, the investment-to-output ratio in $j$ can be written as

$$I(\kappa^j_t) = \frac{\psi s_t}{\frac{s_t}{\kappa^j_t} + 1}.$$

The $I(\kappa^j_t)$ and $S(\kappa^j_t)$ curves cross at the point at which $\kappa^j_t = 1$, where the the capital-labor ratios are equalized across countries, or in other words, where no country has a comparative advantage over another.

---

$^16$ $p_i Y^j_t$ can be conveniently expressed as $\gamma_i Y^j_t / Y^g_t$. Since $Y^j_t / Y^g_t = K^j_t / K^g_t = \tilde{N}^j_t / \tilde{N}^g_t = \eta^j_0$, and domestic GDP is $Y^j_t = \sum_i p_i Y^j_i = \sum_{i \neq 1} \gamma_i \eta^j_0 + \gamma_1 \tilde{N}^j$. Wage equalization across sectors in $j$, $(1 - \alpha_i) p_i Y^j_i / N^j_i = A^j_i N^j_i, \forall i \neq 1$, implies $N^j_t = (1 - \alpha_i) \gamma_i / \gamma_1 \eta^j_0 \tilde{N}^j$ where $i \neq 1$. $j$’s domestic to world GDP ratio, $Y^j_t / Y^g_t$, can be expressed as in Eq. [21]
The $I(\kappa^j_t)$ and $S(\kappa^j_t)$ schedules are graphed in the first panel of Figure 1. Greater comparative advantage in labor (to the left of $\kappa_t = 1$) causes greater specialization in labor-intensive goods, which raises the relative share of output allocated to wage income. Since savings derives from wage income in this model, the saving-to-output curve is therefore downward sloping. On the other hand, greater specialization in labor-intensive goods reduces the share of output that is needed for investment, and the investment-to-output curve is upward sloping. The difference between the curves represents $j$’s current account as a share of GDP. The two curves intersect at the point where countries’ capital-labor ratio is equalized, the point at which domestic savings is just enough for domestic investment, 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 current account surplus.

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. The reason is that by the neoclassical force, a permanent labor force boom in Foreign that reduces its capital-labor ratio induces higher investment so that capital can scale up with labor. On the other hand, the savings rate is a constant, a result of assuming logarithmic utility and a Cobb-Douglas production function. In contrast to the multi-sector model, $j$ moves into greater current account deficit as its capital-labor ratio falls.

These two figures depict the savings-investment relationship when the composition effect and the neoclassical effect are each respectively isolated. The striking difference is the slope of the investment demand, from negative in the multi-sector case to positive in the one-sector case. In the general case, where both composition and neoclassical 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 neoclassical effect is stronger. The condition for which one effect dominates the other is demonstrated in Section 4.3.

3.2 The Price and Quantity of Capital

The evolution of the effective aggregate capital-labor ratio is characterized by:

$$\tilde{k}^j_{t+1} = \Theta \left( \sum_i \mu_i \eta^j_0 \right)^{\phi s_t} e^{-\left(\epsilon^j_{N,t=1} + \epsilon^j_{A,t=1} + \epsilon^j_{N,t} + \epsilon^j_{A,t} \right)} \left( \frac{\bar{N}^g_t}{\bar{N}^j_t} \right)^{\phi s_t} (\tilde{k}^j_t)^{1 - \phi s_t},$$

where $\Theta$ is a constant.\footnote{\(\Theta = a(y s_t/s_k \prod \gamma_i \alpha_i \gamma_i + (1 - \alpha_i) \gamma_i)^{\alpha_i \gamma_i} \)} This implies the following propositions:

**Proposition 2 (Path Dependence)** The evolution of the $\tilde{k}^j_t$ depends on $j$’s initial weighted-average capital-intensity, $\sum_i \mu_i \eta^j_0$; 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.

$$\tilde{k}^j_t = \Theta \left( \sum_i \mu_i \eta^j_0 \right)^{\phi s_t} e^{-\left(\epsilon^j_{N,t=1} + \epsilon^j_{A,t=1} + \epsilon^j_{N,t} + \epsilon^j_{A,t} \right)} \left( \frac{\bar{N}^g_t}{\bar{N}^j_t} \right)^{\phi s_t} (\tilde{k}^j_t)^{1 - \phi s_t},$$
Figure 1: Savings/GDP and Investment/GDP ratio as a function of $\kappa_1^j$, $\tilde{\kappa}_j^i$. 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. 16 when $i = 1; \alpha_1 = 0.3, \beta = 0.7$ and $\phi = 0.5$. 
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 price of capital 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 $j$, $K^j_i/K^j$. The logarithm of the price of capital in sector $i$ in $j$ evolves according to:

$$
\ln q^j_{it} = \left[ 1 - \phi s_i \right] \ln q^j_{i,t-1} + (1 - \phi)s_i \left( \ln \tilde{N}^j_{it} - \ln \tilde{N}^j_{i,t-1} \right) - \ln \Theta_i,
$$

where $\Theta_i$ is a sector-specific constant. This leads to the following proposition:

**Proposition 3 (Price of capital)** $q^j$ in any region $j$ and any sector $i$, where $i \neq 1$, 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 $\epsilon_{N,t}$ or $\epsilon_{A,t}$. 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 $t$, $\sum_{i \neq 1} q^j_i K^j_{i,t+1}/Y^j_t$, is increasing in j’s relative capital-labor ratio, $\tilde{k}^j_i/\tilde{k}^j_g$.

Using $q^j_i K^j_{i,t+1} = (1/\phi) I^j_{it}$, this result immediately follows from Eq. 18.

**Corollary 5** The ratio of sector $i$’s stock market-capitalization to domestic GDP, in any country $j$, is increasing in $\alpha_i, \gamma_i, \eta_0$.

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, $\eta_0$.

Aggregate investment is the economic channel through which a labor force boom or a productivity shock affects the price of capital, and trade in goods with different factor intensities is the conduit through which aggregate savings can be allocated globally rather than locally. A labor force boom or a labor productivity boom in period $t$ leads to a high aggregate wage income, which

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18In the one-sector, closed-economy framework of Abel (2003), the stock market-capitalization to domestic GDP ratio is a constant in the long run.
is accrued to Foreign’s young consumers, who are the savers in the economy. As Foreign becomes relatively more labor-abundant, it shifts its industrial structure towards more labor-intensive sectors. Consequently, Foreign’s supply of savings rises by more than its demand for investment, the difference of which is exported to Home. 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 Neoclassical and Composition Effects

The previous special case which isolates the composition effect leads to factor price equalization after one period. 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 neoclassical and the composition effect coexist and are competing, and the question of which effect dominates becomes a numerical issue. I show that when factor intensities are sufficiently different in a multiple-sector world, the composition effect outweighs the neoclassical effect, and the previous qualitative results on asset prices and financial flows are preserved.

4.1 General Capital Adjustment Function and Parameter Values

For quantitative purposes, the drawback of the log-linear capital adjustment function is that depreciation and adjustment costs, both of which are captured by the parameter \( \phi \), cannot be separated. However, a second-order Taylor approximation shows that the log-linear model and a standard capital adjustment model

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

are equivalent if \( \phi = \delta, b = (1 - \phi)/\phi, \) and \( a = \phi^{-\phi} \). Henceforward, the general capital adjustment model is used in the quantitative exercises.

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. Capital adjustment costs are widely used in international RBC models but there is no consensus on the calibration strategy to parameterize them. The strategy adopted in this model is to take a standard adjustment cost parameter value, \( b = 1 \), based on an annual frequency, and

19 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.

20 For example, Baxter and Crucini (1993) calibrated the elasticity of investment relative to Tobin’s \( q \) to match investment variability in industrial countries. Chari, Kehoe, and McGrattan (2000) calibrated the parameter to match the relative variability of consumption to output. Kehoe and Perri (2002) targeted the variability of investment.
compute the amount of capital adjustment that takes place over twenty years. Then, the parameter $b$ is 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 sensitivity analysis. The discount factor $\beta$ is set to 0.45 to match the initial steady-state annual real interest rate of 4%.

The baseline model takes benchmark case where the of Cobb-Douglas preferences, i.e. $\theta = 1$. In this case, $\gamma_i$’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 $\gamma_i$’s are provided in Cunat 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. $\gamma_i$’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. In aggregating the 28 sectors into two large sectors, I rank the sectors by their capital intensity and assume that the first 14 sectors are labor-intensive, and the second half capital intensive. $\gamma$ is then chosen such that $\gamma = \sum_{i=1}^{14} \gamma_i$. $\alpha_1$ and $\alpha_2$ are calibrated to match the weighted mean of the capital share of the 28 sectors, $s_k = \sum_{i=1}^{28} \gamma_i \alpha_i = 0.36$, and the weighted variance, $\sum_i \gamma_i (\alpha_i - s_k)^2$, which is 0.04 as measured from the 28-sectors data. The resulting parametrization is $\gamma = 0.61$, $\alpha_1 = 0.11$, and $\alpha_2 = 0.52$.

Although the key results of interest pertain to symmetric countries as well as asymmetric countries, the exercise is done for countries that are meant to mimic a developing and a developed country. Therefore, the two countries differ in initial capital-labor ratios and labor productivity. While higher initial capital-labor ratio in North increases the amount of investment flows from South (the path dependence result), lower initial labor productivity in South reduces the extent of its capacity to save and therefore the amount of investment that flows to North. Initial capital-labor ratios for each country 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. TFP in North is chosen to normalize per capita income to 1, and TFP in South is chosen to match South’s income per capita being one seventh of that of North in 1988.

### 4.2 Impulse Response

The experiment I consider is one in which the effective labor force in South unexpectedly doubles permanently. The impact effect on goods and factor prices are shown analytically in Appendix C.2.

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21Internationally 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.
Since capital is fixed for one period, in order to equalize wages, South allocates a greater fraction of labor to the labor-intensive sector. The higher world supply of labor-intensive goods causes the relative price of labor goods $p_1$ to fall, and the price of capital goods $p_2$ to rise. In response to the greater profitability in the capital-intensive sector, North shifts resources there, and the return to capital rises in the capital-intensive sector, which is North’s 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.

Figures 2 displays the response of other variables. The vertical axis represents the levels 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. The increase in investment initially generates a trade deficit in North, followed by a permanent trade surplus as it pays capital gains and interest income abroad.

The increase in investment in both countries causes the aggregate price of capital to be bid up 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.

Figure 3 juxtaposes the response of North in the one-sector and two-sector case, and brings the two cases in 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-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 neoclassical 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 neoclassical 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 neoclassical 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 simple two-sector case where the only difference across sectors come from the capital share, i.e., the case where $\gamma = 0.5$, a simple statistic to gauge the extent of specialization is the factor intensity ratio $\alpha_2/\alpha_1$. The first graph in Figure 4 shows the results of the response of North’s investment, at the time of the shock, for various values of the factor-intensity ratio in the $m = 2$ case. The inflection point is the crucial ratio of 1.4, above which North’s investment rises and below which North’s investment falls. This cutoff ratio is naturally also the point where the change in the price of capital turns from negative to positive, and where the current account turns from surplus to deficit. This shows that as factor intensities become more similar, the neoclassical 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. The relative strength of the composition effect and the neoclassical effect matters not only qualitatively but also quantitatively.

What is an analogous simple statistic for the multi-sector case? The reasonable measure of the dispersion of factor intensities in this case is the weighted variance of $\alpha_i$, with weights $\gamma_i$ capturing the effective size of the sector:

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

Estimated from the OECD data with 28 sectors, the weighted mean of capital intensity, $\sum_i \alpha_i \gamma_i$, is 0.36, and the weighted variance is 0.04. The experiment that holds fixed the weighted mean while increasing the weighted variance shows that North’s investment again rises with the dispersion of factor intensities. Figure 4 plots the regression line of Home’s investment response when simulating a model with five sectors.\(^{22}\) The correlation is strongly positive. As the weighted variance of sectors increases, Home’s investment rises. The inflection point is around a weighted variance of 0.02 when the weighted mean is held fixed at 0.36.

**Other parameters**

Adjustment costs change the quantitative response of asset prices and the current account although not their qualitative predictions. Table 3 shows that increasing 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 $\alpha_2/\alpha_1$.

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

\(^{22}\)There is no unique correspondence between North’s investment level and the weighted variance, since there is one extra degree of freedom in choosing parameters to satisfy a constant weighted mean and weighted variance. For this reason, only a linear regression line of the simulated responses is plotted.
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.

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 stand in stark contrast to the standard one-sector models.

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, 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. Developing countries are running a current account surplus, while developed countries are running a current account deficit. If MPK’s are indeed similar, this pattern cannot be reconciled in a standard neoclassical model without appealing to some type of friction, of which a most recent popular one has become financial heterogeneity.\(^{23}\) Yet, the standard assumption that inherently different trading economies can only produce the same, single good (with rich countries only producing more of it) is unreasonable in this context. In the data, developing and developed have comparative advantages in the production of different goods. Romalis (2004) shows that as an aggregate whole, industrial countries tend to capture higher market shares of U.S. imports in more capital-intensive industries.\(^{24}\)

It seems thus natural to incorporate the possibility of commodity trade when analyzing the impact of globalization on capital flows and asset prices. The following analysis shows that allowing for the interaction between goods trade and asset trade can become crucial.

Assume that two countries are initially in autarky. The difference between the industrialized


\(^{24}\) More precisely, the study shows that every 1 percentage point increase in the capital intensity leads to a 0.5-percentage point rise in industrial countries’ market share of U.S. imports.
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:

\[
\begin{align*}
    p_{k}^{j,\text{aut}} & \propto \left( \frac{K_{j}}{N_{j}} \right)^{\sum \alpha_{i} \gamma_{i} - \alpha_{k}} \quad (25) \\
    w_{j,\text{aut}} & \propto A_{j} \left( \frac{K_{j}}{N_{j}} \right)^{\sum \alpha_{i} \gamma_{i}} \quad (26) \\
    R_{k,\text{aut}}^{j} & \propto A_{j} \left( \frac{K_{j}}{N_{j}} \right)^{\sum \alpha_{i} \gamma_{i} - 1} \quad (27)
\end{align*}
\]

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. 32, capital-abundant North features a lower relative price of capital-intensive goods: \( \left( \frac{p_{k}}{p_{i}} \right)^{n,\text{aut}} < \left( \frac{p_{k}}{p_{i}} \right)^{s,\text{aut}} \) 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 \( p_{i}^{n,\text{aut}} < p_{i}^{s,\text{aut}} \), or in other words, all goods \( i \geq k \) such that

\[
\alpha_{k} \geq \sum \alpha_{i} \gamma_{i},
\]

and South will see an increase in the price of goods \( i < k \). 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 \( m = 2 \) case (analyzed in Appendix C.1). 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 neoclassical 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.

Numerical results in the \( m = 2 \) case are displayed in Figure 5. TFP differences are chosen so that North’s capital-labor ratio is initially taken to be about six times that of South. Other parameters are taken to be the same as before, provided in Table 2. The experiment assumes that countries initially start from autarky, and globalization is introduced as a permanent unanticipated regime change of both trade and financial liberalization. The overall impact is a rise in the aggregate price of capital in North and a fall in South. The capital-intensive sector contracts sharply in South, causing a large drop in the price of capital in that sector. The price of capital rises however, in the labor-intensive sector where investment demand is high. The opposite occurs in North. Since North’s savings falls at the same time that its investment rises, it runs a large current account deficit to GDP ratio.

\[25\] If \( \left( \frac{K_{n}}{N_{n}} \right)^{n} > \left( \frac{K_{s}}{N_{s}} \right)^{s} \), \( p_{k}^{n} < p_{k}^{s} \) iff \( \sum \alpha_{i} \gamma_{i} - \alpha_{k} > 0 \).
The implication is that we cannot use the similarity in MPK’s across countries to infer that there will be little capital movements across regions when these economies open up. The reason is that an important channel of adjustment is through trade, which can cause the respective marginal product of capital to diverge as a consequence of industrial restructuring. Yet, while trade liberalization and financial liberalization are both integral parts of globalization, the timing of liberalization have different implications on 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. 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 in the context of 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. Figure 6 shows that demographic trends have diverged between industrialized countries and emerging markets since the mid-1980s, and is likely to continue for the next few decades. According to 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.

Two caveats are in order. The first is that these results rely on the premise that demographic differences translate into differences in comparative advantage, and affect specialization patterns. While no existing empirical relationship has been established between demographics factors and the structure of trade, Section 6 takes a first step in this direction. A second caveat is that one may
argue 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 7 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. 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 accumulated in the presence of adjustment costs. It is achieved through investment flows from North, whose consumers benefit from being paid higher asset prices. North thus initially runs a current account surplus while South runs a deficit, before the shock occurs. However, at the time of the shock $t = 4$, aggregate savings in South rises and capital allocation of the additional savings involves sending capital both locally and abroad, since North now specializes in capital-intensive sectors. 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.

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 C.1). 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.
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 Empirical Implications and Evidence

A central prediction of the model is that countries which have become more specialized in capital-intensive industries experience greater demand for financial capital and thus run a greater current account deficit. Since no studies have yet examined the empirical relationship between the current account and the capital-intensity of a country’s export, this segment of the paper serves as a starting point. The theory does not provide a closed-form solution relating the current account and specialization patterns, and therefore I perform a reduced-form regression.

A requisite variable is a measure of a country’s capital intensity of exports. To construct this measure, I borrow a notion of “revealed comparative advantage” (RCA) often adopted in the trade literature. Most recently, Romalis (2004) uses this measure to examine the relationship between factor proportions and the structure of trade. To do so, he estimates a country-specific coefficient \( \alpha_c \) from the following regression:

\[
 x_{cz} = \beta_c + \alpha_c \cdot k_z + \gamma_c \cdot s_z + \epsilon_{cz} 
\]  

(28)

\( x_{cz} \) is the share that country \( c \) commands of U.S. imports in industry \( z \), \( k \) and \( s \) are the capital intensity and skill intensity of industry \( z \). \( \alpha_c \) is thus the percentage point increase in country \( c \)'s market share of \( z \), for each 1-percentage point increase in capital-intensity. Countries can thus be ranked according to \( \alpha_c \), a “revealed comparative advantage” in capital-intensive sectors.

Factor intensities, \( k \) and \( s \), of each industry are calculated using the “NBER Manufacturing Industry Productivity Database”, which covers 459 industries, until 1996. I assume that factor intensities of each industry are the same across countries and thus use the U.S. data as a benchmark. As a result of data availability, I also assume that between the periods of 1996-2006, the factor intensities of industries have not changed. Following Romalis (2004) \( k \) is measured as 1 less the share of total compensation in value added. \( s \) is measured as the share of nonproduction workers in total employment in each industry. U.S. imports (data described in the appendix) are classified by detailed commodity and country of origin.

To examine the “RCA” for developing and developed countries as a whole, regression \[28\] is first performed for South, defined to be countries with per capita GDP at PPP of not more than 50 percent of the U.S. level in each period\[26\]. South’s market share is calculated as \( x_{sz} = \sum_{c \in \text{South}} x_{cz} \)

\[26\] North comprises of Australia, Austria, Belgium, Canada, Denmark, Spain, Finland, France, Greece, Hong Kong, Ireland, Iceland, Israel, Italy, Japan, Netherlands, Norway, New Zealand, Singapore, Sweden, and the United Kingdom.
for each industry \( z \). The periods in consideration are 1989, 1993, 1998, 2002, and 2006. Table 4 reports the results for South over time. South’s market share falls significantly with the capital intensity of the industry. Each 1-percentage point increase in capital intensity is estimated to reduce South’s market share by 0.75 percent in 2006. Between the period 1989-2006, South’s “RCA” in capital-intensity fell from \(-0.47\) to \(-0.75\), with the largest drop occurring between 1989-93. The opening up of China and India over this period may have contributed to the fall in capital intensity of developing countries, as these countries were largely labor abundant. The model performs well for the aggregate South and therefore for the aggregate North.

### 6.1 Empirical Relationship between Specialization and the Current Account

Using \( \alpha_c \), the “RCA” in capital-intensive goods, I proceed to examine whether there is a systematic relationship between a country’s capital-intensity of exports and the current account in a panel regression model. The regression specification considered is:

\[
CA_{ct} = \alpha + \beta_1 \cdot \alpha_{ct} + \gamma' Z_{ct} + u_{ct}
\]  

(29)

where \( CA_{ct} \) is the current account to GDP ratio, \( \alpha_{ct} \) is country \( c \)’s coefficient on capital intensity, \( Z_t \) is a vector of controls, and \( u_{ct} \) is a disturbance term. The sample period covers 1989, 1993, 1998, 2002 and 2006. Control variables are taken from the standard literature, provided in both Gruber and Kamin (2005) and Chinn and Prasad (2003). These include per capita income, GDP growth rate, demographic variables (population growth and the share of working age population to total population), and openness.

Panel regression estimates are presented in Table 5. The first column shows the OLS estimates of \( \beta_1 \) in a regression that pools all country/year observations. The estimate obtained from the pooled regression uses all the available variation in \( \alpha_{ct} \)’s and current accounts. A 1-percentage point higher market share of U.S. imports for every 1-percentage point increase in capital intensity is associated with a 0.19-percentage point fall in the Current-Account/GDP ratio. To give a sense of the meaning of this magnitude, consider a concrete example. In 2002, India’s coefficient \( \alpha_c \) was \(-0.7\), and China’s \(-2.19\). Their actual current account/GDP ratio was respectively 1.38% and 2.4%. By contrast, Great Britain’s \( \alpha_c \) was 2.9, and Australia’s was 1.1. Their current account/GDP ratio were respectively \(-1.56\)% and \(-3.7\)%.

The regression results imply that had India attained U.K.’s degree of specialization in capital-intensive goods, 25% of the actual difference between their CA/GDP ratios is explained by differences in specialization. Similarly, had China reached Australia’s degree of specialization, 20% of the actual current account difference between

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27 I assume that the measurement error arising from estimating \( \alpha_{ct} \) is uncorrelated with \( u_{ct} \).
28 It is derived based on normalized shares of import, \( \tilde{x}_{cz} \), where by the the import share in country \( c \) in industry \( z \) is divided by the average value of \( x_{cz} \), so as to make \( \alpha_c \) comparable across countries.
29 Unlike these papers, I do not include measures for financial crisis, financial deepeness and fiscal balances.
the two countries is explained.

The OLS estimates, however, omit variables that vary across countries but are constant across time (such as institutions, macroeconomic environment), and those that are constant across countries but vary across time (such as oil prices). For this reason, fixed-effects panel regressions are performed. Another reason for using fixed-effect estimation is to separate the between-country variation from the within-country variation, which is the focus of the empirical analysis as it most closely reflects the central theoretical prediction that countries which become more specialized in capital-intensive industries over time run greater current account deficits. Column (6) reports the coefficient estimate that use both between-country and within-country variation. The estimate in column (4) uses only the between-country variation, while the estimate in (5) uses only the within-country variation. The coefficients are negative and highly significant. The magnitudes of the fixed-effect coefficient and the within coefficient are similar, suggesting that both between-country and within-country variation are important in explaining current account dynamics. The within-regression coefficient suggests that countries that become more capital-intensive over time run higher current account deficits.

These results are clearly preliminary, and a more thorough empirical analysis of the relationship between specialization and the current account needs to take into account the possibility that countries' current account dynamics may vary, and that there may be omitted variables that are correlated with the capital-intensity of exports and also affect the current account. For instance, countries with better financial institutions may be net exporters of more capital-intensive goods while at the same time being better producers of quality assets, which some believe to have caused the large current account deficits in the U.S. The extent of the analysis conducted in the paper can only serve as a starting point, but at the very least, these initial results seem to suggest that there is a systematic negative relationship between specialization patterns and current account dynamics, one which that has not been examined before, and one which is consistent with the predictions of the theoretical framework.

6.2 The Relationship between Demographics and Specialization

The next question I examine is the relationship between demographic factors and specialization patterns. While there has been little disagreement on whether globalization has engendered trade patterns largely driven by factor endowment differences between developing and developed countries, little is known about whether demographic differences between developing and developed countries, little is known about whether demographic factors and their impact on the labor force also affect specialization patterns. To the extent that the most important aspect of demographic change, for the purpose of this analysis, is its impact on the labor force, the demographic variable adopted is the working age to total population ratio. To examine whether changes in demographic factors over time affect specialization patterns, I exploit the panel dimension of the data and perform the regression

\[ \alpha_{ct} = \beta_c + \text{Share}_{ct} + \gamma Z_{ct} + \epsilon_{ct} \]  

(30)
for all countries. $Share_{ct}$ is the ratio of working-age population to total population in country $c$ at $t$.

Table 6 reports the results. Variables that vary across countries but that are constant over time are clearly important in explaining specialization patterns. The within regression result (column (3)) suggests that a 1-percentage point increase in the share of working-age population over time is associated with a 0.27-percentage point reduction in the country’s “RCA” in capital-intensive industries. The coefficient results are negative and significant, and are robust to the inclusion of additional controls, such as per-capita income and population growth. These results suggest that countries’ demographic trends may potentially be an important factor in contributing to specialization patterns. Thus, future demographic differences between developing and developed countries may cause diverging specialization patterns, and therefore the trade channel of adjustment should be taken into account when analyzing their impact on current account dynamics and global asset prices.

7 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 neoclassical 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 indus-
trialized 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.
References


Appendix: Initial Equilibrium

The Open Economy: The following results assume $\theta = 1$. If countries diversify in production, factor prices are equalized in the steady state, which is just the integrated equilibrium. 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:

$$\frac{p_i}{p_j} \propto \left( \frac{K^g \tilde{N}^g}{N^g} \right)^{\alpha_j - \alpha_i}$$

where $\tilde{N}_i^g = A^n N_i^n + A^s N_i^s$ represents world effective labor in sector $i$.

Factor prices are given by:

$$w \propto A \left( \frac{K^g}{N^g} \right)^{\sum \alpha_i \gamma_i}$$

$$R \propto \left( \frac{K^g}{N^g} \right)^{\sum \alpha_i \gamma_i - 1}.$$

Returns are pinned down by preferences in the steady state. From the Euler equation,

$$R = \frac{C_o^g}{\beta C_y^g} = 1 + \frac{1 - \phi \psi s_l}{\beta s_l} \left( \sum_i \alpha_i \gamma_i + \frac{1 - \phi}{\phi} \psi s_l \right), \quad (31)$$

in the log-utility case, $\rho = 1$. Global consumption of the old, $C_o^g$, and global consumption of the young, $C_y^g$, are derived in $\text{C.2}$.

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 determined by

\[
p_k \propto \left( \frac{K}{N} \right) \sum_i \alpha_i \gamma_i \alpha_k \quad (32)
\]

Wages and returns can be expressed as

\[
w \propto A \left( \frac{K}{N} \right) \sum_i \alpha_i \gamma_i
\]

\[
R \propto A \left( \frac{K}{N} \right) \sum_i \alpha_i \gamma_i - 1
\]

which, in the steady state, is pinned down by preferences, the same as in the integrate equilibrium, Eq. 31. Since preferences are assumed to be the same across countries, \( A^n > A^s \) implies that the capital-labor ratio is higher in North: \( \left( \frac{K}{N} \right)^n > \left( \frac{K}{N} \right)^s \). From 32 it is thus the case that \( p_k^n < p_k^s \) \( \Leftrightarrow \sum_i \alpha_i \gamma_i - \alpha_k < 0 \). International goods prices after opening up the economies to trade will be a weighted average of the autarky prices in each country, and therefore trade liberalization raises all prices of goods \( k \) in North such that \( \alpha_k > \sum_i \alpha_i \gamma_i \).

B The Closed-Form Solution

Proof of Proposition 1

Proof. Guess that \( \frac{K^h_{it}}{K^g_{it}} = \eta_{it} \), and using \( K_{i,t+1} = a I_{it}^\phi K_{it}^{1-\phi} \), \( I_{it}^h = \frac{\eta_{it}}{1-\eta_{it}} \) by construction,

\[
\frac{Y^h_{i,t+1}}{Y^g_{i,t+1}} = \frac{K^n_{i,t+1}}{K^g_{i,t+1}}
\]

\[
= \frac{1}{1 + \frac{K^h_{t+1}}{K^g_{t+1}}}
\]

\[
= \frac{1}{1 + \frac{(1-\eta_{it})\phi (K^h_{it})^{1-\phi}}{\eta_{it} (K^g_{it})^{1-\phi}}}
\]

\[
= \eta_{it}
\]

This shows that if \( \frac{K^h_{it}}{K^g_{it}} = \eta_{it} \), then we naturally have \( \frac{K^h_{t+1}}{K^g_{t+1}} = \eta_{it} \). By induction, \( \frac{K^h_{t+m+1}}{K^g_{t+m+1}} = \eta_{t+m} = \eta_{t+m-1} = ... = \eta_0 \), for any \( k \geq 0 \), so that \( \frac{Y^h_{i,t+m+1}}{Y^g_{i,t+m+1}} = \eta_0 \forall k \geq 0 \).

\[\text{30}\]

Using the price index \( 1 = \prod_i p_i^\gamma \) and the relative price formula \( \frac{p_i}{p_j} = \frac{\gamma_i}{\gamma_j} \) for any \( i \) and \( j \), we find the absolute price for any good \( k \), \( p_k = \prod_i (\frac{\gamma_i}{\gamma_j})^{\alpha_i} \). This leads to Eq. 32 where more precisely, \( p_k = (s_k/s_h)^{\gamma_k-\alpha_k} \prod_i (\gamma_k/\gamma_i)^{\alpha_k \gamma_i (1 - \alpha_k) \gamma_i} \).

\[\text{31}\]

More precisely, \( w = M(s_i/s_h) s_k^{1-\alpha_k} A(\frac{K^h}{N})^{\gamma_k} \), and \( R = M(s_h/s_i) s_k^{1-\alpha_k} (1-\alpha_k)^{1-\alpha_k} A(\frac{K^h}{N})^{\gamma_k-1} \).
This implies that:

\[
\eta_{it} = \lambda \sum_{m=0}^{\infty} (1 - \lambda)^{m} E_t \left[ \frac{K^{h}_{i,t+m+1}}{K^{g}_{i,t+m+1}} \right] \\
= \lambda \sum_{m=0}^{\infty} (1 - \lambda)^{m} E_t[\eta_{it}], \\
= \eta_{it},
\]

which proves that the guess \(\eta_{it} = \eta_{i0}\) is a solution that satisfies the contraction mapping. ■

Next I derive results supplementing the main results in Section 3. In a model which imposes assumptions \((i) - (v)\), wage equalization across sectors and conditional wage equalization across countries give the result that capital-effective labor ratios in each sector \(i\) is equalized across countries, and global labor allocated to each sector \(i\) is a constant fraction of the world labor force, as is labor in all sectors \(i \neq 1\) in \(j\):

\[
\begin{align*}
\tilde{k}^{h}_{i} &= \tilde{k}^{f}_{i} \quad (33) \\
\tilde{N}^{h}_{i} \quad \quad = \eta_{i} \quad (34) \\
\tilde{N}^{g}_{i} \quad \quad = \frac{(1 - \alpha_{i})\gamma_{i}}{1 - \sum \alpha_{i}\gamma_{i}} = \nu_{i} \quad (35) \\
\tilde{N}^{g}_{j} \quad \quad < 0 \quad (36)
\end{align*}
\]

**Prices:** Using the fact that \(\gamma_{i}\hat{p}_{i} = 0\) (the definition of the price index) and \(\hat{p}_{i} - \hat{p}_{j} = \alpha_{i}\hat{N}_{i} - \alpha_{j}\hat{N}_{j}\), (the wage equalization condition), the percentage change in the price of good \(k\) can be written as

\[
\hat{p}_{k} = \alpha_{k}\hat{N}^{g}_{k} - \sum \alpha_{i}\gamma_{i}\hat{N}_{i}
\]

Since \(N^{g}_{i}\) is a constant fraction of world labor, it must be that

\[
\hat{p}_{k} > 0 \iff \alpha_{k} > \sum \alpha_{i}\gamma_{i}
\]

**Wages:**

\[
\hat{w}^{f} = \hat{p}_{k} - \alpha_{k}\hat{N}^{f}_{k} \\
= -\sum \alpha_{i}\gamma_{i}\hat{N}_{i} \\
= -\sum \alpha_{i}\gamma_{i}\hat{N}^{g} < 0
\]

36
Since $\frac{w^h}{w^f} = \frac{A^h}{A^f}$, wages also fall at Home.

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

$$N_1^{h'} + N_1^{f'} > N_1^h + N_1^f. \quad (37)$$

Since wages fall at Home, from above, we know that

$$\begin{align*}
(i) & \quad \Delta \hat{k}_i^j < 0 \quad \forall i \neq 1 \\
(ii) & \quad \Delta \hat{N}_1^h < 0, \quad \Delta \hat{N}_1^f > 0, \quad \Delta \hat{N}_i^j < 0 \quad \forall i \neq 1
\end{align*} \quad (38)$$

For non-specialization to occur, it must be that both countries produce the most labor-intensive good, good 1, so that:

$$N_1^{nt} - N_1^s < \epsilon \quad (40)$$
$$N_1^{nt} > 0 \quad (41)$$

From Eq. 37:

$$N_1^{f'} - N_1^f < \epsilon \iff N_1^h - N_1^{h'} < N_1^{f'} - N_1^f < \epsilon \quad (42)$$
$$\Rightarrow N_1^{h'} > N_1 - \epsilon \quad (43)$$

A sufficient condition for which $N_1^{h'} > 0$, and hence, diversification in production, is therefore

$$\epsilon < N_1^h$$

**C Derivation of the General Model and Numerical Method**

This section derives the two-sector general case and provides the computational method. The analog for the multiple-sector case follows directly.

**C.1 Factor and Goods Prices**

A high $\epsilon_{N,t}^f$: 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 $j$:

\[ \hat{w}_j^1 = \hat{p}_1 - \alpha_1 \hat{N}_j^1 \]  
\[ \hat{w}_j^2 = \hat{p}_2 - \alpha_2 \hat{N}_j^2 \]  
\[ \hat{R}_j^1 = \hat{p}_1 + (1 - \alpha_1) \hat{N}_j^1 \]  
\[ \hat{R}_j^2 = \hat{p}_2 + (1 - \alpha_2)(\hat{N}_j^2), \]

where we assume that $\epsilon_{A,t}^j = 0$ 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 labor force boom in Foreign, only one configuration of the change in goods and factor prices is possible:

\[ \hat{R}_2^h > \hat{p}_2 > \hat{w}_h, \hat{w}_h > \hat{p}_1 > \hat{R}_1^h \]  
\[ \hat{R}_1^f > \hat{R}_2^f > \hat{p}_2 > 0 > \hat{p}_1 > \hat{w}_f. \]

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 $\hat{w}_2 = (\gamma - 1)\alpha_2(\hat{N}_2^f) - \gamma \alpha_1 \hat{N}_1^f$. The condition that determines whether wages rise or fall in Home amounts to:

\[ \hat{w}_h^1 < 0 \iff \frac{N_{1,t-1}^h}{N_{2,t-1}^h} < \frac{\gamma \alpha_1}{1 - \gamma \alpha_2} \]  
(50)

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:

\[ \hat{R}_2^h > \hat{p}_2 > \hat{w}_h^f > \hat{w}_h^f > \hat{p}_1 > \hat{R}_1^h \]  
\[ \hat{R}_1^f > \hat{R}_2^f > \hat{p}_2 > 0 > \hat{p}_1 > \hat{w}_f. \]

where wages falls unambiguously in North, since condition (50) is satisfied in the closed-economy equilibrium, where $\frac{N_{h}^f}{N_2^f} = \frac{\gamma(1-\alpha_1)}{(1-\gamma)(1-\alpha_2)}$ (from Appendix A).

**C.2 Model Derivation**

Let the relative price of good 1 and good 2 be $p_t = \frac{p_{1t}}{p_{2t}}$, and $x_t$ be the fraction of labor allocated to sector 1 at Home. For notational convenience, home country subscripts are omitted, and foreign country variables are denoted as subscript $f$. The wage equalization conditions are:

\[
\begin{align*}
\frac{p_{1t}(1-\alpha_1)Y_{1f}}{p_{2t}(1-\alpha_2)Y_{2f}} &= \frac{x_t}{(1-x_t)} \\
\frac{(1-\alpha_1)Y_{1f}}{(1-\alpha_2)Y_{2f}} &= \frac{x_{1f}}{(1-x_{1f})}.
\end{align*}
\]

38
Using Eq. 1 and using the expression for the relative price \( p_t = \frac{\gamma}{1-\gamma} Y_{it}^g \), these two equations can be rewritten as:

\[
\frac{x_{it}^{\alpha_1}}{(1 - x_t)^{\alpha_2}} = \frac{N_{ft}^{\alpha_1 - \alpha_2} K_{1t}^{\alpha_2} K_{2t, f}^{\alpha_2}}{N_t^{\alpha_1} K_{1t, f}^{\alpha_2}} \frac{x_{ft}^{\alpha_1}}{(1 - x_t)^{\alpha_2}}
\]

(53)

\[
\frac{\gamma(1 - \alpha_1)(1 - x_t)}{1 + \frac{N_{t}^{1-\alpha_1} K_{1t, f}^{\alpha_1}(1-x_{ft})}{N_{t}^{1-\alpha_1} K_{1t}^{\alpha_1}(1-x_{ft})} = \frac{(1 - \gamma)(1 - \alpha_2)x_t}{1 + \frac{N_{ft}^{1-\alpha_2} K_{2t, f}^{\alpha_2}(1-x_{ft})}{N_{ht}^{1-\alpha_2} K_{2t}^{\alpha_2}(1-x_{ft})}}}
\]

(54)

At each point in time \( t \), given \( K_{it}, K_{it, f}, A_{it}, A_{it}, x_t, x_{t, f} \) are uniquely pinned down by these two equations.

Summing Eq. 4 across countries, and using \( (I_{1t}^g + I_{2t}^g)/\phi = \frac{\beta}{1 + \beta} [p_{it}(1 - \alpha_1)Y_{it}^g + p_{2t}(1 - \alpha_2)Y_{2t}^g] \), denoted as \( S_t^g \), the global consumption of the old can be expressed as:

\[
C_{o, t+1}^g = p_{it+1}^{\alpha_1} Y_{1, t+1}^g + p_{2t+1}^{\alpha_2} Y_{2, t+1}^g + \frac{1 - \phi}{\phi} (I_{1, t+1}^g + I_{2, t+1}^g),
\]

\[
= \left[ \frac{p_{it+1}^{\alpha_1} Y_{1, t+1}^g + p_{2t+1}^{\alpha_2} Y_{2, t+1}^g}{p_{it}^{\alpha_1} (1-\alpha_1) Y_{1, t+1}^g + (1-\alpha_2) Y_{2, t+1}^g} + \frac{\beta (1-\phi)}{1 + \beta} \right] (p_{it+1} (1 - \alpha_1) Y_{1, t+1}^g + p_{2t+1} (1 - \alpha_2) Y_{2, t+1}^g).
\]

Substituting this into the Euler equations \( u'(c_t) = E_t[u'(c_{t+1})R_{t, t+1}^j] \), while letting \( \frac{p_{it}^g}{\phi} = \mu_t S_t^g \), \( \mu_{it} = \mu_t \eta_t S_t^g \), and \( \mu_{it} = (1 - \mu_t) \kappa_t S_t^g \), we have

\[
\begin{cases}
\mu_t = E_t \left[ \frac{p_{it+1}^{\alpha_1} Y_{1, t+1}^g + \beta (1-\phi) \mu_{t+1}}{p_{it}^{\alpha_1} Y_{1, t+1}^{\alpha_1} + \alpha_2 Y_{2, t+1}^{\alpha_2}} + \frac{\beta (1-\phi)}{1 + \beta} \mu_{t+1} \eta_{t+1} + \frac{\beta (1-\phi)}{1 + \beta} \mu_{t+1} \kappa_{t+1} \right], \\
\mu_{it} = E_t \left[ \frac{p_{it+1}^{\alpha_1} Y_{1, t+1}^g + \beta (1-\phi) \mu_{t+1}}{p_{it}^{\alpha_1} Y_{1, t+1}^{\alpha_1} + \alpha_2 Y_{2, t+1}^{\alpha_2}} + \frac{\beta (1-\phi)}{1 + \beta} \mu_{t+1} \eta_{t+1} + \frac{\beta (1-\phi)}{1 + \beta} \mu_{t+1} \kappa_{t+1} \right], \\
(1 - \mu_t) \kappa_t = E_t \left[ \frac{p_{it+1}^{\alpha_1} Y_{1, t+1}^g + \beta (1-\phi) \mu_{t+1}}{p_{it}^{\alpha_1} Y_{1, t+1}^{\alpha_1} + \alpha_2 Y_{2, t+1}^{\alpha_2}} + \frac{\beta (1-\phi)}{1 + \beta} \mu_{t+1} \eta_{t+1} + \frac{\beta (1-\phi)}{1 + \beta} (1 - \mu_{t+1}) \kappa_{t+1} \right]
\end{cases}
\]

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Substituting in $p_t = \frac{\gamma Y_t^g}{1 - \gamma Y_t^g}$ yields

$$
\mu_t = \frac{\alpha_1 \eta}{(1-\alpha_1)\gamma + (1-\alpha_2)\gamma} + \frac{\beta(1-\phi)}{1+\beta} E_t[\mu_{t+1}],
$$

$$
\mu_t \eta_t = \frac{\alpha_1 \eta}{(1-\alpha_1)\gamma + (1-\alpha_2)\gamma} + \frac{\beta(1-\phi)}{1+\beta} E_t[Y_{1t+1}^g Y_{1t+1}^g] + \frac{\beta(1-\phi)}{1+\beta} E_t[(1-\mu_{t+1})K_{t+1}]
$$

$$
(1 - \mu_t) \kappa_t = \frac{\alpha_1 \gamma}{(1-\alpha_1)\gamma + (1-\alpha_2)\gamma} + \frac{\beta(1-\phi)}{1+\beta} E_t[Y_{2t+1}^g Y_{2t+1}^g] + \frac{\beta(1-\phi)}{1+\beta} E_t[(1 - \mu_{t+1})K_{t+1}]
$$

The first equation implies that $\mu_t$ is a constant $\mu = \frac{\lambda_1}{1 - \lambda_3} = \frac{\lambda_1}{\lambda_1 + \lambda_2} = \frac{\alpha_1 \gamma}{\alpha_1 \gamma + \alpha_2 (1-\gamma)}$, since $\lambda_1 + \lambda_2 + \lambda_3 = 1$. The two remaining equations become

$$
\begin{align*}
\eta_t &= (1 - \lambda_3) E_t[Y_{1t+1}^g Y_{1t+1}^g] + \lambda_3 E_t[\eta_{t+1}]\\
\kappa_t &= (1 - \lambda_3) E_t[Y_{2t+1}^g Y_{2t+1}^g] + \lambda_3 E_t[\kappa_{t+1}].
\end{align*}
$$

Iterating forward,

$$
\begin{align*}
\eta_t &= (1 - \lambda_3) \sum_{k=0}^{\infty} \lambda_3^k E_t[Y_{1t+k+1}^g Y_{1t+k+1}^g] + \lambda_3 E_t[\eta_{t+1}]\\
\kappa_t &= (1 - \lambda_3) \sum_{k=0}^{\infty} \lambda_3^k E_t[Y_{2t+k+1}^g Y_{2t+k+1}^g]
\end{align*}
$$

### C.3 Computational Method

In the two-sector case, solving the model amounts to finding the set of paths $\eta, \kappa, K, K_f$ such that:

$$
\begin{align*}
\eta_t &= (1 - \lambda_3) E_t[Y_{1t+1}^g Y_{1t+1}^g] + \lambda_3 E_t[\eta_{t+1}]\\
\kappa_t &= (1 - \lambda_3) E_t[Y_{2t+1}^g Y_{2t+1}^g] + \lambda_3 E_t[\kappa_{t+1}]
\end{align*}
$$

for all time step $t$.

$$
\begin{align*}
K_{1,t+1} &= a(\phi \mu \eta_t S_t^g) S_t^g K_{1t} - \phi K_{1t} + a(\phi (1 - \mu) \kappa_t S_t^g) K_{1t} - \phi K_{1t}\\
K_{2,t+1} &= a(\phi (1 - \mu) \kappa_t S_t^g) S_t^g K_{1t} - \phi K_{2t} + a(\phi (1 - \mu) (1 - \kappa_t) S_t^g) K_{1t} - \phi K_{2t}
\end{align*}
$$

with $S_t^g = \frac{\beta(1 - \alpha_1) Y_t^q + p_{2t} (1 - \alpha_2) Y_{2t}^q}{1 + \beta}$ and where sector-dependant productivities $Y_{1t+1}$ and $Y_{1t+1,f}$ are computed from sector-dependant capitals $K_{1t}$ and $K_{1t,f}$ using the wage equalization
conditions:

\[
\begin{align*}
\frac{\eta_t^{(n)}}{\gamma(1-\alpha_1)(1-x_t)} &= \frac{\eta_t^{(n)}}{\gamma(1-\alpha_1)(1-x_t)} = \frac{N_{ht}^{(\alpha_2)K_{1ht}^{(n)}}N_{ht}^{(\alpha_2)K_{2ht}^{(n)}}}{(1-\gamma)(1-\alpha_2)x_t}
\end{align*}
\]  

For every time step \( t \), we define \( G_t \) as the contraction mapping:

\[
G_t(\eta^{(n)}, \kappa^{(n)}, K_1^{(n)}, K_2^{(n)}, K_1^{(f)}, K_2^{(f)}) \rightarrow (\eta^{(n+1)}, \kappa^{(n+1)}, K_1^{(n+1)}, K_2^{(n+1)}, K_1^{(f+1)}, K_2^{(f+1)})
\]

such that:

\[
\begin{align*}
\eta^{(n+1)}_u &= (1 - \lambda_3)\frac{\gamma u^{(n)}}{\gamma_{u+1}^{(n)}} + \lambda_3 \eta^{(n)}_{u+1} \\
\kappa^{(n+1)} &= (1 - \lambda_3)\frac{\gamma u^{(n)}}{\gamma_{u+1}^{(n)}} + \lambda_3 \kappa^{(n)}_{u+1} \\
K^{(n+1)}_{1u} &= a(\phi \mu u^{(n)})S_{1, u}^{(n)} \phi \kappa^{(n+1)}_{1u} \\
K^{(n+1)}_{2u+1} &= a(\phi \mu u^{(n)})S_{2, u+1}^{(n)} \phi \kappa^{(n+1)}_{2u+1} \\
K^{(n+1)}_{1f+1} &= a(\phi \mu (1 - \eta^{(n)}_u)S_{t}^{(n)} \phi \kappa^{(n+1)}_{1f+1} \\
K^{(n+1)}_{2f+1} &= a(\phi \mu (1 - \kappa^{(n)}_u)S_{t}^{(n)} \phi \kappa^{(n+1)}_{2f+1}
\end{align*}
\]

At a specific time \( t \), the solution to the deterministic case is the set of paths \( \{\eta, \kappa, K_{1h}, K_{2h}, K_{1f}, K_{2f}\} \) such that \( \{\eta_{u \geq t}, \kappa_{u \geq t}, K_{1u \geq t h}, K_{2u \geq t h}, K_{1u \geq t f}, K_{2u \geq t f}\} \) is the unique fixed-point of the contraction \( G_t \) by the contraction mapping theorem.

### D Data Appendix

**Factor Intensity:** Factor Intensity data are taken from the NBER Manufacturing Industry Productivity Database for the years 1989, 1993, and 1996. This database is based on SIC (1987 Edition) classifications and features 459 industries. Factor intensity estimates are described in Section 6 of the text.


**Current Account, annual GDP growth, GDP Per Capita at PPP, Imports and Exports:** from World Development Indicators.

**Demographic Variables:** Population growth, the working age (ages 15-64) to total population ratio are taken from the U.N.’s “World Population Prospects : 2006 Revision”.

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Initial TFP: TFP in 1989 for all countries are taken from Hall and Jones (1999).

E Tables and Figures
Table 2: Parameters for Simulation

<table>
<thead>
<tr>
<th>Benchmark Parameter Values</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferences</strong></td>
<td>β = 0.45</td>
<td>γ = 0.61</td>
</tr>
<tr>
<td></td>
<td>ρ = 1</td>
<td>θ = 1</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>α_1 = 0.52</td>
<td>α_2 = 0.11</td>
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<td></td>
<td>b = 0.2</td>
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Figure 2: The response to an unexpected doubling of the labor force in South (Foreign).
### Sensitivity to the Adjustment Cost Parameter and Factor Intensities

<table>
<thead>
<tr>
<th>Two-Sector CA:</th>
<th>T=1</th>
<th>q:</th>
<th>T=1</th>
<th>T=5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(1) Varying Adjustment Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b=0.05</td>
<td>-8.37%</td>
<td>2.96%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>b= 0.1</td>
<td>-8%</td>
<td>5.04%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>b= 0.3</td>
<td>-7.04%</td>
<td>9.41%</td>
<td>0.31%</td>
<td></td>
</tr>
<tr>
<td>b= 0.5</td>
<td>-6.43%</td>
<td>11.27%</td>
<td>1.12%</td>
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</tr>
<tr>
<td><strong>(2) Varying Factor Intensity</strong></td>
<td></td>
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</tr>
<tr>
<td>$\alpha_2/\alpha_1 = 1$</td>
<td>0.1%</td>
<td>-0.1%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$\alpha_2/\alpha_1 = 3$</td>
<td>-4.84%</td>
<td>5.88%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>$\alpha_2/\alpha_1 = 9$</td>
<td>-5.06%</td>
<td>6.08%</td>
<td>0.47%</td>
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</tr>
<tr>
<td><strong>(3) Interaction</strong></td>
<td></td>
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</tr>
<tr>
<td>High $b$ and high $\alpha_2/\alpha_1$</td>
<td>-7.57%</td>
<td>16.75%</td>
<td>4.04%</td>
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<tr>
<td>low $b$ and high $\alpha_2/\alpha_1$</td>
<td>-9.10%</td>
<td>5.45%</td>
<td>0</td>
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<td>high $b$ and low $\alpha_2/\alpha_1$</td>
<td>-2.95%</td>
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<td>2.85%</td>
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<td><strong>(4) Elasticity of Substitution</strong></td>
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<td></td>
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<tr>
<td>$\theta = 0.8$</td>
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<td>6.29%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>$\theta = 4$</td>
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<td>6.41%</td>
<td>0.08%</td>
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<tr>
<td><strong>(5) Risk Aversion</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\rho = 0.8$</td>
<td>-6.33%</td>
<td>6.71%</td>
<td>0.17%</td>
<td></td>
</tr>
<tr>
<td>$\rho = 2$</td>
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<td>4.4%</td>
<td>0.44%</td>
<td></td>
</tr>
</tbody>
</table>

| One-Sector |       |    |     |     |
| b=0.1      | 0.01% | 0.3% | 0   |     |
| b= 0.3     | 0.02% | -1%  | 0   |     |
| b= 0.5     | 1.22% | -4%  | 0   |     |

Table 3: Responses of 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 2. The second set of results holds constant all parameters in Table 2 except the factor intensity ratio, $\alpha_2/\alpha_1$: The levels of $\alpha_1$ and $\alpha_2$ are obtained by fixing the weighted mean $\gamma \alpha_1 + (1 - \gamma) \alpha_2 = 0.36$ and setting their ratio to each of the values above; The third set of results explores interactions between $b$ and $\alpha_2/\alpha_1$. 

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Figure 3: The response of North (Home) to an unexpected doubling of the effective labor force in South (Foreign), in the one and two sector cases.
Figure 4: The first graph shows North’s (Home’s) response to an unexpected doubling of South’s (Foreign’s) labor force, varying $\alpha_2/\alpha_1$. The second graph shows North’s response in a 5 sector model, in which $\sum_i \alpha_i \gamma_i = 0.36$ is held constant, while varying the weighted variance $\sum_i (\alpha_i - \sum_i \alpha_i \gamma_i)^2 \gamma_i$. 

Figure 5: Globalization Shock
Figure 6: The Share of Working Age Population for Developing and Developed Countries
Table 4: This table shows the estimated coefficient $\alpha_c$ for developing countries as a whole over time. Standard errors are in parentheses; $\ast\ast\ast$ denotes significance at the 1-percent level.

<table>
<thead>
<tr>
<th>Year</th>
<th>$\alpha_c$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>-0.47$^{***}$</td>
<td>0.32</td>
</tr>
<tr>
<td>1993</td>
<td>-0.73$^{***}$</td>
<td>0.32</td>
</tr>
<tr>
<td>1998</td>
<td>-0.60$^{***}$</td>
<td>0.29</td>
</tr>
<tr>
<td>2002</td>
<td>-0.67$^{***}$</td>
<td>0.25</td>
</tr>
<tr>
<td>2006</td>
<td>-0.75$^{***}$</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Table 5: This table reports the results of estimating $CA_{ct} = \alpha + \beta_1 \cdot \alpha_{ct} + \gamma' Z_t + u_{ct}$. Column (3) uses an alternative definition of the independent variable: the average CA/GDP over a period. The between regression reports the results using country-averages of all variables, and including a constant. The within regression reports results using country fixed effects, and (6) reports results using country and year fixed effects. Constants, country, and year effects are not reported. The sample consists of the years $t$, 1989, 1993, 1998, 2002, 2006, for all countries. Additional controls include GDP, and GDP per capita.

<table>
<thead>
<tr>
<th></th>
<th>Pooled</th>
<th>Pooled</th>
<th>Within</th>
<th>F-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_c$</td>
<td>-0.19$^{***}$</td>
<td>-0.19$^{***}$</td>
<td>-0.18$^{**}$</td>
<td>-0.12$^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.074)</td>
<td>(0.01)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Openness</td>
<td>1.98$^{***}$</td>
<td>2.47$^{***}$</td>
<td>1.54</td>
<td>-0.42</td>
</tr>
<tr>
<td></td>
<td>(0.69)</td>
<td>(0.124)</td>
<td>(1.03)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>Annual GDP growth</td>
<td>-0.03</td>
<td>0.29$^{***}$</td>
<td>2.8</td>
<td>-0.1$^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.074)</td>
<td>(0.02)</td>
<td>(12.7)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Population growth</td>
<td>-0.67$^{**}$</td>
<td>-0.65$^{***}$</td>
<td>-1.3</td>
<td>-0.22</td>
</tr>
<tr>
<td></td>
<td>(0.27)</td>
<td>(0.02)</td>
<td>(13.5)</td>
<td>(0.35)</td>
</tr>
</tbody>
</table>

Table 6: This table reports the results of estimating $\alpha_{ct} = \beta_c + \gamma Share_{ct} + \gamma' Z_{ct} + \epsilon_{ct}$. The within regression reports results using country fixed effects, and column (4) reports results using country and year fixed effects. Constants, country, and year effects are not reported. The sample consists of the years $t$, 1989, 1993, 1998, 2002, 2006, for all countries. Additional controls include GDP per Capital, and population growth.

<table>
<thead>
<tr>
<th></th>
<th>Pooled</th>
<th>Pooled</th>
<th>Within</th>
<th>F-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Share$</td>
<td>-0.03$^{***}$</td>
<td>-0.03$^{***}$</td>
<td>-0.25$^{***}$</td>
<td>-0.27$^{***}$</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.02)</td>
<td>(0.01)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Annual GDP growth</td>
<td>-0.05$^{***}$</td>
<td>0.04$^{***}$</td>
<td>0.03$^{***}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.0045)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>Initial Openness</td>
<td>0.62$^{***}$</td>
<td>1.61$^{***}$</td>
<td>1.85$^{***}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.17)</td>
<td>(0.18)</td>
<td></td>
</tr>
<tr>
<td>Initial Capital Stock</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Country Fixed Effect</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year Fixed Effect</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.02</td>
<td>0.04</td>
<td>0.62</td>
<td>0.64</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
</tbody>
</table>
Figure 7: An anticipated doubling of labor force in Foreign, in both the one and two-sector case.