Globalization, Rent Protection Institutions, and Going Alone In Freeing Trade

This version: April 3, 2009

Wolf-Heimo Grieben*
University of Konstanz

Fuat Şener‡
Union College

Abstract: We construct a two-country North-South product cycle model of trade with endogenous growth and trade barriers. We remove the scale effects on growth by incorporating rent protection activities by Northern incumbents. We examine the effects of two forms of globalization – an expansion of the relative size of the South and unilateral trade liberalization by either country. We find that the location of rent protection institutions and the sectoral trade structure determine whether or not globalization raises steady-state economic growth. We demonstrate that for accelerating worldwide economic growth, contrary to conventional wisdom, unilateral Northern trade liberalization is preferable to bilateral trade liberalization.

Keywords: globalization, innovation, imitation, product cycle, endogenous growth

JEL classification: F12, F43, O31, O32, O34

* **Corresponding Author**. Department of Economics, University of Konstanz, 78457 Konstanz, Germany; e-mail: heimo.grieben@uni-konstanz.de, phone: +49-7531-88-5192, fax: +49-7531-88-4558.

Part of this work was done while I was a visiting scholar at the economics department of Columbia University, New York. I thank them for their hospitality. This work was supported by a grant from the Ministry of Science, Research and the Arts of Baden-Württemberg, Germany (Az: 21-655.042-5-2/1) to Wolf-Heimo Grieben. We thank two referees for their very helpful and constructive comments. The usual disclaimer applies.

‡ Department of Economics, Union College, Schenectady, New York, 12308 USA; senerm@union.edu

1 Introduction

The past two decades have been marked by the entry of large developing countries, such as Argentina, Brazil, China, Egypt, India, Turkey, Poland and Romania into the world trading system. As shown in Figure 1, between 1990 and 2002 the world trade share of middle-income countries has increased from 15 percent to 22 percent. During the 1983-2003 period, China as the world's most populous country has increased its share in global trade from 1.01 percent to 5.04 percent.

Insert here: Figure 1: World trade share of country groups

Moreover, during the eight GATT negotiation rounds from Geneva 1947-48 to Uruguay 1986-93, the average tariff rates among participants declined from 52.7 % to 13.1% of the 1931 level, as shown in Table 1. From earlier to later rounds, the number of participants increased significantly, mainly due to developing countries joining the GATT negotiations.

Insert here: Table 1: Tariff reductions during GATT and WTO rounds

With more developing countries establishing international trade linkages and pursuing freer trade policies, these globalization trends are likely to continue in the following years.

Is 'globalization' good for economic growth? We analyze this question theoretically in a general-equilibrium North-South Schumpeterian growth model with a continuum of high-tech industries.[1] Northern entrepreneurs participate in R&D races to innovate higher quality consumption goods. Southern entrepreneurs compete to imitate the current Northern production technologies. In each industry, the winner of the R&D race establishes temporary monopoly power until driven out of the market by further innovation or imitation. Global economic growth is driven by the continuous arrival of higher quality goods through Northern R&D races. During their tenure, Northern monopolists engage in Rent-Protection Activities (RPAs) to safeguard their monopoly profits.[2] RPAs encompass all activities that deter the innovation and imitation efforts targeted at the incumbent firm (such as patent enforcement, practicing trade secrecy, and lobbying the government to

---

[1] The empirical evidence on the trade-growth nexus is mixed: while the majority 'optimistic' view is that, mostly based on the Sachs-Warner criteria for openness, trade raises growth (see e.g. Lewer and van den Berg, 2003, Wacziarg and Welch, 2008, Winters, 2004, or Noguer and Siscart, 2005), other researchers have important reservations on how the 'optimists' have derived and interpreted their results, and hence remain overall skeptic (see e.g. Rodríguez and Rodrik, 2000, Hallak and Levinsohn, 2008, or Wälde and Wood, 2004). A recent thoughtful discussion of the potential of the Sachs-Warner criteria to measure the trade policy impact on growth is provided by Lucas (2009), who supports the 'optimistic' view.

[2] RPAs in an endogenous growth model are originally proposed by Dinopoulos and Syropoulos (2007). See Dinopoulos and Syropoulos (2007, pp. 310-312), Şener (2008, fn. 20) and Scotchmer (2004, chapter 7) and the references therein for detailed discussion and empirical evidence on RPAs in a closed economy setting. The available evidence suggests that patent enforcement by successful innovators is prevalent across all industries and costly to undertake. Many companies, especially small firms, cite this as a deterrent to their R&D success. Lobbying activities to influence the judicial and legislative system are also well documented in the literature.

promote stronger intellectual property rights protection). Northern innovation and Southern imitation rates are determined endogenously. With lower production costs in the South, successful imitation in a certain industry implies the shifting of production from the North to the South. This gives rise to North-South "product-cycle trade": the North exports newly invented goods which are not yet imitated, and the South exports imitated products. The governments in both the North and the South impose ad-valorem tariffs on high-tech imports.

We focus on two alternative aspects of globalization: increased trade integration of the South in the form of an expansion of the relative size of the South that is open to trade (modeled as an increase in the Southern population size relative to the North [3]), and incremental trade liberalization that takes the form of a reduction of ad-valorem import tariffs.

In our model, we make two distinctions which turn out to be crucial for our main findings on whether or not globalization raises growth. **First**, we differentiate between two institutional frameworks through which rent protection in the South may materialize. The evidence on RPAs in a North-South context suggests that such activities can take two broad forms. The first is through domestic legislative bodies and involves lobbying the government to influence trade-related legislations/treaties.[4] We view this primarily as an activity that utilizes domestic resources (e.g., US firms hiring US lawyers to influence the US-China trade talks in an attempt to make the case for stronger IPR protection). The second is through the foreign judicial institutions and involves the standard patent enforcement mechanisms (patent litigation, administrative action and etc.).[5] We view this

---

[3] This exercise follows Lu (2007, p. 338) as well as Dinopoulos and Segerstrom (2007). The standard North-South product cycle model essentially represents a world economy that consists of three regions: an Open North, an Open South, and a Closed South that has no contact with the open regions. Thus, an increase in the relative size of the *Open* South can appropriately capture the South's increased presence in the world trading system. This integration encapsulates two potential effects on Northern innovation incentives: on the one hand, more Southern labor resources allow the South to invest more in imitation, thereby increasing the imitation threat faced by Northern monopolists. On the other hand, more Southern consumers mean a larger market for sales of Northern incumbent firms, which raises monopoly profits.

[4] Lanjouw and Cockburn (2000) report on the significance of such US firms' lobbying activities. Scotchmer (2004, pp. 320-325) argues that the current US trade policy, in particular, the 1974 trade act and the subsequent amendments to its section 301 in 1984 and 1988 have provided an "automatic platform" for powerful lobbies (such as Intellectual Property Alliance, Business Software Alliance and International Federation of the Phonographic Industry) to influence the US government for promotion of increased global IPR protection. Scotchmer (2004, p. 323) also views the injection of IPRs into Generalized Agreement on Trade and Tariffs (GATT) negotiations in the 1990s as "perhaps the greatest victory of the copyright and patent lobby." Eventually, this led to the signing of the TRIPS (Trade Related Aspect of IPRs) under the World Trade Organization umbrella, which required the member countries to provide at least minimum standards of patent protection with regards to the length of the protection and the coverage of certain products.

[5] A significant number of IP related cases that involve Northern innovators and Southern firms has been reported in specialized intellectual property journals, such as Managing Intellectual Property. Such cases have been prevalent in a wide range of industries (e.g., Pfizer against a dozen of Chinese pharmaceutical companies on the validity of Pfizer's patent covering Viagra[TM], settled by the Beijing High People's Court in October 2007 in favor of Pfizer; source: http://www.managingip.com/Article.aspx?ArticleID=1915362). It should be noted that international patenting by itself is a costly activity. For a single invention the total

primarily as an activity that utilizes foreign resources (e.g., US firms hiring Chinese lawyers for patent litigation in Chinese courts). We intend to capture this distinction in resource utilization by considering two cases:

1. Local-resource using rent protection: Southern resources are used for imitation-deterring activities and Northern resources are used for innovation-deterring activities;

2. Northern-resource using rent protection: Both activities are combined as general rent protection and use only Northern resources.

We find that in the Northern-resource-using case, increased trade integration of the South exerts a positive effect on imitation, innovation, and hence on economic growth. In the local-resource using case, imitation still increases, but the rates of innovation and economic growth can be lower (**main result 1**).

Second, we consider as our baseline setting a model in which only "high-tech" sector goods are produced in both countries. We then allow for a Southern "low-tech" sector that does not feature quality improvements and operates under free trade conditions. We find that without a low-tech sector, tariff changes have no impact on the rates of Northern innovation, Southern imitation, and economic growth (we refer to this as the "*tariff-neutrality*" result). If a low-tech sector exists (which we consider the more realistic case [6]), unilateral Northern trade liberalization for high-tech goods unambiguously increases Northern innovation, Southern imitation, and economic growth, whereas unilateral Southern trade liberalization has the exact opposite results. From a growth perspective, this provides the North with an argument for 'going alone' in freeing trade (**main result 2**).

Our model differs from the existing literature on endogenous growth and trade on five accounts. **First**, we consider economic integration and incremental trade liberalization in a North-South setting. The relevant product cycle literature mostly focuses on North-North settings with a few exceptions (e.g., Dinopoulos and Segerstrom 2007, Şener and Zhao 2009, Grieben 2005, 2009). Moreover, we introduce into our main North-South setting a Southern low-tech sector and show its crucial role in determining the impact of tariff reductions.

---

cradle to grave costs of patent coverage in 52 countries is estimated to be roughly $472,414 (see Berrier, 1996). The costs range from a high of $40,000 in Japan to a low of about $2,000 in South Africa with an average of $9,085. (2006) and the references therein provide further details and examples on RPAs in a North-South context.

6 The existence of a low-tech sector only in the South implies that the unit cost of low-tech production in the North is prohibitively high for any Northern firm to successfully compete under free trade. Low-tech industries appear to be vanishing in high-wage countries, as already noted by Wood (1995, p. 65) when he criticizes factor-content studies for Northern developed countries: "[…] manufactured imports from developing countries […] consist mostly of items of low skill intensity that are no longer produced on any significant scale in developed countries".

Second, we investigate the effects of unilateral trade liberalization by both the North and the South. Most of the existing literature studies bilateral trade liberalization. Our results show that Northern and Southern unilateral trade liberalization have opposite effects on innovation and imitation.[7] This issue cannot be addressed in a framework of symmetric iceberg trade costs like in Dinopoulos and Segerstrom (2007).

Third, we offer a scale-free endogenous growth model, which distinguishes our paper from the early literature (like Grossman and Helpman, 1991, or Rivera-Batiz and Romer, 1991) where the steady-state growth rate increases in the amount of resources allocated to R&D. As a consequence of this scale effect, these models propose a positive relationship between economic integration and growth: in an integrated world economy, more workers can create more technical knowledge without duplicating each other's R&D efforts, and R&D returns are higher when technical knowledge can be applied to a larger market. Hence, economic growth should be higher than under autarky. However, despite clear evidence for increased global integration as stated above, and dramatically rising R&D investments during the last decades (as documented e.g. in Jones, 1995a, and Segerstrom, 1998), there has been no clear tendency for growth rates to increase in the advanced countries, which suggests that the scale effect is counterfactual.[8]

Fourth, we incorporate RPAs by incumbents into our North-South model. We find that the effects of economic integration crucially depend on the location of these activities. The only other North-South model with rent-protection activities is the companion paper by Şener (2006).[9] Relative to other two-country Schumpeterian non-scale growth models like Dinopoulos and Segerstrom (1999a, 2007), the benefit of having RPAs is twofold: it provides microeconomic foundations for explaining increasing R&D difficulty, and enables us to study globalization effects under different institutional set ups for RPAs.

---

7 To the best of our knowledge, this is a new finding in the literature. Dinopoulos and Syropoulos (1997), Baldwin and Forslid (1999), and Ben-David and Loewy (2000) also study unilateral trade liberalization but consider settings with structurally-identical countries that do not differentiate between the Northern and Southern research activities as innovation and imitation targeted.

8 Among the many non-scale growth models that have emerged since the "Jones critique", we note Jones (1995b), Young (1998), Peretto (1998), Segerstrom (1998), Peretto and Smulders (2002), Dinopoulos and Segerstrom (1999a), and Şener (2001), where only the latter two consider international trade (in a symmetric North-North setting) at the same time. For further insightful discussion on growth with and without scale effects, see e.g. Dinopoulos and Thompson (1999), Jones (1999, 2005), Christiaans (2004), and Laincz and Peretto (2006).

9 That paper differs from the current paper in a number of ways. Şener (2006) considers a free trade model which studies the effects of strengthening Southern IPRs, instead of economic integration and tariff effects. In addition, Sener considers only the local-resource using RPA case and does not model a Southern low-tech sector. However, to investigate the impact of IPRs from a broad perspective, Şener (2006) allows for North-South Foreign Direct Investment (FDI) and endogenous fragmentation of production within multinationals, which are beyond the scope of this paper. The effects of multinational firms in scale-free endogenous growth models with North-South trade have also been addressed by Dinopoulos and Segerstrom (2009), and Gustafsson and Segerstrom (2008).

Fifth, our model features fully endogenous growth, that is, the steady-state growth rate is a function of the fraction of resources allocated to R&D and thus affected by a wide range of parameters. Tariff rates and the degree of international integration can have an impact on the long-run growth rate by altering this fraction. Within the non-scale growth literature, this result differentiates our paper from the semi-endogenous growth models such as Dinopoulos and Segerstrom (2007), where the steady-state growth rate is pinned down by exogenous parameters and unaffected by tariffs and increased integration.[10]

The remainder of this paper is organized as follows. Section 2 presents the elements of the baseline model in which RPAs exclusively use Northern resources and there is no low-tech sector in the South. Section 3 analyses the steady-state effects of increased Southern trade integration and unilateral trade liberalization. Section 4 provides the two crucial extensions of the baseline model (Southern-resource-using imitation-deterring activities, Southern low-tech sector) which are shown to change the main results. Section 5 concludes. Formal derivations and proofs are relegated to several appendices.

2 The Model

2.1 Household Behavior

The world economy consists of two countries, the North and the South, indexed by $i \in \{N, S\}$, respectively (variables and parameters without country index are common to both countries). Each country has a fixed number of identical households, and the number of household members N_{ti} at time t within each country i is identical at each point in time. For simplicity, we assume that the number of households (but not of household members) is normalized to one in each country. We allow for different initial numbers of household members for both countries, $N_{0N} \neq N_{0S}$, but these are growing at the common rate $n > 0$, thus the population size and also the labor force in country i at time t, $N_i(t)$, equal $N_{0i}e^{nt}$. The representative household maximizes the utility function

$$U_i(t) = \int_0^\infty e^{-\rho t} \log u_i(t)\, dt \qquad \text{for } i = N, S, \tag{1}$$

[10] Madsen (2007, 2008) empirically rejects the assumption of decreasing returns to R&D which removes the scale effect in semi-endogenous growth models, and he finds supporting evidence for Schumpeterian models of non-scale growth which uphold the assumption of constant returns to R&D. Ha and Howitt (2007) also argue that the predictions of the fully-endogenous growth models are more consistent with time series data from advanced countries than those of semi-endogenous growth models. Important fully-endogenous growth models include Howitt (1999), Segerstrom (2000), Dalgaard and Kreiner (2001), and Strulik (2005), but they all are confined to a closed economy and stress the role of public policies to affect the long-run growth rate. However, based on more general considerations, Temple (2003, p. 501-502) points out that emphasizing the different long-run policy implications of semi- and fully-endogenous growth models may be of little practical relevance.

where $\rho > n$ is the subjective discount (or time preference) rate, and where the instantaneous logarithmic utility function of each household member is

$$\log u_i(t) \equiv \int_0^1 \log\left[\sum_j \lambda^{j(\omega,t)} x_i(j,\omega,t)\right] d\omega \qquad \text{for } i = N, S. \tag{2}$$

$\lambda > 1$ is the size of each quality improvement, $j(\omega,t)$ is the number of successful innovations in industry $\omega \in [0,1]$ up to time t, and $x_i(j,\omega,t)$ is the per-capita demand for a product with j quality improvements in industry ω at time t. Hence, as is standard in quality-ladder models, product quality starts at $\lambda^0 = 1$ in any industry ω and improves at discrete steps with each successful innovation which is governed by a stochastic process.

The household optimization process consists of two steps. The first step is to allocate consumption expenditure across products to maximize $u_i(t)$ with given product prices. Since products in a typical industry ω differ only in their quality, and λ units of quality j are a perfect substitute for one unit of quality j+1, households purchase in each industry only the product with the lowest quality-adjusted price. In addition, since products enter (2) symmetrically, each household spreads consumption expenditure evenly across product lines. This results in a unit-elastic per-capita demand function $x_i(\omega,t) = c_i(t)/p(\omega,t)$ in each industry ω, where $c_i(t)$ is the consumption expenditure per capita in country i at time t, and $p(\omega,t)$ is the market price for the purchased product.[11]

Given the static demand functions, the second step is to determine the consumption expenditure path over time. This involves maximizing

$$\int_0^\infty e^{-\rho t} \log c_i(t)\, dt \qquad \text{for } i = N, S, \tag{3}$$

subject to the intertemporal budget constraint

$$\dot{B}_i(t) = W_i(t) + r(t)B_i(t) - c_i(t),$$

where $B_i(t)$ denotes the per-capita stock of financial assets owned by the household (that arises from the ownership of firms earning monopoly profits to be discussed later), $W_i(t)$ is the per-capita wage income earned by the household per-period, and $r(t)$ is the instantaneous rate of return in the global market. The solution to this dynamic optimization problem is the familiar Euler equation ("Keynes-Ramsey rule")

$$\dot{c}_i(t)/c_i(t) = r(t) - \rho \qquad \text{for } i = N, S. \tag{4}$$

[11] In an extension of the basic model, in section 4.2 we will introduce a "low-tech sector" where goods of constant quality are produced. Then, we will term the goods we have been discussing so far as "high-tech goods".

At the steady-state equilibrium, c_i will be constant since the wage rate and labor supply per worker will be constant, thus $r(t) = \rho$. Since we focus on steady-states and consider structurally-identical industries, we henceforth drop the time index t and the industry index ω where appropriate.

2.2 Labor and Activities

Labor is the only factor of production and is immobile across countries. In the North, the labor force consists of general-purpose and specialized workers, with the proportion of the former given as $1-s_N$ and that of the latter given as $s_N \in (0, 1)$. In the North, there are three types of activities: innovation, manufacturing of final goods and rent-protection. General-purpose workers can be employed in manufacturing or innovation, whereas specialized workers (like lawyers or lobbyists) are only employed in RPAs.[12] In the South, there is only general-purpose labor which can be employed in manufacturing of final goods or imitation, which are the only types of activities. In an extension of the baseline model, section 4.1 introduces Southern specialized labor which is employed in RPAs.

2.3 Industry Structure and Product Markets

The world economy consists of a continuum of structurally-identical industries indexed by $\omega \in [0, 1]$, i.e. the mass of industries is normalized to unity. In the North, entrepreneurs participate in innovation races to discover the technology of producing *next* generation consumer goods, where each innovation improves the existing generation by a quality step of size $\lambda > 1$. In the South, entrepreneurs participate in imitation races to acquire the technology of producing *current* generation products, which refer to the existing state-of-the-art products manufactured by the current Northern quality leader in industry ω. Producer firms compete to offer the lowest quality-adjusted price given their state of technology and regional factor prices. Northern entrepreneurs target their innovation efforts at *all* industries, while Southern entrepreneurs target their imitation efforts only at industries with a Northern quality leader since price competition among two Southern firms with identical technologies for the same industry ω would imply zero profits. As is usual in neo-Schumpeterian growth theory, whenever a higher quality product is discovered in the North, the technology of producing the previous generation product becomes common knowledge in the world economy.

In both countries, production of one unit of final goods requires one unit of general-purpose la-

---

[12] This labor assignment follows Dinopoulos and Syropoulos (2007). We note that this is indeed a restrictive assumption; however, its advantage is that it yields fully-endogenous growth with a parsimonious structure by creating a link between the innovation rate and the Northern relative wage rate between specialized and general-purpose labor. We will later discuss the robustness of our main results with respect to alternative labor assignments.

bor, regardless of the quality level of the manufactured goods. Let w_{LN} represent the wage rate of general-purpose labor in the North, while the Southern wage rate is normalized to 1. For each industry, there are two possible structures at any point in time. Whenever a Northern entrepreneur discovers a next-generation product, the resulting structure is a *Northern industry*, in which the Northern quality leader competes with Southern followers that have access to the one-step down technology. Whenever a Southern entrepreneur acquires the technology of producing a current generation product, the resulting structure is a *Southern industry*, in which a successful Southern imitator competes with a Northern incumbent, where both firms have access to the same state-of-the-art technology. Northern (Southern) firms face an ad-valorem import tariff rate of τ_S (τ_N) in the Southern (Northern) market. According to the terminology of Dinopoulos and Segerstrom (1999b, p. 194), these are "rent-extracting", but not "protective" tariffs: they transfer rents from foreign quality leaders to domestic governments in both countries, but are not large enough to enable domestic follower firms to survive competition from foreign quality leaders.

Consider first the profits of the **Northern quality leader** who competes with Southern followers in both Northern and Southern markets.[13] **In the Northern market,** Southern followers can produce the one-step-down quality product at the marginal cost of 1. Under marginal cost pricing and with tariffs in place, the Southern followers can offer their goods to the Northern consumers at a price $1+\tau_N$. In this case, the Northern quality leader charges the limit price $p_N^N = \lambda(1+\tau_N)$ and drives the Southern followers out of the market. The profits of the Northern quality leader from sales in the Northern market are:

$$\pi_N^N = \frac{c_N N_N}{\lambda(1+\tau_N)}[\lambda(1+\tau_N) - w_{LN}] = c_N N_N \left[1 - \frac{w_{LN}}{\lambda(1+\tau_N)}\right].$$

Intuitively, the existence of tariffs enables the *local* producer to raise its price and thus enjoy higher profits from local sales.

In the Southern market, Southern followers under marginal cost pricing can offer a price of 1. The Northern quality leader faces an ad-valorem tariff rate of τ_S. To capture the Southern market, the Northern firm must set its price such that the price faced by the Southern consumers does not exceed λ. This implies that the Northern firm's limit price is $p_N^S = \lambda$, of which the firm receives

[13] Northern followers' unit cost is w_{LN} whereas the Southern followers' unit cost is 1. Northern followers cannot compete with Southern followers in the Southern market if $w_{LN}(1+\tau_N) > 1$. This condition holds automatically given that $w_{LN} > 1$ at the steady-state. Moreover, Northern followers cannot compete with Southern followers in the Northern market provided $w_{LN} > 1+\tau_N$. We assume that this restriction holds which implies that Southern imitators realize positive profits from sales in the North as is shown further below.

$\lambda/(1+\tau_S)$ per unit sold. The profits of the Northern quality leader from sales in the Southern market are:

$$\pi_N^S = \frac{c_S N_S}{\lambda}\left(\frac{\lambda}{1+\tau_S} - w_{LN}\right).$$

For $\pi_N^S > 0$, we need $\tau_S < (\lambda/w_{LN}) - 1$. Total profits from sales of Northern monopolists are:

$$\pi_N^P = \pi_N^N + \pi_N^S = c_N N_N\left[1 - \frac{w_{LN}}{\lambda(1+\tau_N)}\right] + c_S N_S\left(\frac{1}{1+\tau_S} - \frac{w_{LN}}{\lambda}\right). \tag{5}$$

Consider next the profits of the successful **Southern imitator** who competes with the Northern quality leader in both Northern and Southern markets.[14] **In the Southern market,** under marginal cost pricing and with tariffs in place, the Northern firm can offer its product to Southern consumers at a price of $w_{LN}(1+\tau_S)$. In this case, the Southern imitator charges the limit price $p_S^S = w_{LN}(1+\tau_S)$ and drives the Northern firm out of the market. The profits of the Southern imitator from sales in the Southern market are:

$$\pi_S^S = \frac{c_S N_S}{w_{LN}(1+\tau_S)}[(1+\tau_S)w_{LN} - 1] = c_S N_S\left[1 - \frac{1}{w_{LN}(1+\tau_S)}\right].$$

In the Northern market, the Northern firm, under marginal cost pricing, can offer a price of w_{LN}. The Southern imitator faces an ad-valorem tariff rate of τ_N. To capture the Northern market, the Southern imitator must set its price such that the price faced by the Northern consumers does not exceed w_{LN}. This implies that its limit price is $p_S^N = w_{LN}$, of which the firm receives $w_{LN}/(1+\tau_N)$ per unit sold. The profits of the Southern imitator from sales in the North are:

$$\pi_S^N = \frac{c_N N_N}{w_{LN}}\left(\frac{w_{LN}}{1+\tau_N} - 1\right).$$

For $\pi_S^N > 0$, we need $\tau_N < w_{LN} - 1$. Total profits from sales of Southern monopolists are:

$$\pi_S = \pi_S^S + \pi_S^N = c_S N_S\left[1 - \frac{1}{w_{LN}(1+\tau_S)}\right] + c_N N_N\left(\frac{1}{1+\tau_N} - \frac{1}{w_{LN}}\right) \tag{6}$$

Finally note that in equilibrium, positive rates of innovation and imitation require positive profits of both successful Northern innovators and Southern imitators, thus $1+\tau_N < w_{LN} < \lambda/(1+\tau_S)$ must be fulfilled: the lower bound for the Northern general-purpose wage rate ensures both $\pi_S^S > 0$ and

---

[14] The followers in both regions are undercut by the top-quality producers and exit the market.

$\pi_S^N > 0$, while the upper bound for w_{LN} ensures both $\pi_N^N > 0$ and $\pi_N^S > 0$.

While Northern quality leaders earn monopoly profits, they face the threat of innovation from the North and imitation from the South. To safeguard their monopoly positions, the incumbents undertake RPAs. These can take the form of patent enforcement, practicing trade secrecy, lobbying the government to promote stronger intellectual property rights protection, corruption to influence the legal and political system, and such. RPAs work to deter the innovation and imitation efforts targeted at the incumbent. To conduct RPAs, each Northern incumbent hires Northern specialized labor at a wage rate of w_{HN}. The cost of performing X units of rent-protection activities (RPAs) is $w_{HN}\gamma X$, where γ is the unit labor requirement of such activities. Hence, a Northern incumbent's profit flow net of RPA costs equals:

$$\pi_N = \pi_N^P - w_{HN}\gamma X \ . \tag{7}$$

2.4 Technology of Innovation and Imitation

In the North, there are sequential and stochastic R&D races in each industry $\omega \in [0,1]$ to discover the next generation product on the industry-specific quality ladder. The R&D technology is identical across Northern firms: by using general-purpose labor, the instantaneous probability of success (Poisson arrival rate) ι_j by firm j is given as

$$\iota_j = R_j / D \qquad \text{with} \qquad \dot{D} = n_N \delta X \ , \tag{8}$$

where R_j represents the intensity of innovation activities undertaken by a typical Northern entrepreneur j targeting industry ω, and D measures the difficulty of targeting innovation at industry ω. According to (8), D is modeled as a stock variable[15], where n_N is the proportion of industries located in the North, X is the flow of RPAs undertaken by the Northern incumbent in industry ω, and δ measures the effectiveness of these RPAs. Hence, whenever an industry is registered as a Northern industry – the probability of which is equal to n_N in equilibrium – the Northern incumbents undertake RPAs which increases the stock of R&D difficulty in that industry by δX. Since the ι_j are independently distributed across firms and industries, the Poisson arrival rate for innovation at the industry level (which is 'the' Northern innovation rate) equals

$$\iota = \sum_j \iota_j = R/D \qquad \text{with} \qquad R = \sum_j R_j \ . \tag{9}$$

[15] Modeling R&D difficulty D as a stock variable better captures the persistence of the institutional and legal framework surrounding intellectual property rights protection than the alternative modeling as a flow variable in Dinopoulos and Syropoulos (2007). All results are robust to assuming a constant depreciation rate for R&D difficulty.

A constant steady-state innovation rate requires that R&D difficulty D must grow at the same rate as resources devoted to R&D, which in equilibrium grows at the rate of population growth n. Hence, $\dot{D}/D = n$ is required. Using this and (8), we obtain the following expression for the stock of R&D difficulty along any steady-state growth path:[16]

$$D = n_N \delta X / n \,. \tag{10}$$

Analogously, the instantaneous probability of imitation success (Poisson arrival rate) μ_j by any Southern firm j is given as

$$\mu_j = M_j / D \tag{11}$$

with $\dot{D}$ as in (8), and D now measures the difficulty of targeting imitation at industry ω as in (10). Note that RPAs are modeled as a general activity that deters both innovation and imitation simultaneously; hence, D stands for both innovation and imitation difficulty (in section 4.1 we differentiate between innovation- and imitation-deterring activities and their resource requirements). Therefore, the Poisson arrival rate for imitation at the industry level equals

$$\mu = \sum_j \mu_j = M/D \qquad \text{with} \qquad M = \sum_j M_j \,. \tag{12}$$

Since Southern entrepreneurs target only Northern industries, the economy-wide Southern imitation rate is given as $m \equiv \mu n_N$. Northern incumbent firms are driven from the market at the *replacement rate* $\iota + \mu$.

2.5 Optimal Innovation and Imitation Decisions

In the North, general-purpose labor is hired for performing innovative R&D. The cost of conducting R_j units of innovative activity is $w_{LN} a_\iota R_j$, where a_ι is the unit labor requirement of innovation. Imposing the usual free-entry assumption for R&D races, expected profits from R&D are competed away, and the maximization problem yields

$$\max_{R_j} \; \frac{v_N R_j}{D} dt - w_{LN} a_\iota R_j dt \quad \Rightarrow \quad v_N = w_{LN} a_\iota D \,, \tag{13}$$

where v_N is the valuation of a successful Northern innovator. In the South, general purpose labor is hired for performing imitative R&D. The cost of conducting M_j units of imitative activity in the

[16]The introduction of R&D difficulty via RPAs removes the scale effects from the model. An alternative would be the "permanent effects on growth" (PEG) specification, as suggested by Dinopoulos and Segerstrom (1999a), which we analyze in Appendix R.1 (available from the authors upon request). The main results are robust to this alternative specification.

South is $a_\mu M_j$ (given that the Southern wage rate is normalized to 1), where a_μ is the unit labor requirement of imitation. Under free entry into imitation, expected profits from R&D are competed away again, and the maximization problem yields

$$\max_{M_j} \frac{v_S M_j}{D} dt - a_\mu M_j dt \quad \Rightarrow \quad v_S = a_\mu D , \tag{14}$$

where v_S is the valuation of a successful Southern imitator.

2.6 Stock Markets

As usual in Schumpeterian growth models, household savings are channeled to firms investing in R&D by means of a global stock market. Over any time period dt, the stockholders of a successful Northern innovating firm receive dividend payments $\pi_N dt$. With probability $(\iota + \mu)dt$, the firm is driven out of the market and the stockholders face a capital loss of size v_N. With probability $1 - (\iota + \mu)dt)$, the firm maintains its monopoly position and the stockholders experience a capital gain or loss given by $\dot{v}_N\, dt$. Households can engage in complete diversification of their asset portfolio to eliminate the industry-specific risk of unsuccessful R&D expenditure, hence in an arbitrage-free asset market equilibrium, the expected return from a stock issued by a successful innovator $\pi_N dt - v_N(\iota + \mu)dt + \dot{v}_N\, dt(1 - (\iota + \mu)dt)$ must equal the return of a risk-free asset that pays the market interest rate on an investment of equal size during the same time period, $rv_N dt$. Imposing this condition for $dt \to 0$ yields

$$v_N = \frac{\pi_N}{r + \iota + \mu - \left(\dot{v}_N / v_N\right)} \ . \tag{15}$$

Similarly, the no-arbitrage condition for investments in Southern R&D firms (which do not face the risk of imitation) yields

$$v_S = \frac{\pi_S}{r + \iota - \left(\dot{v}_S / v_S\right)} \ . \tag{16}$$

2.7 Optimal Rent Protection Activities By Northern Incumbents

Substituting D from (10) into (9) and (12), we derive $\iota\left(X\right) = \frac{Rn}{n_N \delta X}$ and $\mu\left(X\right) = \frac{Mn}{n_N \delta X}$, which clearly show that a higher level of RPAs X reduces both ι and μ and thus diminishes the threat of replacement faced by the incumbent. The incumbent avoids the capital loss v_N and realizes the change in its valuation $\dot{v}_N$ by the extent of the decline in ι and μ per unit of time. In the meanwhile each unit of RPA costs $w_{HN}\gamma$ per unit of time. When choosing the optimal level of X, Northern incumbents weigh the gains against the costs at the margin. Formally, they choose X to maximize the expected returns on their stocks

$$\left(\pi_N^P - w_{HN}\gamma X\right)dt - v_N\left[\iota\left(X\right)+\mu\left(X\right)\right]dt + \dot{v}_N dt\left\{1-\left[\iota\left(X\right)+\mu\left(X\right)\right]dt\right\},$$

where (7) is used for π_N and the expressions for $\iota(X)$ and $\mu(X)$ are from above. Setting the derivative of the above expression with respect to X to zero, using $d\iota(X)/dX = -\iota/X < 0$ and $d\mu(X)/dX = -\mu/X < 0$, and taking limits as $dt \rightarrow 0$, we derive the first order condition for the optimal X as:

$$X = v_N\left(\iota+\mu\right)/\left(w_{HN}\gamma\right). \tag{17}$$

Intuitively, the optimal level of RPAs X increases with the firm value v_N (since there is more at stake) and the replacement rate $\iota+\mu$ (the instantaneous probability of full capital loss at each point in time), and it decreases with $w_{HN}\gamma$ (the unit cost of RPAs).[17]

2.8 Labor Markets

Since one unit of production goods of any quality is produced by one unit of labor, the Northern demand for manufacturing labor is given by the proportion of Northern industries n_N times the quantity of consumption goods produced for the North and the South, respectively. From our results of section 2.3, this is $n_N\{c_N N_N/[\lambda(1+\tau_N)] + c_S N_S/\lambda\}$. The Northern demand for R&D labor is $a_\iota R = a_\iota \iota D$, where (9) is used. Thus the *Northern general-purpose labor market clearing* (*LABN*) *condition* is

$$n_N Q_N\left(c_N, c_S\right)N_N + a_\iota \iota D = \left(1-s_N\right)N_N \qquad \text{with} \qquad Q_N\left(c_N, c_S\right) \equiv \frac{1}{\lambda}\left(\frac{c_N}{1+\tau_N} + c_S\eta_S\right), \tag{18}$$

where $Q_N N_N$ denotes the aggregate production of a Northern incumbent firm, and $\eta_S \equiv N_S/N_N$ measures the relative size of the South. The *Northern specialized labor market clearing condition* is

$$n_N\gamma X = s_N N_N. \tag{19}$$

The Southern demand for manufacturing labor is given by the proportion of Southern industries n_S times the quantity of consumption goods produced for the North and the South, respectively. From our results of section 2.3, this is $n_S\{c_S N_S/[w_{LN}(1+\tau_S)] + c_N N_N/w_{LN}\}$. The Southern demand for R&D labor is $n_N a_\mu M = n_N a_\mu \mu D$, where (12) is used. Thus the *Southern labor market clearing*

---

[17] It should be noted that one can also obtain (17) by maximizing the steady-state market value of the firm with respect to X. This involves plugging in $\iota(X)$, $\mu(X)$ and π_N from (7) into (15) and then setting $\partial v_N/\partial X = 0$. Hence, from a methodological point of view, maximizing the *stock market value of the firm* and maximizing the *expected return on the stocks* are equivalent.

($LABS$) *condition* is

$$n_S Q_S\left(c_N, c_S, w_{LN}\right) N_N + a_\mu \mu D n_N = N_S \qquad \text{with} \qquad Q_S\left(c_N, c_S, w_{LN}\right) \equiv \frac{1}{w_{LN}}\left(\frac{c_S \eta_S}{1+\tau_S} + c_N\right), \tag{20}$$

where $Q_S N_N$ denotes the aggregate production of a Southern incumbent firm, and n_S is the fraction of Southern industries.

2.9 Steady-State Equilibrium

Northern (Southern) entrepreneurs capture industry leadership from Southern (Northern) firms at a rate of ιn_S (μn_N), and constancy of industry shares requires $\iota n_S = \mu n_N$. Given $n_N + n_S = 1$, this implies

$$n_S = \mu/\left(\iota + \mu\right) \qquad \text{and} \qquad n_N = \iota/\left(\iota + \mu\right). \tag{21}$$

Let $A_\iota \equiv (a_\iota \delta)/(n\gamma)$ and $A_\mu \equiv (a_\mu \delta)/(n\gamma)$, which capture the resource requirement in innovative and imitative R&D relative to RPA, respectively. We solve the model for a steady-state equilibrium where the endogenous variables c_N, c_S, ι, μ, w_{LN} and w_{HN} remain constant, and R, M, π_N, π_S, X, v_N and v_S all grow at a common rate of n. We impose a *balance-of-trade* (BOT) *condition*, which requires that the value of exports net of tariffs be equal between the North and the South[18]:

$$n_N \frac{c_S N_S}{\lambda} \frac{\lambda}{(1+\tau_S)} = n_S \frac{c_N N_N}{w_{LN}} \frac{w_{LN}}{(1+\tau_N)} \;,$$

where the LHS (RHS) denotes the value of Northern (Southern) exports net of tariffs. This can be rewritten, by using (21), as

$$c_S = c_N \frac{\mu}{\iota \eta_S} \frac{(1+\tau_S)}{(1+\tau_N)} \qquad\qquad \mathbf{BOT}\left(c_S, c_N, \iota, \mu\right). \tag{22}$$

which determines the relative consumer expenditure levels for both countries.

Substituting in (17) for v_N from (13), then for D from (10) and finally for n_N from (21), we obtain the Northern specialized wage rate as

$$w_{HN} = A_\iota \iota w_{LN}\,, \tag{23}$$

implying that w_{HN}/w_{LN} is increasing in ι. This is because a higher innovation rate increases the profitability of RPAs relative to innovation and thus w_{HN}/w_{LN}.

[18] As an alternative approach, Appendix R.2 (available upon request) considers the steady-state solution with an asset market equilibrium condition instead of a BOT condition. It turns out that this leads to exactly the same conclusions regarding the globalization effects on the main variables of interest.

Plugging (17) into (7), using (5), and inserting all this into (15), using the steady-state results $r_t = \rho$ and $\dot{v}_N / v_N = n$, we solve for the stock-market value of Northern firms as

$$v_N = \frac{c_N N_N \left[1 - \frac{w_{LN}}{\lambda(1+\tau_N)}\right] + c_S N_S \left(\frac{1}{1+\tau_S} - \frac{w_{LN}}{\lambda}\right)}{\rho - n + 2(\iota + \mu)} \ . \tag{24}$$

Setting (24) equal to (13), substituting for D from (10), then for Xn_N from (19), using the definitions of A_ι and η_S, and imposing the BOT condition (22), we obtain the *free-entry in innovation* (*FEIN*) *condition*, which equates discounted innovative R&D benefits and current innovative R&D costs:

$$\frac{c_N \left[1 + \frac{\mu}{\iota(1+\tau_N)}\right] - \tilde{Q}_N(c_N) w_{LN}}{\rho - n + 2(\iota + \mu)} = A_\iota w_{LN} s_N \qquad \textbf{FEIN}(c_N, w_{LN}, \iota, \mu), \tag{25}$$

where $Q_N\left[c_N, c_S(c_N)\right] \equiv \tilde{Q}_N(c_N) = \frac{c_N}{\lambda(1+\tau_N)}\left[1 + \frac{\mu(1+\tau_S)}{\iota}\right]$ by using (22). Analogously, by setting (14) equal to (16), and using (6), (10), (19), and (22), we obtain the *free-entry in imitation* (*FEIM*) condition which equates discounted imitative R&D benefits and current imitative R&D costs:

$$\frac{\overbrace{\frac{c_N}{1+\tau_N}\left[1 + \frac{\mu(1+\tau_S)}{\iota}\right]}^{\lambda \tilde{Q}_N(c_N)} - \tilde{Q}_S(c_N, w_{LN})}{\rho - n + \iota} = A_\mu s_N \qquad \textbf{FEIM}(c_N, w_{LN}, \iota, \mu), \tag{26}$$

where $Q_S\left[c_N, c_S(c_N), w_{LN}\right] \equiv \tilde{Q}_S(c_N, w_{LN}) = \frac{c_N}{w_{LN}}\left[1 + \frac{\mu}{\iota(1+\tau_N)}\right]$ by using (22).

For given ι and μ, the FEIN and FEIM conditions determine a unique steady-state solution for c_N and w_{LN} as shown in Figure 2 below.

Insert here: Figure 2: The determination of $c_N(\iota, \mu)$ and $w_{LN}(\iota, \mu)$

The FEIN curve as implied by (25) is upward sloping in (c_N, w_{LN}) space because a higher w_{LN} reduces R&D profitability by increasing both production and R&D costs in the North. Restoring the zero-profit condition for innovation requires an increase in c_N. The FEIM curve as implied by (26) is downward sloping in (c_N, w_{LN}) space because a higher w_{LN} raises imitation profitability by raising the limit price successful Southern followers can charge both in the Northern and in the Southern market. Restoring the zero-profit condition for imitation requires a decrease in c_N. Solving (25) and (26) simultaneously for c_N and w_{LN} yields

$$c_N(\iota, \mu) = \frac{\iota s_N \lambda (1+\tau_N)\left\{A_\iota\left[\rho - n + 2(\iota + \mu)\right] + A_\mu(\rho - n + \iota)\right\}}{(\lambda - 1)\left[\iota + \mu(1+\tau_S)\right]} \ , \tag{27}$$

$$w_{LN}(\iota,\mu)=\frac{\lambda\left\{A_\iota\left[\rho-n+2(\iota+\mu)\right]+A_\mu(\rho-n+\iota)\right\}\left[\iota(1+\tau_N)+\mu\right]}{\left\{\lambda A_\iota\left[\rho-n+2(\iota+\mu)\right]+A_\mu(\rho-n+\iota)\right\}\left[\iota+\mu(1+\tau_S)\right]}\quad . \tag{28}$$

Dividing (25) by (26) and simplifying gives

$$\frac{\iota(1+\tau_N)+\mu-\frac{w_{LN}}{\lambda}\left[\iota+\mu(1+\tau_S)\right]}{w_{LN}\left[\iota+\mu(1+\tau_S)\right]-\iota(1+\tau_N)-\mu}\cdot\frac{\rho-n+\iota}{\rho-n+2(\iota+\mu)}=\frac{A_\iota}{A_\mu} \tag{29}$$

This ratio essentially summarizes the relative profitability conditions between innovation and imitation. The LHS captures the *profit margins* for innovators relative to imitators and the RHS-captures the *cost* of innovation relative to imitation. Hence, a reduction in the Northern tariff rate τ_N reduces the profitability of innovation relative to imitation. Restoring the free-entry conditions for given ι and μ requires a decrease in w_{LN} which increases innovation profitability (by raising the innovators' profit margins and reducing their R&D costs) and reduces imitation profitability (by reducing the imitators' limit prices and thus their profit margin). A reduction in the Southern tariff rate τ_S causes the opposite effects by increasing the profitability of innovation relative to imitation. We summarize our findings as:

Lemma 1: *Independently of c_N, the North-South general-purpose relative wage gap $w_{LN}/w_S \equiv w_{LN}$ is increasing in the profitability of innovation relative to imitation.*

Using (10) and (19), we find $D=s_N N_N\delta/(\gamma n)$. Using this, (21) and the expression for $\tilde{Q}_N$, the *LABN* condition (18) can be rewritten as

$$\frac{\tilde{Q}_N(c_N)\iota}{\iota+\mu}+A_\iota\iota s_N=1-s_N \qquad \mathbf{LABN}(c_N,\iota,\mu). \tag{30}$$

Similarly, by using $D=s_N N_N\delta/(\gamma n)$, (21) and the expression for $\tilde{Q}_S$, the *LABS* condition (20) can be rewritten as

$$\frac{\tilde{Q}_S(c_N,w_{LN})\mu}{\eta_S(\iota+\mu)}+\frac{A_\mu\mu s_N}{\eta_S}\frac{\iota}{\iota+\mu}=1 \qquad \mathbf{LABS}(c_N,w_{LN},\iota,\mu). \tag{31}$$

Using (27) in (30) gives the Northern labor market equilibrium condition as a function solely in ι and μ:

$$\frac{\iota s_N\left\{A_\iota\left[\rho-n+(\iota+\mu)(1+\lambda)\right]+A_\mu(\rho-n+\iota)\right\}}{(\lambda-1)(\iota+\mu)}=1-s_N \qquad \mathbf{LABN}(\iota,\mu), \tag{32}$$

which does not depend on the tariff rates. The LHS of (32) is strictly increasing in ι and strictly decreasing in μ (since $\rho - n > 0$), hence the curve for LABN is strictly upward sloping in (ι, μ)-space. Intuitively, an increase in ι raises Northern general-purpose labor demand for R&D and for manufacturing by raising both n_N and c_N, where the latter follows from $\partial c_N/\partial \iota > 0$ in (27). Restoring the Northern labor market equilibrium requires an increase in μ since this reduces Northern labor demand by decreasing both n_N and c_N, where the latter follows from $\partial c_N/\partial \mu < 0$ in (27).[19]

Using (27) and (28) in (31) gives the Southern labor market equilibrium condition as a function solely in ι and μ:

$$\frac{\mu s_N \left\{ A_\iota \lambda \left[\rho - n + 2(\iota + \mu) \right] + A_\mu \left(\rho - n + \iota\lambda \right) \right\}}{\eta_S (\lambda - 1)(\iota + \mu)} = 1 \qquad \textbf{LABS}(\iota, \mu), \tag{33}$$

which also does not depend on the tariff rates. The LHS of (33) is strictly increasing in μ, while it is strictly increasing in ι provided that the following condition is satisfied which will be maintained for the rest of this paper:

$$\mu > (\rho - n)\left(\frac{1}{\lambda} + \frac{A_\iota}{A_\mu} \right). \tag{34}$$

This amounts to the assumption that the households' net discount rate $\rho - n$ is sufficiently small. Given that condition (34) is satisfied, the curve for LABS is strictly downward sloping in (ι, μ)-space such that the steady-state equilibrium illustrated in Figure 3 below is unique.[20] An increase in μ raises the labor demand for Southern manufacturing by increasing both n_S and c_N. This is rein-

[19] To uncover the underlying mechanisms for $\partial c_N/\partial \iota > 0$ and $\partial c_N/\partial \mu < 0$ we use (25), (26), and Figure 2. A higher ι increases the pace of creative destruction and also leads to lower c_S for a given c_N through the BOT condition (the reason is that a higher ι reduces the fraction of Southern industries n_S and leads to lower Southern consumption expenditure). Thus, the rewards from both innovation and imitation decline. Restoring equilibrium requires an increase in c_N, shifting both the FEIN and FEIM curves up in Figure 2. For the case of an increase in μ the opposite shifts are observed. A higher μ increases the pace of replacement for Northern innovators but at the same time leads to higher c_S through the BOT condition (the reason being an increase in n_S). In the neighborhood of zero tariffs, the net impact implies higher rewards from innovation. Simultaneously, the higher μ increases the rewards from imitation through the increased c_S effect without exerting a replacement effect for Southern imitators. With both innovation and imitation profitability increased, restoring equilibrium requires a decrease in c_N, which shifts both the FEIN and FEIM curves down in Figure 2.

[20] Existence of the steady-state equilibrium is ensured by noting that, first, the LABS curve (33) cannot hit the vertical axis since (34) guarantees $\mu > 0 \ \forall \ \iota$ on LABS, second, the LABN curve (32) for $\mu \to 0$ clearly starts at some $\iota > 0$, and third, the LABN curve is concave in μ. The latter is easily verified by applying the implicit function theorem to (32), which gives

$$\frac{\partial \iota}{\partial \mu} = \frac{\iota \left[A_\iota (\rho - n) + A_\mu (\rho - n + \iota) \right]}{\mu \left\{ A_\iota \left[\rho - n + (\iota + \mu)(1 + \lambda) \right] + A_\mu (\rho - n + \iota) \right\} + (\iota + \mu)\iota \left[A_\iota (1 + \lambda) + A_\mu \right]} > 0 .$$

Since this derivative is clearly decreasing in μ, the concavity of the curve for LABN follows.

forced by the lower w_{LN} which is triggered by an increase in μ. To see this, differentiate (28) with respect to μ. The lower w_{LN} increases Southern production employment because it reduces the limit prices successful Southern imitators can charge in both the Southern and the Northern markets which in turn raises consumption demand and hence production. In addition, an increase in μ directly increases Southern R&D labor demand by raising the Southern economy-wide imitation rate $m \equiv \mu n_N$.

Restoring the Southern labor market equilibrium requires a decrease in ι, which has four effects on Southern labor demand: first, it reduces Southern R&D labor demand by reducing the Southern economy-wide imitation rate $m \equiv \mu n_N$. Second, it increases w_{LN} provided that both tariff rates are sufficiently low and $\mu > (\rho - n)/2$. To see this, differentiate (28) with respect to ι. An increase in w_{LN} raises the limit prices (in both countries) charged by successful Southern imitators and hence reduces Southern production employment. Third, a decrease in ι raises n_S which tends to increase Southern production employment. Fourth, a decrease in ι has an ambiguous effect on c_S. The net effect is a decrease in total Southern labor demand provided that (34) is fulfilled.

Insert here: Figure 3: The steady-state equilibrium

Finally, from (2) we can derive as usual the common steady-state utility growth rate of both countries, which is $\dot{u}_N / u_N = \dot{u}_S / u_S = \iota \log \lambda$.[21]

3 Globalization Effects

3.1 Increased Trade Integration Of The South

We first consider the effects of increased trade integration of the South, modeled as an increase in the relative size of the South $\eta_S \equiv N_S/N_N$.[22] This exercise is motivated by the recent entry of large developing countries into the world trading system. Using the Sachs and Warner openness criteria, Wacziarg and Welch (2008) calculate that between 1980 and 2000, the percentage of open economies had increased from about 26 % to 73 %. During the same time period, the percentage of the world population living in open economies has increased from about 25 % to 46 %. The discrepancy between the two measures stems from the fact that China and India, the world's two most popul-

[21] Details of the derivation can be found in Appendix R.3, which is available from the authors upon request.

[22] When one investigates the consequences on North-South integration, the issue of scale effects becomes especially important. In scale-dependent product cycle models like Grossman and Helpman (1991), changes in one region's population size can affect the steady-state rates of innovation or imitation even if that region's *share* in the world economy remains the same. Scale-free product cycle models like this one do not have this questionable feature. Instead, steady-state outcomes depend on *relative* population sizes; that is, an expansion in the absolute size of the South generates the same qualitative steady-state effects as does a contraction in the absolute size of the North, and vice versa.

ous countries, were still classified as closed economies as of year 2000 in Wacziarg and Welch (2008). However, it is well known that these two countries have made substantial progress towards trade liberalization and appear to be on their way to meeting the Sachs and Warner openness criteria.

An expansion in the relative size of the Southern market η_S leaves the free-entry conditions (25) and (26) unaffected. Thus the FEIN and FEIM curves in Figure 2 remain the same. This is because the BOT condition (22) requires a constant ratio of Southern to Northern consumption expenditure $c_S N_S/(c_N N_N) = \mu(1+\tau_S)/[\iota(1+\tau_N)]$ for given levels of ι and μ. Hence, the profit flows of Northern innovators and Southern imitators are independent of η_S. The LABN curve (32) of Figure 3 is not affected either. The see this, first note again by the BOT condition that total expenditure by Southern consumers is proportional to that by Northern consumers. Thus, Northern exports $n_N c_S N_S/\lambda$ are proportional to N_N. Second, the levels of Northern production for domestic consumption and innovation difficulty D are also proportional to N_N. With the aggregate Northern labor supply given by N_N, it follows that the N_N terms in the LABN equation cancel out. Thus, changes in relative market size $\eta_S \equiv N_S/N_N$ exert no direct influence on the LABN condition.

In the South, using again the BOT condition, we observe that Southern production for domestic consumption $n_S c_S N_S/[(1+\tau_S)w_{LN}]$ is proportional to N_N. The levels of Southern exports and imitation difficulty D are also proportional to N_N. Hence, in the South, aggregate labor demand is proportional to N_N, whereas aggregate labor supply is obviously proportional to N_S. Therefore a higher η_S creates room for an expansion in both imitative and manufacturing activities, resulting in a larger μ for a given ι. Consequently, the LABS curve shifts to the right, and the equilibrium rates of both μ and ι increase. The intuition can be understood by appealing to the upward sloping LABN curve. When μ increases, Northern manufacturing labor demand falls due to the decrease in n_N and c_N. Restoring equilibrium calls for an increase in ι, which boosts both R&D and manufacturing labor demand in the North. The result is shown in Figure 4 below.

Insert here: Figure 4: Steady-state effects of increased Southern trade integration

To investigate the change in w_{LN}, we use the relative profitability ratio given in (29). With the rise in the equilibrium level of μ, Northern firms face a stronger imitation threat from the South. Hence, the profitability of innovation relative to imitation declines. At the same time, the higher equilibrium level of ι increases the replacement rate of firms in all industries, thereby reducing the rewards to both innovators and imitators. This raises the profitability of innovation relative to imitation if and only if $\mu > (\rho - n)/2$. Hence, the increase in ι can cause a countervailing effect on relative innovation-imitation profitability. Nevertheless, for sufficiently low tariffs, we find that the impact coming from μ dominates all other effects and the profitability of innovation *relative* to imitation declines.[23] It then follows from Lemma 1 that the relative wage of Northern general-purpose labor w_{LN} declines as well. Furthermore, we can also establish $dn_N/d\eta_S < 0$ and $dm/d\eta_S > 0$.[24] The proportion of Northern industries n_N decreases since the resulting increase in μ more than outweighs the resulting increase in ι. The aggregate Southern imitation rate $m = \mu n_N$ increases since the resulting increase in the industry-wide imitation rate μ more than outweighs the resulting decrease in n_N. The effects of increased Southern trade integration are summarized in

Proposition 1: *Given that* (34) *is fulfilled, a unique steady-state equilibrium exists, and increased Southern trade integration (i.e. an increase in η_S) results in*

i. *an increase in the Northern innovation rate ι and hence in the steady-state utility growth rate of both countries,*

ii. *an increase in the frequency of imitations per industry μ,*

iii. *an increase in the economy-wide Southern imitation rate $m \equiv \mu n_N$, and*

iv. *a decrease in the fraction of the Northern industries n_N.*

For sufficiently low τ_N and τ_S, it also results in

v. *a decrease in the relative Northern general-purpose wage rate w_{LN}.*

3.2 Unilateral Trade Liberalization

Since tariffs do not enter equations (32) and (33), a decrease in τ_N or τ_S does not affect the curves in Figure 3, and ι and μ remain unchanged. We begin with the technical analysis for τ_N. First, note that $c_N/(1+\tau_N)$ is pinned down by ι and μ in (27) independently of τ_N. It then follows that the $\tilde{Q}_N$ expression stated below (25) is also determined by ι and μ independently of τ_N. Given this, we observe from the FEIM condition (26) that the $\tilde{Q}_S$ expression becomes a function of ι and μ again independent of τ_N. With manufacturing levels not responding to Northern tariff changes, we immediately see from the labor market conditions that (30) and (31) that the industry-wide rates of innovation and imitation ι and μ are neutral to variations in τ_N.

---

[23] This restriction means that we are able to formally establish this result for $\tau_N = \tau_S = 0$, but obviously it holds for a full range of tariff rates, although the exact upper boundaries cannot be determined. These boundaries are consistent with our assumptions $\tau_N < w_{LN} - 1$ (which is necessary to ensure $\pi_S^N > 0$) and $\tau_S < (\lambda/w_{LN}) - 1$ (which is necessary to ensure $\pi_N^S > 0$).

[24] For proofs, see Appendix A.

To uncover the intuition, we analyze the FEIN and FEIM conditions holding ι and μ constant. First, a lower τ_N reduces the extent of protection granted to Northern firms in the domestic market. This cuts into their profit margins, forcing them to reduce their limit price p_N^N and thus their profits in the Northern market π_N^N decline. Second, a lower τ_N leads to a higher c_S through the BOT condition (22) and thus increases the Northern firms' profits in the Southern market π_N^S. To see this, note that a fall in τ_N increases the net-of-tariff price enjoyed by the Southern exporters, $w_{LN}/(1+\tau_N)$, implying a Southern Terms-of-Trade (TOT) improvement. Through the BOT condition, the improved Southern TOT allows for a higher Southern per-capita expenditure c_S. With π_N^N decreasing and π_N^S increasing, the net impact on Northern innovation profitability is ambiguous. Thus, the FEIN curve may shift up or down.

For the Southern imitators, the TOT improvement directly raises the profit margins on exports and thus leads to higher profits realized in the Northern market π_S^N. In addition, the higher c_S raises domestic market sales and thereby increases the profits in the Southern market π_S^S. As a result, Southern imitation profitability clearly increases. To restore equilibrium, c_N must decrease and the FEIM curve shifts down.

By differentiating (27) and (28), we conclude that for given levels of ι and μ, the fall in τ_N reduces both c_N and w_{LN}. To examine the change in c_S, we analyze the BOT condition (22), which implies that c_S decreases due to the fall in c_N and increases due to the fall in τ_N. Substituting for c_N from (27) into (22) reveals that the two effects exactly cancel out and there is no change in c_S.

We note the fall in c_N and w_{LN} for given levels of ι and μ and now analyze the labor markets. In the North, the lower c_N reduces the demand for labor (by decreasing sales and thus production) and the lower tariff τ_N increases it (by reducing product prices and boosting production). As noted above, the Northern firm's aggregate production $Q_N N_N$ is independent of τ_N; thus, the two effects cancel out, leaving the LABN equation unaffected. In the South, the lower c_N reduces the demand for labor (again via reduced sales) and the lower w_{LN} increases the demand for labor (again via lower prices). Since the Southern firm's aggregate production $Q_S N_N$ is independent of τ_N, the two effects cancel out and the LABS equation remains unaffected.

The technical analysis for τ_S is very similar. First, note that from (27) and (28), the ratio c_N/w_{LN} is independent of τ_S. It then follows that $\tilde{Q}_S$ expression stated below (26) is also a function of ι and μ independent of τ_S. Given this, we observe from the FEIM condition (26) that $\tilde{Q}_N$ is also pinned down by ι and μ independently of τ_S. With manufacturing levels not responding to Southern tariff changes, we immediately note from the labor market conditions (30) and (31) that ι and μ are neutral to variations in τ_S. The economic intuition can be uncovered via the same mechanisms as used for a decrease in τ_N.

To investigate the change in the equilibrium relative wage w_{LN}, we note that the equilibrium levels of ι and μ remain unchanged: thus the decline in w_{LN} established by the shifts in FEIN and FEIM curves remain intact. The intuition is that a lower τ_N decreases the Northern firm's profit margin but increases the Southern firm's profit margin, as implied by (29). This leads to a fall in the profitability of innovation relative to imitation and it follows from Lemma 1 that w_{LN} decreases. The opposite is true for a decline in τ_S. We summarize our findings in

Proposition 2: *Given that* (34) *is fulfilled, a unique steady-state equilibrium exists, and a reduction in the Southern [Northern] import tariff τ_S [τ_N] results in*

*i. no change in the Northern innovation rate ι or the frequency of imitations per industry μ, and therefore also no change in the fraction of the Northern industries n_N and the economy-wide Southern imitation rate $m \equiv \mu n_N$ ('**tariff-neutrality result**'),*

ii. an unambiguous increase [decrease] in the Northern general purpose wage rate w_{LN}.

We conclude that in our two-country monopolistic competition setting with a symmetric production and trade structure, and with consumption expenditure being proportional to tariffs by balanced trade, firm-level aggregate production $Q_N N_N$ and $Q_S N_N$ are independent of tariffs. The mechanism for this result follows from the three main conditions of the model: balanced trade, and free-entry in innovation and imitation. Consequently, changes in tariffs do not call for any reallocation between manufacturing and innovation or imitation. It should be noted that this neutrality result also holds with CES consumer preferences and monopolistic pricing, as is shown by Dinopoulos and Segerstrom (2007) in a setting with symmetric trade costs instead of tariffs.

4 Variations Of The Basic Model

4.1 Increased Southern Trade Integration with Southern Specialized Labor

How robust are the findings to incorporating Southern institutions that require employment of Southern resources for imitation-deterring activity? To check for this, we now assume that Northern firms hire Northern specialized labor for innovation-deterring activity, and Southern specialized labor for imitation-deterring activity, the latter being paid the Southern specialized wage rate w_{HS}. We denote the level of imitation (innovation)-deterring activities X_μ (X_ι) with corresponding unit-labor requirement γ_μ (γ_ι), and the share of specialized labor in the South is given by s_S. Innovation and imitation difficulty evolve according to $\dot{D}_\iota = n_N \delta_\iota X_\iota$ and $\dot{D}_\mu = n_N \delta_\mu X_\mu$, respectively. On the steady-state growth path, $\dot{D}_{\iota}/D_{\iota} = \dot{D}_{\mu}/D_{\mu} = n$. This, together with the new Southern specialized-labor market-clearing condition $n_N\gamma_\mu X_\mu = s_S N_S$, implies $D_\mu = (s_S N_S\delta_\mu)/(\gamma_\mu n)$.

The FEIN condition (25) remains the same (with only $\hat{A}_\iota \equiv (a_\iota\delta_\iota)/(n\gamma_\iota)$ replacing A_ι), whereas the RHS of the FEIM condition (26) becomes $\hat{A}_\mu s_S\eta_S$, with $\hat{A}_\mu \equiv (a_\mu\delta_\mu)/(n\gamma_\mu)$. Using this notation and D_μ from above, we present the new reduced-form equations for LABN(ι, μ) and LABS(ι, μ) in Appendix B. As before, the LABN curve is upward sloping and the LABS curve is downward sloping. To simplify the exposition, we set $\tau_N = \tau_S = 0$.

To investigate the impact of increased Southern trade integration, we first note that an increase in η_S does not affect the FEIN curve but shifts the FEIM curve upwards in Figure 2, hence both c_N and w_{LN} increase for given levels of ι and μ. Intuitively, an increase in η_S now renders more resources available for imitation-deterring activities and reduces the profitability of imitation. Restoring the free-entry condition requires an increase in c_N and hence an upward shift of the FEIM curve.

Next, to uncover the labor-market implications, we write the new labor market equilibrium conditions as

$$\frac{c_N(\iota,\mu,\eta_S)}{\lambda} + \hat{A}_\iota \iota s_N = 1 - s_N \qquad \textbf{LABN}(\iota,\mu), \tag{35}$$

$$\frac{c_N(\iota,\mu,\eta_S)\mu}{w_{LN}(\iota,\mu,\eta_S)\iota} + \frac{\hat{A}_\mu \mu s_S \iota \eta_S}{\iota+\mu} = (1-s_S)\eta_S \qquad \textbf{LABS}(\iota,\mu),^{25} \tag{36}$$

where the new solutions for w_{LN} and c_N are given in (B.4) and (B.5), respectively.

In the South, an increase in η_S raises the (relative) Southern labor supply and also labor demand via two channels. First, an increase in η_S raises the intensity of imitation-deterring activity per Northern worker D_μ/N_N, and thereby increases the resource requirement for imitation. Second, a higher η_S leads to an expansion in Southern manufacturing activity (formally, $\partial(c_N/w_{LN})/\partial\eta_S > 0$, see equation (B.6)) and puts more pressure on Southern resources. The direct increase in labor supply outweighs the increase in labor demand, creating room to expand imitation for any given ι, which explains the rightward shift of the LABS curve as in Figure 4 before.

[25] Equation (35) follows from (30) by using the definition of $\tilde{Q}_N$ from the line below (25), setting $\tau_N = \tau_S = 0$, and replacing A_ι by $\hat{A}_\iota$. Similarly, equation (36) follows from (31) by using the definition of $\tilde{Q}_S$ from the line below (26), setting $\tau_N = 0$, and replacing A_μ by $\hat{A}_\mu$ and (since now Southern workers are used for imitation-deterring activities) s_N by $s_S\eta_S$ on the LHS, and η_S by $(1-s_S)\eta_S$ on the RHS.

In the North, the increases in c_N triggered by the increase in η_S leads to an expansion in Northern manufacturing. To restore equilibrium in (35), there must be a decline in ι for a given μ, and hence the LABN curve shifts down (recall that aggregate labor demand in the North is increasing in ι). This is a new effect relative to the analysis illustrated in Figure 4 for the case of general RPAs performed only by Northern specialized workers. Hence, contrary to the basic setting in section 3.1, the net effect of increased Southern trade integration on the Northern innovation rate ι becomes ambiguous[26], whereas the Southern industry-wide imitation rate μ again increases.

To investigate the change in w_{LN}, we focus on the FEIN to FEIM ratio (B.3), which captures the relative innovation-imitation profitability. An increase in η_S now exerts a *direct* effect on innovation profitability by raising the amount of resources channeled to imitation-deterring activities (captured by the $\hat{A}_\mu s_S \eta_S$ term on the RHS of FEIM, see (B.2)). This raises D_μ/D_ι and implies an increase in the cost of imitation relative to innovation.[27] Thus, the direct effect works towards increasing the profitability of innovation relative to imitation. Simultaneously, as in the baseline model, there are two other effects. One is triggered by the increase in μ which works to decrease relative innovation profitability (as it increases the threat of replacement for innovators, but not for imitators) and the other is an ambiguous effect stemming from the ambiguous change in ι. Despite the presence of other effects, we find that the decisive force is the direct effect, and the profitability of innovation relative to imitation increases. It then follows from Lemma 1 that w_{LN} increases (see Appendix B for formal proof). Observe that this is the exact opposite of our finding from the baseline model where the effect of the increase in μ was the decisive force and caused a decrease in relative profitability of innovation and therefore a fall in w_{LN}. It follows our

Main Result 1: *When the institutional set-up requires Southern resources to be employed for imitation deterring activities, increased Southern trade integration will bring forth an expansion in imitation-deterring activities as well. Relative to the baseline model, this*

i. ***will*** *reverse the (negative) effect of increased Southern trade integration on the Northern general-purpose wage rate* w_{LN} *and*

ii. ***can*** *reverse the (positive) effect of increased Southern trade integration on the Northern innovation rate* ι *and thus global growth.*

To shed further light on the differential response of ι, we analyze the impact on the *absolute*

[26] Indeed, for a sufficiently low consumer discount rate $\rho - n$, one can show that the net impact on ι becomes unambiguously negative, see Appendix B.

[27] Note the crucial difference to the baseline setting: with only general RPAs in the North, Southern R&D difficulty cannot increase relative to Northern R&D difficulty since these are identical by assumption.

profitability of innovation. In both the baseline model, and the model with Southern-resource-using RPAs an increase in the relative size of the South η_S, as expected, generates an expansion in the imitation activities undertaken by the South, raising the frequency of imitations per industry μ. The higher imitation exposure shortens the duration of monopoly power for successful Northern innovators and induces them to intensify their imitation-deterring expenditures (note that the additional $\iota + \mu$ term in the discount factor of FEIN captures the impact of total rent protection costs on firm value). Clearly, in both settings, these two forces decrease the stock market valuation of Northern innovators and adversely affect innovation incentives in the North.

In the baseline model, the decline in w_{LN} more than compensates for the reduced innovation incentives by reducing both R&D and production costs. Hence the equilibrium innovation rate ι increases. In the model with Southern-resource-using RPAs, however, the rise in w_{LN} works to strengthen the negative innovation incentives. In addition, there is now a direct effect of a higher η_S that works through c_N. The mechanism is as follows. An increase in η_S raises imitation costs by increasing the intensity of imitation-deterring activities. The resulting decline in imitation profitability induces resources to move from imitation to Southern manufacturing. Through the BOT condition, this translates into increased expenditure in Northern products and thus an expansion in Northern manufacturing. Consequently, with both Northern and the Southern manufacturing expanding (i.e., c_N and c_S increasing), the profit flows enjoyed by Northern innovators increase. This direct effect is absent in the baseline model and can work to overturn the negative innovation incentives. Hence, the innovation rate ι can go either way. Observe that in the comparison of the two models, the differential response of the North-South general purpose wage rate w_{LN} and the direct impact of η_S on Northern per-capita expenditure c_N play crucial roles in determining the net change in innovation incentives and thus the change in ι.

4.2 Trade Liberalization With A Low-Tech Sector In The South

We now introduce inter-industry trade to our basic setup and reevaluate the tariff-neutrality result of proposition 2. We assume that in the South, there is an additional, perfectly competitive sector which produces a low-tech good Z according to the production function $Z_S = bL_Z$, where $b > 0$ is a productivity factor and L_Z is Southern labor input in Z production. The two distinctive features relative to the other ("high-tech") sector are that, first, no innovation targets the low-tech sector, and, second, the South is the sole producer of the low-tech good and thus becomes the net exporter of this product to the North.[28] The real wage received by Southern low-tech workers equals their mar-

[28] The modeling of the low-tech sector follows Grieben (2004, 2005).

ginal product b, hence $w_Z = bp_Z$, with p_Z being the supply price for Z. Since Southern workers are perfectly mobile between the high-tech and the low-tech sector, and the wage rate in the former is normalized to 1, the low-tech goods price is fixed to the unit labor requirement, $p_Z = 1/b$. This is also the price faced by Northern consumers, given that we assume free trade for low-tech goods (which is reasonable since there is no low-tech Northern industry to protect).

The reduced form of the instantaneous utility function (2) changes to

$$\log u_i(t) \equiv \alpha \int_0^1 \log\left[\frac{\lambda^{j(\omega,t)} c_i(t)}{p(\omega,t)}\right] d\omega + (1-\alpha)\log\left[\frac{z_i(t)}{p_Z}\right], \tag{37}$$

where $\alpha \in\,]0,1[$ is a taste parameter and $z_i(t)$ denotes the per-capita consumption expenditure for the low-tech goods at time t in country i. The household's optimization problem is to maximize discounted utility (1) with the subutility function (37) subject to the intertemporal budget constraint

$$WI_i(t) + FA_i(t) = \int_t^\infty e^{-[R(s)-R(t)]}\left[c_i(s) + z(s)\right] ds. \tag{38}$$

In (38), WI_i denotes the discounted wage income per capita of the representative household in country i from time t on, $FA_i(t)$ is the value of the financial assets per capita of the representative household in country i at time t, and $R(t) \equiv \int_0^t r(s)\, ds$ is the market discount factor with $\dot{R}(t) = r(t)$ denoting the instantaneous interest rate at time t. Appendix C derives the following additional condition for optimal consumer behavior in both countries:

$$c_i / z_i = \alpha/(1-\alpha) \qquad \text{for } i = N, S, \tag{39}$$

hence in each country, consumers spend a portion α on high-tech goods and the rest $(1-\alpha)$ of their expenditure on low-tech goods.

The free-entry conditions (25) and (26) remain unchanged because the functions for Northern and Southern monopoly profits, (5) and (6), do not change, respectively. The Northern general-purpose labor market clearing condition (30) also does not change since (18) is not affected, but the Southern labor market clearing condition (31) changes because we have to account for Southern labor demand in the low-tech sector L_Z. This is derived by imposing that the value of Northern low-tech consumption must equal the value of Southern low-tech exports:

$$z_N N_N = \frac{1-\alpha}{\alpha} c_N N_N \overset{!}{=} p_Z Z_S - z_S N_S = L_Z - \frac{1-\alpha}{\alpha} c_S N_S$$

$$\Leftrightarrow L_Z = \frac{1-\alpha}{\alpha}\left(c_N N_N + c_S N_S\right), \tag{40}$$

where we have used (39), $Z_S = bL_Z$, and $p_Z = 1/b$. The BOT condition now implies that the value of Northern exports of high-tech goods net of tariffs must equal the value of Southern high-tech exports net of tariffs plus the value of Southern low-tech exports, formally:

$$n_N \frac{c_S N_S}{\lambda} \frac{\lambda}{(1+\tau_S)} = n_S \frac{c_N N_N}{w_{LN}} \frac{w_{LN}}{(1+\tau_N)} + \frac{(1-\alpha) c_N N_N}{\alpha}$$

$$\Leftrightarrow \quad \frac{c_S}{c_N} = \frac{1+\tau_S}{n_N \eta_S}\left(\frac{n_S}{1+\tau_N} + \frac{1-\alpha}{\alpha}\right) = \frac{1+\tau_S}{\iota \eta_S}\left[\frac{\mu}{1+\tau_N} + \frac{(\iota+\mu)(1-\alpha)}{\alpha}\right] \qquad \mathbf{BOT}(c_N, c_S, \iota, \mu), \quad (41)$$

where (21) is used for the last equality. With (40) included and using (21), (20) is replaced by

$$\frac{Q_S(c_N, c_S)\mu}{\eta_S(\iota+\mu)} + \frac{A_\mu \mu s_N}{\eta_S} \frac{\iota}{\iota+\mu} + \frac{1-\alpha}{\alpha}\left(\frac{c_N}{\eta_S} + c_S\right) = 1 \qquad \mathbf{LABS}(c_N, c_S, \iota, \mu). \quad (42)$$

Setting (24) equal to (13), substituting for D from (10), then for Xn_N from (19), and imposing the new BOT condition (41), we obtain the new **FEIN**(c_N, w_{LN}, ι, μ) condition as

$$c_N \frac{\iota\left\{\frac{\lambda(1+\tau_N)}{\alpha} - w_{LN}\left[1+(1+\tau_N)(1+\tau_S)\frac{1-\alpha}{\alpha}\right]\right\} + \mu \frac{1+\tau_N(1-\alpha)}{\alpha}\left[\lambda - (1+\tau_S) w_{LN}\right]}{\iota\lambda(1+\tau_N)\left[\rho - n + 2(\iota+\mu)\right]} = A_\iota w_{LN} s_N . \quad (43)$$

Analogously, by setting (14) equal to (16), and using (6), (10), (19), and (41), we obtain the new **FEIM**(c_N, w_{LN}, ι, μ) condition as

$$c_N \frac{\iota\left\{-\frac{1+\tau_N}{\alpha} + w_{LN}\left[1+(1+\tau_N)(1+\tau_S)\frac{1-\alpha}{\alpha}\right]\right\} + \mu \frac{1+\tau_N(1-\alpha)}{\alpha}\left[w_{LN}(1+\tau_S) - 1\right]}{\iota w_{LN}(1+\tau_N)(\rho - n + \iota)} = A_\mu s_N . \quad (44)$$

The curve for (43) is unambiguously upward sloping and the curve for (44) is unambiguously downward sloping in (c_N, w_{LN})-space as in Figure 2. Solving (43) and (44) simultaneously for c_N and w_{LN} yields $c_N(\iota, \mu)$ and $w_{LN}(\iota, \mu)$, given in Appendix C. Using (41) and $c_N(\iota, \mu)$ in (30) gives again (32) as the upward-sloping **LABN**(ι, μ) condition since without low-tech production in the North, all terms containing α and the tariff rates just cancel out. Substituting $c_N(\iota, \mu)$ in (42) and using (41) gives a new expression for **LABS**(ι, μ) as stated in Appendix D, equation (D.1), which is downward sloping for sufficiently low tariff rates.

We now discuss the mechanisms by which trade liberalization affects the global economy.[29]

[29] Formal derivations for tariff results can be found in Appendix C. We should note that an increase in η_S generates the same effects as in the baseline model. It implies a rightward shift of the LABS curve, leading to higher levels of ι and μ. The steady-state North-South relative wage w_{LN} declines via the same mechanisms discussed in the baseline model.

As in our baseline model without a Southern low-tech sector, a decline in the Northern tariff rate τ_N reduces the level of c_N for given ι and μ. The mechanisms remain the same. A lower τ_N exerts two competing effects on Northern firms' profits: a negative through reduced protection in their domestic market, and a positive through a Southern TOT improvement which tends to increase c_S. With two competing effects on innovation profitability, the FEIN curve in Figure 2 may shift in either direction. In addition, a lower τ_N raises Southern firms' profits π_S by increasing $w_{LN}/(1+\tau_N)$ and c_S. To restore the FEIM condition (44), c_N must decline and hence the FEIM curve shifts down in Figure 2. The net effect of both curves' shifts implies again a lower c_N, see equation (C.7).

What is different in the model with the Southern low-tech sector is that the decline in τ_N now also reduces c_S, which was unaffected in the baseline model. To see the mechanism, focus on the first line of the BOT condition in (41). The lower τ_N directly increases c_S via the Southern TOT improvement and indirectly decreases c_S via the fall in c_N. The TOT-driven increase in c_S is independent of α and hence is as strong as in the baseline model, where $\alpha = 1$. Meanwhile the c_N-triggered decrease in c_S becomes larger in the model with a Southern low-tech sector, where $\alpha < 1$. The intuitive reasoning is that with $\alpha < 1$, the lower c_N not only reduces the net-of-tariff value of Southern high-tech exports $n_S c_N N_N/(1+\tau_N)$ but also the value of Southern low-tech exports $(1-\alpha)c_N N_N/\alpha$ because the consumer optimality condition (39) dictates a constant high-tech to low-tech spending ratio. Hence, c_S decreases due to two forces. We show formally in (C.8) that for $\alpha < 1$, the c_N-triggered decrease in c_S dominates the TOT-driven increase in c_S, and thus c_S declines.

With both c_N and c_S declining, the Southern low-tech sector unambiguously contracts, see the third term on the RHS of (42), and also (40). In addition, using (41), (C.5) and (C.6) reveals that Southern high-tech production per industry $Q_S N_N$ again is independent of tariffs, as in the baseline model. Thus, the decline in low-tech production creates room for an expansion in imitation activity, implying an increase in μ to clear the Southern labor market. Consequently, for a given ι, the LABS curve shifts to the right as in Figure 4. Since the LABN curve does not shift, the equilibrium levels of ι and μ both increase. Intuitively, the increase in ι follows from the upward sloping LABN curve: the decline in Northern labor demand triggered by a higher μ (which reduces Northern production labor demand by reducing the share of Northern industries n_N and also Northern consumption expenditure c_N) must be offset by a higher ι, which raises Northern employment in both production and R&D again.

We now investigate the impact of a decline in τ_S. It exerts two competing effects on π_N^P. First, a lower τ_S increases π_N^P by increasing the Northern net-of-tariff export revenue per unit, $\lambda/(1+\tau_S)$. Second, a lower τ_S decreases π_N^P by decreasing c_S through the BOT condition (41), which is triggered by the increase in the Northern net-of-tariff export price $\lambda/(1+\tau_S)$, a TOT deterioration for the South. The net effect turns out to be an increase in the Northern firms' profit flow. To restore equilibrium, c_N must decrease and the FEIN curve shifts down.

Next, a lower τ_S decreases Southern firms' profits π_S by reducing protection for Southern incumbents in the domestic market, which forces them to cut their limit price p_S^S. This effect is magnified by the fall in c_S driven by the Southern TOT deterioration. To restore the FEIM condition (44), c_N must increase, and the FEIM curve shifts up. The net effect of both curves' shifts in Figure 2 turns out to be that a lower τ_S increases c_N. To determine the change in c_S, we note from the BOT condition (41) that c_S increases with c_N and decreases with the Southern TOT deterioration. The net effect is a decrease in c_S.[30]

With c_N increasing and c_S decreasing, the net impact on the Southern low-tech sector appears ambiguous, but the c_N effect turns out to dominate (as long as $\tau_N > 0$, see (C.11)) and thus Southern low-tech sector employment L_Z increases. Since Southern high-tech production per industry $Q_S N_N$ is independent of τ_S, the expansion in the Southern low-tech sector leaves less resources for imitation, implying a decrease in μ to clear the Southern labor market. Consequently, for a given ι, the LABS curve shifts to the left, opposite to the situation shown in Figure 4. The equilibrium levels of both ι and μ decline. We summarize our findings in

Proposition 3: *In the neighborhood of sufficiently low but positive tariffs, a unilateral reduction of the Southern (Northern) import tariff τ_S (τ_N) results in a decrease (an increase) in the industry-wide rates of both Northern innovation and Southern imitation.*

The formal proof of Proposition 3, including the existence and uniqueness of equilibrium, is provided in Appendix D. We have also analyzed the effects of bilateral trade liberalization with $\Delta\tau_N = \Delta\tau_S < 0$ (which allows for different starting levels of tariff rates). The result is qualitatively equivalent to unilateral Northern trade liberalization, but the positive growth effect is obviously smaller since Southern trade liberalization works towards reducing innovation and growth (for details see Appendix E). These findings imply:

Main Result 2: *If a Southern low-tech sector is added to the baseline model of section 2, in the neighborhood of sufficiently low but positive tariffs*

[30] It should be noted that the positive response of c_S triggered by the increase in c_N is stronger when a Southern low-tech sector exists (i.e., the case with $\alpha < 1$). It follows from the BOT condition (41) that the c_N increase boosts the value of *both* Southern high-tech exports and low-tech exports for given n_S. Thus, in comparison to the baseline model of section 3.2, there is an additional increase in Southern exports due to the increase in low-tech exports, which ceteris paribus generates a further increase in c_S. This attenuates but not completely offsets the initial negative TOT effect on c_S.

i. Northern (Southern) unilateral trade liberalization unambiguously raises (reduces) growth in both countries; hence, the tariff-neutrality result of Proposition 2 no longer holds,

ii. bilateral trade liberalization has qualitatively the same but quantitatively a weaker implication for growth compared to unilateral Northern trade liberalization; this provides the North with an argument for 'going alone' in freeing trade.

Observe that in the model with the Southern low-tech sector, the additional export value due to Southern low-tech exports entering the new BOT condition (41) coupled with the required proportionality of high-tech and low-tech consumption expenditure from consumer optimization (39) play crucial roles in overturning the tariff-neutrality result of Proposition 2.[31]

5 Conclusions

We analyze the long-run economic growth effects of globalization in a fully-endogenous growth model that features rent-protection activities and is free of scale effects. We consider two aspects of globalization: increased North-South trade integration and incremental trade liberalization.

Our model provides a unique setting that highlights the economic consequences of increased trade integration of the South under different institutional set ups for RPAs. We find that when imitation-deterring activities use Northern resources (e.g., US firms hire US lawyers to lobby the US government for more strict IPR protection), increased North-South integration unambiguously increases Northern innovation and thus worldwide growth. However, when imitation-deterring activities use Southern resources (e.g., US firms hire Chinese lawyers for patent litigation cases in China), the positive growth effect can be reversed. Our results also highlight the need for more syste-

[31]The Appendices R.5 – R.8 (available upon request) show that our central findings are to a large extent robust to two alternative labor assignments. In the first alternative, we consider only one type of labor that can perform all three types of activities (production, R&D and RPAs). This model yields less than fully-endogenous growth in the sense that the rate of innovation ι is pinned down by a small subset of parameters, excluding tariff rates and η_S. Propositions 1 and 2 continue to hold with the only exception that in Proposition 2 an increase in η_S now exerts no effect on ι. Thus, the innovation effects stated in part ii. of Main Result 1 and Proposition 3 are effectively muted. However, part i. of Main Result 1 remains fully intact. In the second alternative, we consider two types of labor as in the baseline model. We assume that Northern general-purpose labor is mobile between R&D, manufacturing and also RPAs, while specialized labor performs only RPAs as before. This model resurrects fully-endogenous growth, in the sense that ι responds to most of the model's parameters, excluding tariff rates but including η_S, as in the baseline model. Propositions 1 and 2 continue to hold. Main Result 1 part ii. still continues to hold, whereas part i. can no longer be checked analytically. With RPA using two types of labor and the South having a low-tech sector the model becomes too complex to analytically check the robustness of Proposition 3. We conjecture though that in this case there will at least be a range for the share of specialized labor in unit-production costs of RPA $\beta \in (\beta^{min}, 1)$ in which the results from the baseline model will hold, where $\beta = 1$ is the case considered in the main text. See Şener (2008, pp. 3912-3913) for further discussion of such robustness checks in a similar but closed economy setting.

matic data collection on the location of these RPAs, which may pave the way for more empirical research on this issue.

We also show that the sectoral production and trade structures are important in determining the effects of incremental tariff reductions. We show that when the production and trade structures are symmetric between the countries (one-sector economy in both countries), tariffs do not matter for long-run growth at all. This finding is shown to be robust to various alternative specifications concerning other aspects of the model. Since many low-tech industries are vanishing in high-wage Northern countries, an asymmetric production and trade structure with a low-tech industry located only in the developing South appears to be the more empirically relevant case. We show that in this case, Northern (Southern) unilateral trade liberalization is conducive (detrimental) for Northern innovation and worldwide long-run growth.

From a theoretical perspective, we clarify for the first time the precise channels by which unilateral Northern and Southern trade liberalization affect long-run growth in a Schumpeterian model without scale effects. From a policy perspective, two strong recommendations follow: **first**, the South's refusal to reduce its trade barriers should not be an excuse for the North to refrain from trade liberalization as well (contrary to what is regularly observed at WTO negotiations). **Second**, by imposing import tariffs on Southern imitated goods, the North can reduce the threat of Southern imitation, but in general equilibrium, this hurts the North by leading to lower rates of innovation and growth.

Appendices

Appendix A: Proof of Proposition 1[32]

Applying Cramer's rule for the system of two equations (32) and (33), we obtain

$$\begin{pmatrix} \dfrac{\partial \iota}{\partial \eta_S} \\ \\ \dfrac{\partial \mu}{\partial \eta_S} \end{pmatrix} = \begin{pmatrix} \dfrac{\iota\left[A_\iota\left(\rho-n\right)+A_\mu\left(\rho-n+\iota\right)\right]K_1}{\eta_S\left(K_2+K_3+K_4\right)}>0 \\ \\ \dfrac{\left\{A_\mu\left[\iota^2+\left(\rho-n\right)\mu+2\iota\mu\right]+A_\iota\left[\left(\rho-n\right)\mu+\left(1+\lambda\right)\left(\iota+\mu\right)^2\right]\right\}K_1}{\eta_S\left(K_2+K_3+K_4\right)}>0 \end{pmatrix} \tag{A.1}$$

where

$$K_1 \equiv \mu\left\{A_\mu\left(\rho-n+\iota\lambda\right)+A_\iota\lambda\left[\rho-n+2\left(\iota+\mu\right)\right]\right\}>0,$$

[32] Here we provide the main results of a corresponding Mathematica© program which is available from the authors upon request.

$$K_2 \equiv A_\iota A_\mu(\iota+\mu)\{\iota[\rho-n+2\lambda(\rho-n)+\iota\lambda(3+\lambda)]+2(\rho-n+2\iota)\lambda\mu\}>0,$$

$$K_3 \equiv A_\iota^2\lambda(\iota+\mu)\left[2(1+\lambda)(\iota+\mu)^2+(\rho-n)(\iota+\iota\lambda+2\mu)\right]>0,$$

$$K_4 \equiv A_\mu^2\iota[\iota\lambda(\iota+\mu)+(\rho-n)(\iota+\lambda\mu)]>0.$$

From $m \equiv \mu n_N = \mu\iota/(\iota+\mu)$, it follows $\partial m/\partial\eta_S = \left(\frac{\mu}{\iota+\mu}\right)^2\frac{\partial\iota}{\partial\eta_S}+\left(\frac{\iota}{\iota+\mu}\right)^2\frac{\partial\mu}{\partial\eta_S} > 0$. From $n_N = \iota/(\iota+\mu)$, it follows $\partial n_N/\partial\eta_S = \left(\frac{1}{\iota+\mu}\right)^2\left(\mu\frac{\partial\iota}{\partial\eta_S}-\iota\frac{\partial\mu}{\partial\eta_S}\right)$, which gives

$$\frac{\partial n_N}{\partial\eta_S} = -\frac{\iota[A_\mu\iota+A_\iota(1+\lambda)(\iota+\mu)]K_1}{\eta_S(\iota+\mu)(K_2+K_3+K_4)}<0. \tag{A.2}$$

Finally, evaluating (28) for $\tau_N = \tau_S = 0$, differentiating with respect to η_S and using (A.1) gives

$$\left.\frac{\partial w_{LN}}{\partial\eta_S}\right|_{\tau_N=\tau_S=0} = -\frac{A_\iota A_\mu(\lambda-1)\lambda K_1(K_5+K_6+K_7)}{\eta_S\{A_\mu(\rho-n+\iota)+A_\iota\lambda[\rho-n+2(\iota+\mu)]\}^2(K_2+K_3+K_4)}<0 \tag{A.3}$$

where

$$K_5 = \iota(\rho-n)[(\rho-n)(A_\iota+A_\mu)+\iota A_\mu]>0,$$

$$K_6 = 2(\rho-n)\{(\rho-n)A_\iota\mu+A_\mu[\iota^2+\mu(\rho-n+2\iota)]\}>0,$$

$$K_7 = 2(\iota+\mu)\left[A_\iota(1+\lambda)(\iota+\mu)(\rho-n+\iota)+A_\mu\iota^2\right]>0.$$

Appendix B: Technical Details for Section 4.1

The FEIN and FEIM equations are:

$$\frac{c_N(\iota+\mu)(\lambda-w_{LN})}{\iota\lambda[\rho-n+2(\iota+\mu)]} = \hat{A}_\iota w_{LN}s_N \qquad \textbf{FEIN}(c_N, w_{LN}, \iota, \mu), \tag{B.1}$$

$$\frac{c_N(\iota+\mu)(w_{LN}-1)}{\iota w_{LN}(\rho-n+\iota)} = \hat{A}_\mu s_S\eta_S \qquad \textbf{FEIM}(c_N, w_{LN}, \iota, \mu). \tag{B.2}$$

Taking the ratio of (B.1) and (B.2) gives the relative-profitability condition

$$\frac{\lambda-w_{LN}}{\lambda(w_{LN}-1)}\cdot\frac{\rho-n+\iota}{\rho-n+2(\iota+\mu)} = \frac{\hat{A}_\iota s_N}{\hat{A}_\mu s_S\eta_S}. \tag{B.3}$$

Solving (B.1) and (B.2) simultaneously for w_{LN} and c_N gives

$$w_{LN} = \frac{\lambda\left\{\hat{A}_\iota s_N\left[\rho - n + 2(\iota+\mu)\right] + \hat{A}_\mu s_S \eta_S(\rho - n + \iota)\right\}}{\lambda\hat{A}_\iota s_N\left[\rho - n + 2(\iota+\mu)\right] + \hat{A}_\mu s_S \eta_S(\rho - n + \iota)}, \tag{B.4}$$

$$c_N = \frac{\iota\lambda\left\{\hat{A}_\iota s_N\left[\rho - n + 2(\iota+\mu)\right] + \hat{A}_\mu s_S \eta_S(\rho - n + \iota)\right\}}{(\lambda-1)(\iota+\mu)}. \tag{B.5}$$

The ratio c_N/w_{LN} is then found as

$$\frac{c_N}{w_{LN}} = \frac{\iota\left\{\lambda\hat{A}_\iota s_N\left[\rho - n + 2(\iota+\mu)\right] + \hat{A}_\mu s_S \eta_S(\rho - n + \iota)\right\}}{(\lambda-1)(\iota+\mu)}, \tag{B.6}$$

which is unambiguously increasing in η_S. Substituting (B.5) in (35), LABN becomes

$$\frac{\iota\left\{\hat{A}_\iota s_N\left[\rho - n + (\iota+\mu)(1+\lambda)\right] + \hat{A}_\mu s_S \eta_S(\rho - n + \iota)\right\}}{(\lambda-1)(\iota+\mu)} = 1 - s_N \qquad \mathbf{LABN}(\iota,\mu), \tag{B.7}$$

which is unambiguously upward sloping in (ι, μ)-space as before. Substituting (B.6) in (36), LABS becomes

$$\frac{\mu\left\{\lambda\hat{A}_\iota s_N\left[\rho - n + 2(\iota+\mu)\right] + \hat{A}_\mu s_S \eta_S(\rho - n + \iota\lambda)\right\}}{\eta_S(\lambda-1)(\iota+\mu)} = 1 - s_S \qquad \mathbf{LABS}(\iota,\mu), \tag{B.8}$$

The LHS of (B.8) is unambiguously increasing in μ, and it is increasing in ι if, and only if,

$$\mu > (\rho - n)\left(\frac{1}{\lambda} + \frac{\hat{A}_\iota s_N}{\hat{A}_\mu s_S \eta_S}\right) \tag{B.9}$$

is fulfilled, which corresponds to (34). Given this, the curve for the LABS equation (B.8) is downward sloping in (ι, μ)-space as before.

To sign $\partial\iota/\partial\eta_S$ and $\partial w_{LN}/\partial\eta_S$[33], we apply Cramer's rule to the system of two equations (B.7) and (B.8):

$$\begin{pmatrix} \dfrac{\partial\iota}{\partial\eta_S} \\ \dfrac{\partial\mu}{\partial\eta_S} \end{pmatrix} = \begin{pmatrix} -\dfrac{\iota(K_8 + K_9)}{\eta_S\left(s_N s_S \eta_S K_2 + s_N^2 K_3 + s_S^2 \eta_S^2 K_4\right)} \\ \dfrac{\mu(K_{10} - K_{11} + K_{12})}{\eta_S\left(s_N s_S \eta_S K_2 + s_N^2 K_3 + s_S^2 \eta_S^2 K_4\right)} \end{pmatrix} \tag{B.10}$$

where

[33] We provide the main results of a corresponding Mathematica© program which is available upon request.

$$K_8 \equiv s_S^2 \eta_S^2 A_\mu^2 \iota(\rho - n + \iota)(\rho - n + \iota\lambda) - s_N^2 \mu A_\iota^2 \lambda(\rho - n)[\rho - n + 2(\iota + \mu)] \lesseqgtr 0,$$

$$K_9 \equiv s_N s_S \eta_S A_\iota A_\mu \lambda(\rho - n + \iota)[(\rho - n)(\iota - \mu) + 2\iota(\iota + \mu)] \lesseqgtr 0,$$

$$K_{10} \equiv A_\iota^2 s_N^2 \lambda[\rho - n + 2(\iota + \mu)][(\rho - n)\mu + (1 + \lambda)(\iota + \mu)^2] > 0 \ ,$$

$$K_{11} \equiv A_\mu^2 \iota(\rho - n + \iota) s_S^2 \eta_S^2 (\rho - n - \mu\lambda) \lesseqgtr 0,$$

$$K_{12} \equiv s_N s_S \eta_S A_\iota A_\mu \lambda[(\rho - n)^2 (\mu - \iota) + 2(\rho - n)\mu(2\iota + \mu) + 2\iota(\iota + \mu)(\iota + 2\mu)] \lesseqgtr 0.$$

From the first line of (B.10) and the definitions of K_8 and K_9 it immediately follows that $\partial\iota/\partial\eta_S < 0$ for a sufficiently small discount rate $\rho - n$.

Differentiating (B.4) with respect to η_S and using (B.10) gives

$$\frac{\partial w_{LN}}{\partial \eta_S} = \frac{s_N s_S (\lambda - 1)\lambda A_\iota A_\mu \iota\left(s_N^2 A_\iota^2 \lambda K_{13} + s_S^2 \eta_S^2 A_\mu^2 K_{14} + s_N s_S \eta_S A_\iota A_\mu K_{15}\right)}{\left\{s_N A_\iota \lambda[\rho - n + 2(\iota + \mu)] + s_S \eta_S A_\mu (\rho - n + \iota)\right\}^2 K_{16}} > 0 \ , \tag{B.11}$$

where

$$K_{13} \equiv \{\iota(\rho - n + \iota)(1 + \lambda) + [2(\rho - n) + \iota + (\rho - n + \iota)\lambda]\mu\}[\rho - n + 2(\iota + \mu)]^2 > 0 \ ,$$

$$K_{14} \equiv (\rho - n + \iota)^2 [2(\rho - n)\iota + (\rho - n)(2 + \lambda)\mu + 2\iota\lambda(\iota + \mu)] > 0 \ ,$$

$$K_{15} \equiv (\rho - n + \iota)[\rho - n + 2(\iota + \mu)][\iota\lambda(3 + \lambda)(\iota + \mu) + (\rho - n)(\iota + 3\iota\lambda + \mu + 5\lambda\mu)] > 0 \ ,$$

$$K_{16} \equiv s_N s_S \eta_S K_2 + s_N^2 K_3 + s_S^2 \eta_S^2 K_4 > 0 \ .$$

Appendix C: Technical Details of Section 4.2

To solve the household's optimization problem of maximizing (1) subject to (37) and (38), we define a new state variable Θ with

$$\dot{\Theta}(s) = e^{-[R(s) - R(t)]}[c_i(s) + z_i(s)], \quad \Theta(0) = 0, \quad \text{and} \quad \lim_{s\to\infty} \Theta(s) = WI_i(t) + FA_i(t) \ .$$

With $p_Z = 1/b$, the present-value Hamilton function can be written as

$$H(\Theta, c_i, z_i, \chi, t) = e^{-\rho s}\{\alpha \log[c_i(s)] + (1 - \alpha)\log[b z_i(s)]\} + \chi(s) e^{-[R(s) - R(t)]}[c_i(s) + z_i(s)] \tag{C.1}$$

with $\chi(s)$ as the new costate variable corresponding to $\Theta(s)$. The costate equation $\partial H/\partial\Theta = 0 = -\dot{\chi}$ implies $\chi(s) = \chi\ \forall\ s$. Applying Pontryagin's maximum principle yields the other foc:

$$\partial H/\partial c_i(s) = e^{-\rho s}[\alpha/c_i(s)] + \chi e^{-[R(s) - R(t)]} \overset{!}{=} 0 \ , \tag{C.2}$$

$$\partial H/\partial z_i(s) = e^{-\rho s}\left[(1-\alpha)/z_i(s)\right] + \chi e^{-[R(s)-R(t)]} \stackrel{!}{=} 0 . \tag{C.3}$$

Differentiating (C.3) with respect to time *s*, and applying $\dot{R}(s) \equiv r(s)$ and (C.3) yields the optimal consumption path for low-tech goods

$$\dot{z}_i(t)/z_i(t) = r(t) - \rho \qquad \text{with } i = N, S. \tag{C.4}$$

Dividing (C.2) by (C.3) yields equation (39) of the main text.

Solving the new FEIN equation (43) and the new FEIM equation (44) simultaneously for c_N and w_{LN} yields:

$$c_N(\iota,\mu) = \frac{\iota s_N \lambda(1+\tau_N)\left\{A_\iota\left[\rho-n+2(\iota+\mu)\right] + A_\mu(\rho-n+\iota)\right\}}{(\lambda-1)\left\{\iota\left[1+\frac{1-\alpha}{\alpha}(1+\tau_N)(1+\tau_S)\right] + \frac{\mu}{\alpha}\left[1+\tau_N(1-\alpha)\right](1+\tau_S)\right\}}, \tag{C.5}$$

$$w_{LN}(\iota,\mu) = \frac{\lambda\left\{A_\iota\left[\rho-n+2(\iota+\mu)\right] + A_\mu(\rho-n+\iota)\right\}}{\left\{A_\iota\lambda\left[\rho-n+2(\iota+\mu)\right] + A_\mu(\rho-n+\iota)\right\}} \times \frac{\left\{\frac{\iota}{\alpha}(1+\tau_N) + \frac{\mu}{\alpha}\left[1+\tau_N(1-\alpha)\right]\right\}}{\left\{\iota\left[1+\frac{1-\alpha}{\alpha}(1+\tau_N)(1+\tau_S)\right] + \frac{\mu}{\alpha}\left[1+\tau_N(1-\alpha)\right](1+\tau_S)\right\}}, \tag{C.6}$$

where setting $\alpha = 1$ in (C.5) and (C.6) yields the baseline model's solutions (27) and (28), respectively. $c_N(\iota, \mu)$ is unambiguously increasing in τ_N:

$$\frac{\partial c_N}{\partial \tau_N} = \frac{\iota s_N \lambda\left\{A_\mu\left[\rho-n+\iota\right] + A_\iota\left[\rho-n+2(\iota+\mu)\right]\right\}\left[\iota+\mu(1+\tau_S)\right]}{(\lambda-1)\left\{(\iota+\mu)\frac{1}{\alpha}\left[1+(1-\alpha)\tau_N\right] + \tau_S\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]\right\}^2} > 0 . \tag{C.7}$$

Using (C.5) and (41) shows that $c_S(\iota, \mu)$ is also unambiguously increasing in τ_N:

$$\frac{\partial c_S}{\partial \tau_N} = \frac{\frac{1-\alpha}{\alpha}\iota s_N \lambda(\iota+\mu)(\iota+\tau_S)\left\{A_\mu\left[\rho-n+\iota\right] + A_\iota\left[\rho-n+2(\iota+\mu)\right]\right\}}{\eta_S(\lambda-1)\left\{(\iota+\mu)\frac{1}{\alpha}\left[1+(1-\alpha)\tau_N\right] + \tau_S\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]\right\}^2} > 0 . \tag{C.8}$$

$c_N(\iota, \mu)$ is unambiguously decreasing in τ_S:

$$\frac{\partial c_N}{\partial \tau_S} = -\frac{\iota s_N \lambda\left\{A_\mu\left[\rho-n+\iota\right] + A_\iota\left[\rho-n+2(\iota+\mu)\right]\right\}(1+\tau_N)\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]}{(\lambda-1)\left\{(\iota+\mu)\frac{1}{\alpha}\left[1+(1-\alpha)\tau_N\right] + \tau_S\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]\right\}^2} < 0 . \tag{C.9}$$

$c_S(\iota, \mu)$ is also unambiguously increasing in τ_S:

$$\frac{\partial c_S}{\partial \tau_S} = \frac{\iota s_N \lambda\left\{A_\mu\left[\rho-n+\iota\right] + A_\iota\left[\rho-n+2(\iota+\mu)\right]\right\}(1+\tau_N)\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]}{\eta_S(\lambda-1)\left\{(\iota+\mu)\frac{1}{\alpha}\left[1+(1-\alpha)\tau_N\right] + \tau_S\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]\right\}^2} > 0 . \tag{C.10}$$

To determine the sign of $\partial L_Z/\partial \tau_S$, we evaluate the following expression:

$$\frac{\partial\left(\frac{c_N}{\eta_S}+c_S\right)}{\partial \tau_S} = -\frac{\iota s_N \lambda\left\{A_\mu\left[\rho-n+\iota\right]+A_\iota\left[\rho-n+2(\iota+\mu)\right]\right\}\tau_N\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]}{\eta_S(\lambda-1)\left\{(\iota+\mu)\frac{1}{\alpha}\left[1+(1-\alpha)\tau_N\right]+\tau_S\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]\right\}^2} < 0 . \quad \text{(C.11)}$$

Appendix D: Proof of Proposition 3

Using (41), (C.5), (C.6) and the expression for $Q_S(c_N, c_S)$ in (42) gives the new **LABS**(ι, μ):

$$\frac{\mu s_N\left\{A_\iota\lambda\left[\rho-n+2(\iota+\mu)\right]+A_\mu(\rho-n+\iota\lambda)\right\}}{\eta_S(\lambda-1)(\iota+\mu)} + \frac{(1-\alpha)s_N\lambda\left\{A_\iota\left[\rho-n+2(\iota+\mu)\right]+A_\mu(\rho-n+\iota)\right\}K(\iota,\mu,\tau_N,\tau_S)}{\alpha\eta_S(\lambda-1)} = 1 \qquad \mathbf{LABS}(\iota,\mu) \quad \text{(D.1)}$$

with $$K(\iota,\mu,\tau_N,\tau_S) \equiv \frac{\iota\left[1+\frac{1-\alpha}{\alpha}(1+\tau_S)\right](1+\tau_N)+\frac{\mu}{\alpha}\left[1+\tau_N(1-\alpha)\right](1+\tau_S)}{\iota\left[1+\frac{1-\alpha}{\alpha}(1+\tau_N)(1+\tau_S)\right]+\frac{\mu}{\alpha}\left[1+\tau_N(1-\alpha)\right](1+\tau_S)} \equiv \frac{num}{den} ,$$

where the baseline model's (33) is obtained for $\alpha = 1$ again. We consider the slope of LABS(ι, μ) curve in the neighborhood of $\tau_N = \tau_S = 0$, which implies $K(.) = 1$. It then follows that the LHS of (D.1) is unambiguously increasing in μ, whereas it is unambiguously increasing in ι if, and only if,

$$\frac{\mu\left[A_\mu(\lambda\mu-\rho+n)-\lambda A_\iota(\rho-n)\right]}{(\iota+\mu)^2} + \frac{(1-\alpha)\lambda(2A_\iota+A_\mu)}{\alpha} > 0 . \quad \text{(D.2)}$$

Observe that the first term of (D.2) is positive if, and only if, condition (34) holds, hence (D.2) is actually a weaker condition than (34). Thus, provided (34) holds, the LABS(ι, μ) curve is again strictly downward sloping and the uniqueness of the steady-state equilibrium is established. Existence of this equilibrium is ensured by the facts that, as in Figure 3, the LABS curve (D.1) does not intersect the vertical axis even for $\iota \to \infty$ because (D.2) ensures $\mu > 0$, and the LABN curve (32) is concave and solved by a $\iota > 0$ for $\mu \to 0$.

Differentiating the K-function with respect to the tariff rates under $\tau_N > 0$ and $\tau_S > 0$ yields

$$\frac{\partial K(\bullet)}{\partial \tau_N} = \frac{\iota\mu(1+\tau_S)+\iota^2\left[1+\tau_S(1-\alpha)\right]}{\alpha(den)^2} > 0 , \quad \text{(D.3)}$$

$$\frac{\partial K(\bullet)}{\partial \tau_S} = -\frac{\iota\tau_N\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]}{den^2} < 0 . \quad \text{(D.4)}$$

We now discuss the implications for shifts in the LABN and LABS curves. A decrease in τ_N unambiguously reduces the LHS of (D.1), hence μ must increase to restore Southern labor market equilibrium for any given ι. Thus, the LABS(ι, μ) curve shifts to the right, whereas the LABN(ι, μ) curve still given by (32) is unaffected. This results in a joint increase in both ι and μ. A decrease in τ_S has the opposite effects: according to (D.4), the LHS of (D.1) increases, hence μ must decrease to restore Southern labor market equilibrium for any given ι. Thus, the LABS(ι, μ) curve shifts to the left, whereas the LABN(ι, μ) curve is again unaffected. This results in a joint decrease in both ι and μ, which completes the proof.

Appendix E: Bilateral Trade Liberalization

To capture bilateral trade liberalization, we consider a simultaneous decline in both τ_N and τ_S by the same amount, $d\tau_N = d\tau_S$. We allow for differences in the levels of tariffs though. Since only the LABS equation (D.1) but not the LABN equation (32) has tariffs in it, we only need to totally differentiate the LHS of (D.1) with respect to τ_N and τ_S and impose $d\tau_N = d\tau_S = d\tau$, which gives

$$-\frac{d\tau \iota s_N \frac{1-\alpha}{\alpha}\lambda\left\{A_\iota\left[\rho-n+2(\iota+\mu)\right]+A_\mu(\rho-n+\iota)\right\}K_{17}}{\eta_S(\lambda-1)\left\{(\iota+\mu)\left[1+\frac{1-\alpha}{\alpha}(1+\tau_N)\right]+\left[\mu+\frac{1-\alpha}{\alpha}(\iota+\mu)(1+\tau_N)\right]\tau_S\right\}^2}, \tag{E.1}$$

where $K_{17} \equiv \iota\left[-1+\frac{1-\alpha}{\alpha}\left(-1+\tau_N+\tau_N^2-\tau_S\right)\right]+\mu\left[-1+\tau_N+\frac{1-\alpha}{\alpha}\left(-1+\tau_N+\tau_N^2-\tau_S\right)-\tau_S\right]$. A sufficient condition for $K_{17} < 0$ is $-1+\frac{1-\alpha}{\alpha}\left(-1+\tau_N+\tau_N^2-\tau_S\right)<0$, for which $\tau_N(1+\tau_N) < 1+\tau_S$ is sufficient, for which in turn $\tau_N(1+\tau_N) < 1$ is sufficient. This latter condition is fulfilled for any $\tau_N \in (0, 0.618034)$. Hence for this reasonable range, a fall in τ_N and τ_S by the same size reduces the LHS of (D.1). To restore equilibrium, there must be an increase in μ and thus a rightward shift of the LABS curve as in Figure 4. Consequently, the levels of both μ and ι increase, which proves the qualitative equivalence of bilateral trade liberalization with unilateral Northern trade liberalization as is claimed in part iii. of our Main Result 2.

References

Baldwin, R. E. and Forslid, R., 1999. Incremental Trade Policy and Endogenous Growth: A q-Theory Approach. Journal of Economic Dynamics and Control 23(5-6), 797-822.

Ben-David, D. and Loewy, M. B., 2000. Knowledge Dissemination, Capital Accumulation, Trade, and Endogenous Growth. Oxford Economic Papers 52(4), 637-650.

Berrier, E.F., 1996. Global Patent Cost Must Be Reduced. IDEA The Journal of Law and Technology 36, 473-511.

Christiaans, T., 2004. Types of Balanced Growth. Economics Letters 82(2), 253-258.

Dalgaard, C.-J. and Kreiner, C. T., 2001. Is Declining Productivity Inevitable? Journal of Economic Growth 6(3), 187-203.

Dinopoulos, E. and Segerstrom, P. S., 1999a. A Schumpeterian Model of Protection and Relative Wages. American Economic Review 89(3), 450-472.

Dinopoulos, E. and Segerstrom, P. S., 1999b. The dynamic effects of contingent tariffs. Journal of International Economics 47(1), 191-222.

Dinopoulos, E. and Segerstrom, P. S., 2007. North-South Trade and Economic Growth. Manuscript, University of Florida and Stockholm School of Economics.

Dinopoulos, E. and Segerstrom, P. S., 2009. Intellectual Property Rights, Multinational Firms and Economic Growth. Journal of Development Economics, in press, doi:10.1016/j.jdeveco.2009.01.007.

Dinopoulos, E. and Syropoulos, C., 1997. Tariffs and Schumpeterian Growth. Journal of International Economics 42(3-4), 425-452.

Dinopoulos, E. and Syropoulos, C., 2007. Rent Protection as a Barrier to Innovation and Growth. Economic Theory 32(2), 309-332.

Dinopoulos, E. and Thompson, P., 1999. Scale Effects in Schumpeterian Models of Economic Growth. Journal of Evolutionary Economics 9(2), 157-185.

Grieben, W.-H., 2004. Schumpeterian Growth, North-South Trade and Wage Rigidity. Contributions to Macroeconomics 4(1), Article 9.

Grieben, W.-H., 2005. A Schumpeterian North-South Growth Model of Trade and Wage Inequality. Review of International Economics 13(1), 106-128.

Grieben, W.-H., 2009. Can Countries With Severe Labor Market Frictions Gain From Globalization? Review of Development Economics 13(2), 230-247.

Grossman, G. and Helpman, E., 1991. Endogenous Product Cycles. Economic Journal 101, 1214-1229.

Gustafsson, P. and Segerstrom, P., 2008. North-South Trade with Multinational Firms and Increasing Product Variety. Manuscript, NIER Stockholm and Stockholm School of Economics.

Ha, J. and Howitt, P., 2007. Accounting for Trends in Productivity and R&D: A Schumpeterian Critique of Semi-Endogenous Growth Theory. Journal of Money, Credit, and Banking 39(4), 733-774.

Hallak, J. C. and Levinsohn, J., 2008. Fooling Ourselves: Evaluating the Globalization and Growth

Debate. In: Zedillo, E. (Ed.), The Future of Globalization: Explorations in Light of Recent Turbulence. Routledge, pp. 209-223.

Howitt, P., 1999. Steady Endogenous Growth With Population and R&D Inputs Growing. Journal of Political Economy 107(4), 715-730.

Jones, C. I., 1995a. Time Series Tests of Endogenous Growth Models. Quarterly Journal of Economics 110(2), 495-525.

Jones, C. I., 1995b. R&D-Based Models of Economic Growth. Journal of Political Economy 103(4), 759-784.

Jones, C. I., 1999. Growth: With or Without Scale Effects? American Economic Review 89(2), 139-144.

Jones, C. I., 2005. Growth and Ideas. In: Aghion, P. and Durlauf, S. (Eds.), Handbook of Economic Growth, vol. 1B. North-Holland, Amsterdam, pp. 1063-1111.

Laincz, C. A. and Peretto, P. F., 2006. Scale Effects in Endogenous Growth Theory: An Error of Aggregation Not Specification. Journal of Economic Growth 11(3), 263-288.

Lewer, J. J. and Van den Berg, H., 2003. How Large is International Trade's Effect On Economic Growth? Journal of Economic Surveys 17(3), 363-396.

Lanjouw, J.O. and Cockburn, I., 2000. Do Patents Matter? Empirical Evidence After GATT. NBER Working Paper No. 7495.

Lu, C.-H., 2007. Moving Up or Moving Out? A Unified Theory of R&D, FDI, and Trade. Journal of International Economics 71(2), 324-343.

Lucas, R. E. Jr., 2009. Trade and the Diffusion of the Industrial Revolution. American Economic Journal: Macroeconomics 1(1), 1-25.

Madsen, J. B., 2007. Are There Diminishing Returns to R&D? Economics Letters 95(2), 161-166.

Madsen, J. B., 2008. Semi-endogenous Versus Schumpeterian Growth Models: Testing the Knowledge Production Function Using International Data. Journal of Economic Growth 13(1), 1-26.

Neary, J. P., 2004. Europe on the Road to Doha: Towards a New Global Trade Round? CESifo Economic Studies 50(2), 319-332.

Noguer, M. and Siscart, M., 2005. Trade Raises Income: A Precise and Robust Result. Journal of International Economics 65(2), 447-460.

Peretto, P. F., 1998. Technological Change and Population Growth. Journal of Economic Growth 3(4), 283-311.

Peretto, P. F. and Smulders, S., 2002. Technological Distance, Growth and Scale Effects. Economic Journal 112(481), 603-624.

Rivera-Batiz, L. A. and Romer, P. M., 1991. Economic Integration and Endogenous Growth. Quarterly Journal of Economics 106(2), 531-555.

Rodríguez, F. and Rodrik, D., 2000. Trade Policy and Economic Growth: A Skeptics Guide to the Cross-National Evidence. In: Bernanke, B. and Rogoff, K. (Eds.), NBER Macroeconomics Annual, vol. 15. MIT Press, Cambridge, pp. 261-325.

Scotchmer, S., 2004. Innovation and Incentives. MIT Press, Cambridge, MA.

Segerstrom, P. S., 1998. Endogenous Growth Without Scale Effects. American Economic Review 88(5), 1290-1310.

Segerstrom, P. S., 2000. The Long-Run Growth Effects of R&D Subsidies. Journal of Economic Growth 5(3), 277-305.

Şener, F., 2001. Schumpeterian Unemployment, Trade and Wages. Journal of International Economics 54(1), 119-148.

Şener, F., 2006. Intellectual Property Rights and Rent Protection in a North-South Product-Cycle Model. Manuscript, Union College, Schenectady.

Şener, F., 2008. R&D Policies, Endogenous Growth and Scale Effects. Journal of Economic Dynamics and Control 32(12), 3895-3916.

Şener, F. and Zhao, L. 2009. Globalization, R&D and the iPod Cycle**.** Journal of International Economics 77(1), 101-108.

Strulik, H., 2005. The Role of Human Capital and Population Growth in R&D-Based Models of Economic Growth. Review of International Economics 13(1), 129-145.

Temple, J., 2003. The Long-Run Implications of Growth Theories. Journal of Economic Surveys 17(3), 497-510.

Van den Berg, H., 2004. International Economics. McGraw-Hill/Irwin, New York.

Wacziarg, R. and Welch, K. H., 2008. Trade Liberalization and Growth: New Evidence. World Bank Economic Review 22(2), 187-231.

Wälde, K. and Wood, C., 2004. The Empirics of Trade and Growth: Where Are the Policy Recommendations? International Economics and Economic Policy 1(2-3), 275-292.

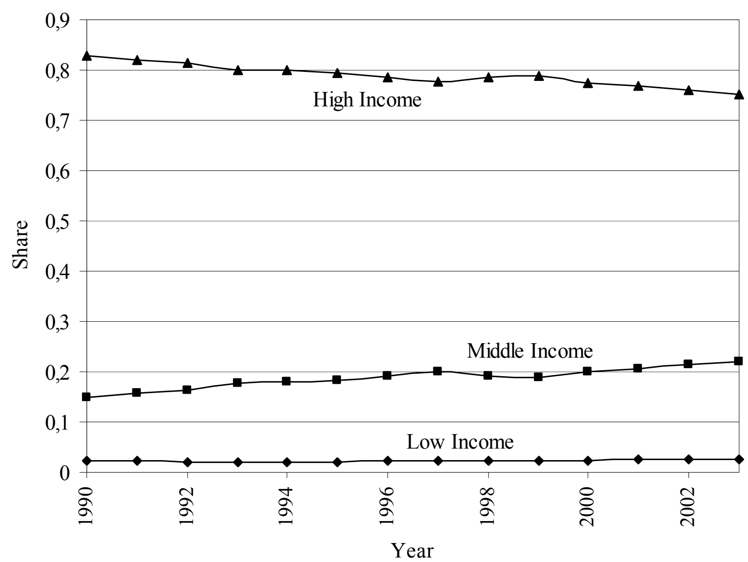
Winters, L. A., 2004. Trade Liberalization and Economic Performance: An Overview. Economic Journal 114, F4-F21.

Wood, A., 1995. How Trade Hurt Unskilled Workers. Journal of Economic Perspectives 9(3), 57-80.

World Bank, 2005. World Development Indicators, Washington, DC.

Young, A., 1998. Growth Without Scale Effects. Journal of Political Economy 106(1), 41-63.

Figure 1: World Trade Share of Country Groups



Data Source: World Bank (2005). For each country group, world trade share is imports plus exports of goods and services measured in current US dollars divided by the corresponding value for the world. Income divisions, which follow the World Bank classifications, are based on 2003 gross national income per capita levels: low income countries, $765 or less; middle income countries (including China), $766–9,385; and high income countries, $9,386 or more.

Table 1: Tariff reductions during GATT and WTO rounds

Round	**Number of participants**	**Average % cut in all tariffs**	**Average tariff level as % of 1931 level**
Geneva, 1947-48	23	21.9	52.7
Annecy, 1949	13	1.9	51.7
Torquay, 1950-51	38	3.0	50.1
Geneva II, 1956	26	3.5	48.9
Dillon, 1960-62	26	2.4	47.7
Kennedy, 1964-67	62	36.0	30.5
Tokyo, 1973-79	102	29.6	21.2
Uruguay, 1986-93	123	38.0	13.1
Doha, 2001-?	141*	?	?

* 141 at the start, 149 at Hong Kong Conference, December 2005

Sources: Van den Berg (2004), Table 8.1, p. 278; Neary (2004), Table 1, p. 321; www.wto.org

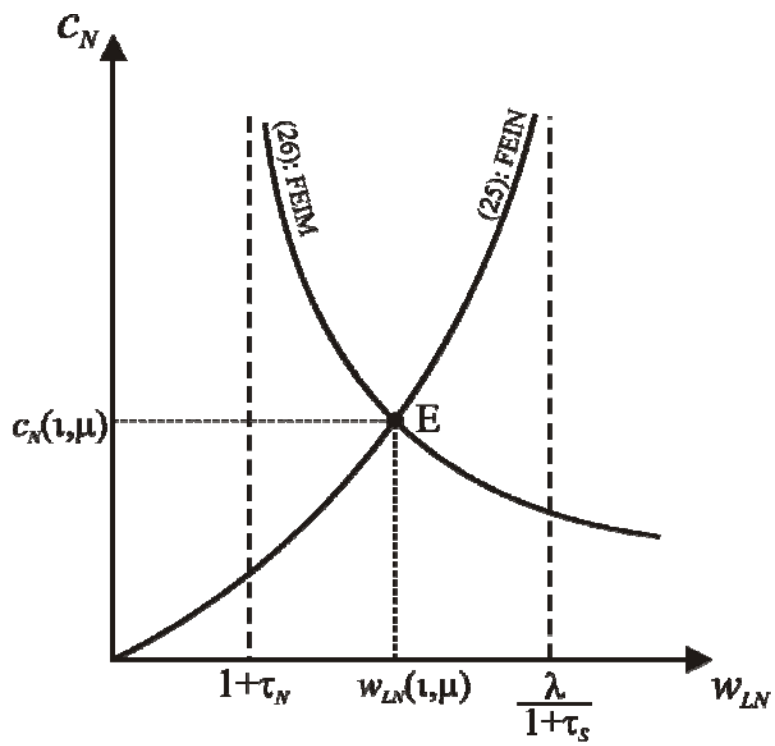


Figure 2: The determination of $c_N(\iota,\mu)$ and $w_{LN}(\iota,\mu)$

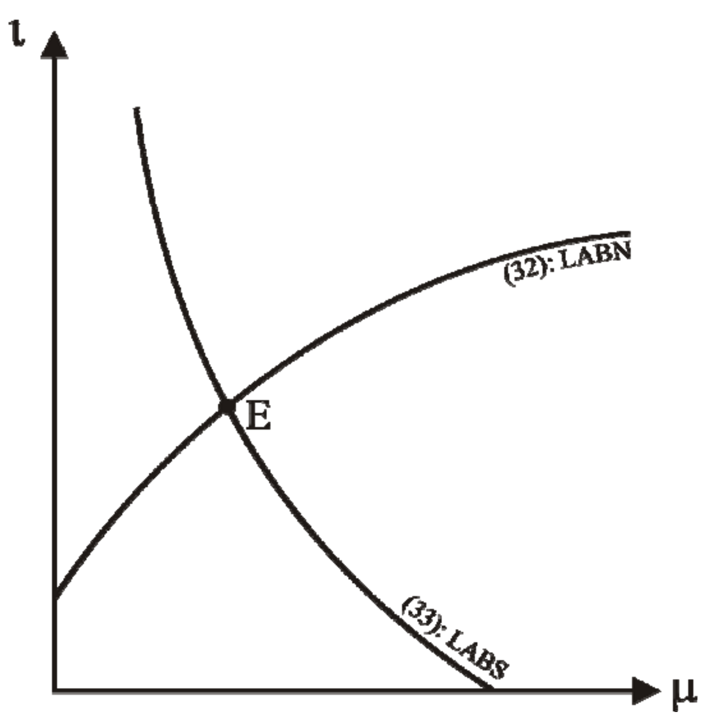


Figure 3: The steady-state equilibrium

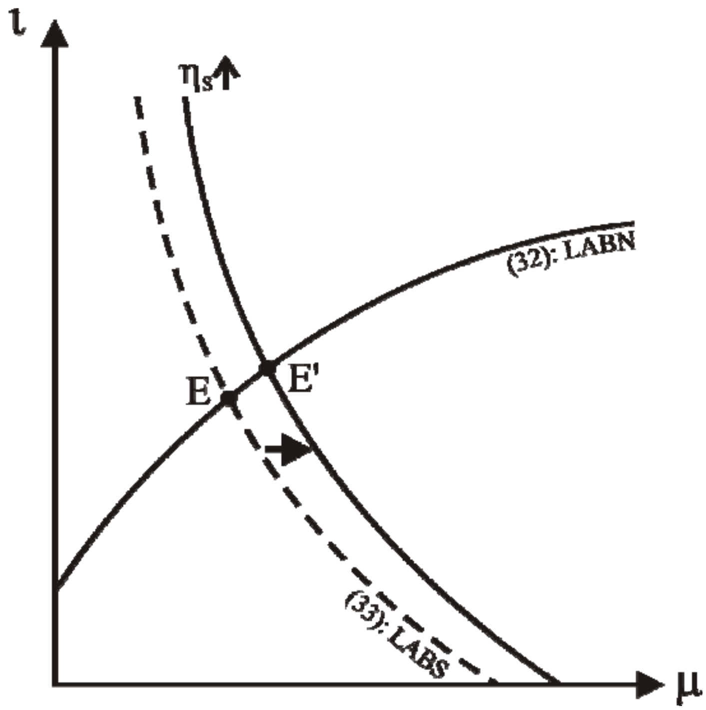


Figure 4: Steady-state effects of increased Southern trade integration