LABOR UNIONS, GLOBALIZATION AND ENDOGENOUS GROWTH

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Abstract: We analyze the growth and employment effects of several globalization forces and changes in the Northern labor market institutions in a dynamic Schumpeterian North-South product-cycle model which features fully endogenous growth without scale effects and wage bargaining in the North. Economic growth is driven by R&D of Northern innovators, while Southern firms engage in imitating Northern production technologies. We get qualitatively different results for Northern-originated and Southern-originated globalization. Moreover, the growth and employment effects of the globalization forces depend critically on whether Southern imitation is exogenously or endogenously determined, and on the relative bargaining power of the Northern labor union.

Keywords: globalization, labor unions, product cycle, endogenous growth without scale effects, unemployment, minimum wage

JEL classification: F12, F43, J51, O31, O32

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1 Introduction

The period since the 1980s has been marked by a significant surge in “globalization” as evidenced by the substantial increase in the trade to GDP ratios of many countries across the globe, most notably those of large developing countries (such as China and India). It is commonly held that the current wave of globalization has been driven by the massive declines in existing trade barriers (tariffs, quotas, and transport costs) and communication costs (with the introduction of internet, fiber optics and such), along with opening up of some countries to trade and investment flows for the first time.\(^1\)

Concurrent with the recent globalization wave, it has been argued that labor unions’ prevalence in developed countries has to some extent declined. Nickell et al. (2005, pp. 6-7) and Nickell (2003, pp. 21-22) report that for most OECD countries, with the exceptions of Scandinavia and Spain, the unionization rates (union members as a percentage of employees) have shown a downward trend since the 1980s. However, the coverage of collective bargaining (percentage of the employed labor force whose pay is determined by collective agreements struck by unions) has remained relatively stable and high (above 70%) for most Continental European countries. Coverage numbers are typically higher than union density numbers because union agreements are extended by law to non-members.\(^2\) Finally, the co-ordination of union wage bargaining has decreased since the 1980s in most OECD countries (with the exceptions of Ireland, Italy and the Netherlands), a change which implies a growing tendency to neglect the possible negative employment effects of the bargained wage rate.\(^3\) Hence, despite the decline in the unionization, the unions’ impact in the labor markets of developed countries appears to be surprisingly robust and persistent, especially in Continental European countries.\(^4\)

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\(^1\) An extensive body of literature has emerged investigating the globalization effects on labor markets. This literature has mostly focused on the effects on wage inequality and/or unemployment, and how to distinguish the impact of globalization from that of various forms of biased technological change (Arnold 2002, Davis 1998b, Dinopoulos and Segerstrom 1999a, Ethier 2005, Grieben 2005, Moore and Ranjan 2005, and Şener 2001, 2006a). Other papers focus on whether the effects of labor market rigidities in one country spill over to other countries (Davis 1998a, Meckl 2006, Helpman and Itskhoki 2007).

\(^2\) The coverage numbers have even increased in France, Spain and the Netherlands. The countries with a declining trend were US, UK and Japan.

\(^3\) Ortigueira (2007) develops a theory to explain the collapse of centralized wage bargaining since the early 1980s.

\(^4\) Recent empirical papers on the employment effects of changes in various labor market institutions in OECD coun-
It is no surprise then that there is a vast theoretical literature on the wage and employment effects of various aspects of globalization in countries with union wage bargaining, which we briefly review in section 2. Surprisingly however, on the one hand, all of these contributions on labor unions and globalization focus on static models, thereby ignoring the potential growth and product-cycle dynamics of globalization. On the other hand, almost all papers which analyze the growth and employment effects of unionization (we note Lingens, 2003, and Palokangas 1996, 2004, all of which find a positive growth and a negative employment effect of stronger labor unions) consider closed-economy frameworks, thereby neglecting the impact of increased integration of Southern economies on Northern labor markets.5

Our aim in this paper is therefore to integrate these two strands of the literature. First, we analyze the impact of globalization on wages and employment (as well as on economic growth) in a framework which captures the dynamic aspects of both globalization (product-cycle dynamics with ongoing firm relocation in an asymmetric North-South model) and R&D-driven economic growth. Second, we analyze the growth and employment effects of changing various aspects of labor market rigidities, including a change in the union’s bargaining power, in this setting of a globalized world.

Our framework is a two-country, North-South Schumpeterian growth model without scale effects with the following additional features. Economic growth is driven by (endogenous) innovations of Northern entrepreneurs who invest in R&D to discover consumer goods of higher quality. There is either costless technology diffusion to the South, or Southern entrepreneurs invest in R&D to imitate the most recent Northern technology in order to attract the corresponding

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5 The only paper we are aware of which analyzes the impact of a certain facet of globalization on the union effects on growth and employment is Palokangas (2005). In a symmetric multi-country framework, countries are connected by technology spillovers (but there is no trade in goods or production factors, and price levels are independent across countries). As in the other papers mentioned before, a higher union’s bargaining power raises both growth (by shifting labor resources to the R&D sector) and unemployment. Globalization is captured by an increase in technology spillovers. The larger technology spillovers are, the smaller is the influence of a country’s labor union on the national growth rate, hence the lower are the bargained wage rate, domestic growth, unemployment and – as shown in that paper – domestic welfare.
industry. With technology diffusion or successful imitation, production shifts to the South due to lower wage costs, while further Northern innovation moves the corresponding industry back to the North, thereby closing the product cycle. Scale effects are removed by endogenous rent protection activities (RPAs) of Northern quality leader firms, which increase both innovative and imitative R&D difficulty. The North exports newly invented goods which are not yet imitated, and the South exports imitated products ("product-cycle trade"). There is balanced trade, i.e. the net export values of the North and the South are identical. The governments in both the North and the South impose ad-valorem import tariffs. A centralized Northern labor union bargains about the wage rate of Northern production and R&D workers, between which there is perfect mobility. The aim of the labor union in the bargaining process is to maximize the expected excess wage income over a given minimum wage income, where the minimum wage rate is set by the government.

In our comparative-static analysis, we concentrate on two different globalization parameters (the relative size of the Southern population which captures the presence of the South on the world trade markets, and import tariffs), and four Northern policy parameters (the union’s bargaining power, the minimum wage rate, employment-protection costs for Northern firms, and the R&D-subsidy rate). We analyze the effects of globalization and changes of the labor market institutions in two stages: first, we simplify the model by interpreting Southern imitation as costless and exogenous technology diffusion, then we endogenize the Southern imitation rate and demonstrate that this leads to a more differentiated view on the growth and employment effects of globalization.

We find that with exogenous Southern imitation, an increased Southern presence in the world economy increases Northern innovation and worldwide growth, and decreases Northern labor-union induced unemployment. The same positive results are obtained for unilateral Southern trade liberalization. However, the opposite results (declining growth and rising unemployment) follow from unilateral Northern trade liberalization. Moreover, we show that tariffs only matter at all for growth and employment if there is a positive (non-binding) minimum wage rate in the North. A lower union’s bargaining power or a decrease in the minimum-wage rate raise

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6 This globalization aspect is also considered in Dinopoulos and Segerstrom (2007), Lu (2007), and Grieben and Şener (2007a, b).
innovation mainly by decreasing marginal R&D costs. By increasing R&D labor demand and by raising the proportion of industries located in the North, this reduces Northern unemployment.

When Southern imitation is endogenous, however, Southern goods supply prices are proportional to the Northern bargained wage rate. This implies that any change in tariffs or Northern labor market institutions’ parameters that affect the Northern bargained wage rate will also affect the Southern labor market, which induces general-equilibrium feedback effects on Northern innovation incentives. Provided that there is a positive Northern minimum wage rate, it turns out that a decrease in $\tau_N$ ($\tau_S$) raises (reduces) innovation and growth if, and only if, the bargaining power of the Northern labor union $\alpha$ does not exceed a critical level $\alpha_{\text{crit}}$. If $\alpha \leq \alpha_{\text{crit}}$, the increase (decrease) in economic growth after a decrease in $\tau_N$ ($\tau_S$) is accompanied by declining (rising) Northern unemployment. If $\alpha > \alpha_{\text{crit}}$, the growth effects are reversed, while the net employment effect becomes ambiguous.\(^7\)

Hence, globalization originating from the South benefits the North in terms of growth only for a sufficiently strong ($\alpha > \alpha_{\text{crit}}$) labor union, and globalization originating from the North benefits the North in terms of growth and employment only for a sufficiently weak ($\alpha \leq \alpha_{\text{crit}}$) labor union. The growth and employment effects of a decline in the Northern labor union’s bargaining power or a decline in the Northern minimum wage rate are qualitatively the same as those of unilateral Southern trade liberalization. Hence, these effects are likewise contingent on whether $\alpha \leq \alpha_{\text{crit}}$ or $\alpha > \alpha_{\text{crit}}$ applies.

When analyzing the growth and employment effects of a higher labor union’s bargaining power, we get different results than Lingens (2003) or Palokangas (1996, 2004) because aside from the North-South framework, our modeling differs from theirs in three respects. First, we remove the scale-effect property of the early endogenous growth models, which is refuted by Jones (1995). Second, in our framework, a higher union’s bargaining power can be conducive for

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\(^7\) The findings with respect to the growth effects of unilateral trade liberalization for the case of a relatively weak labor union ($\alpha \leq \alpha_{\text{crit}}$) are in line with our companion paper Grieben and Şener (2007a), where we assume perfectly competitive labor markets. In that paper, we show that tariffs only matter for steady-state growth if there is an asymmetric production and trade structure (i.e., there exists an additional “low-tech” sector in the South, and hence there is North-South interindustry trade in addition to intraindustry trade). This is because in that case, tariff changes affect R&D benefits and R&D costs asymmetrically under balanced trade. The corresponding symmetry-breaking feature in this paper is the Northern minimum wage rate.
growth not simply because of a labor reallocation from production to R&D, which in the previous literature is a result of assuming that only the production workers’ wage rate is bargained. Third, in the previous literature, competition on product markets is such that if the labor union is able to bargain higher wages, this increase in production costs is passed on to consumer prices. This reduces consumption demand and hence necessarily raises unemployment. In our model, however, supply prices do not reflect production costs but competition, which is a fundamental feature of all market economies. Bertrand price competition between Northern and Southern firms implies that Northern goods prices are independent of the Northern bargained wage rate. The Northern labor union affects Northern employment only indirectly through its impact on the Northern innovation rate. As a consequence, we find that a higher labor union’s bargaining power does not necessarily increase unemployment.

Finally, we derive a growth-maximizing and unemployment-minimizing policy for the North, which amounts to set the levels of job protection and R&D subsidies such that $\alpha^{\text{crit}} = \alpha$.

The remainder of this paper is organized as follows. Section 2 briefly reviews the related theoretical literature which captures various aspects of globalization in a static framework with labor unions. Section 3 provides all elements of our basic model with exogenous Southern imitation, derives the steady-state equilibrium, and analyzes its properties. Section 4 derives our results for the more general case of endogenous Southern imitation, including the growth-maximizing and unemployment-minimizing Northern policy. Section 5 concludes.

2 Related Literature

This section gives a brief overview of some contributions to the voluminous literature on wage and employment effects of various facets of globalization when there is wage bargaining. The main distinction to our model is that all of the following contributions neglect dynamic (globalization and growth) aspects.

Mezzetti and Dinopoulos (1991) analyze in partial equilibrium the output and welfare effects of an increase in the bargaining power of employment- and wage-oriented labor union, respectively. Zhao (1995) studies the effects of cross-hauling FDI in partial equilibrium and show that it increases (decreases) employment and welfare when the national labor union is wage (employ-
ment) oriented. Zhao (1998) analyzes wage and employment effects of FDI in a general-equilibrium model when a competitive (non-unionized) sector is also taken into account. Zhao (2001) shows that vertical integration of firms induces outsourcing which decreases the negotiated wage rate. The effects of international fragmentation (outsourcing) are analyzed by Gaston (2002), Egger and Egger (2003), and Skaksen (2004). The latter generalizes the partial-equilibrium model of Skaksen and Sørensen (2001) to a general-equilibrium setting. Skaksen (2004) finds that the mere threat of (non-realized) outsourcing reduces bargained wages and raises employment, while realized outsourcing does the opposite. Naylor (1998), in refining previous work by Huizinga (1993), shows that increased international product market competition leads to a less competitive labor market because monopoly unions react by setting higher wages. This result is further generalized in Naylor (1999). Driffield and van der Ploeg (1995) analyze a model with intraindustry trade under monopolistic competition and increasing returns to scale. They find that increased international product market competition (a reduction in trade barriers) reduces the bargained wage rate and increases the number of firms when workers are organized at the national (as opposed to the international) level.

More recently, Andersen (2005) analyzes the labor market effects of international product market integration in a Ricardian trade model with worker heterogeneity, and finds that it results in an overall welfare gain but also more wage dispersion, lower effective bargaining power of the labor union, and more unemployment among the less productive workers since the minimum (reservation) wage becomes more binding. Andersen and Skaksen (2007) develop a two-country general-equilibrium model with Ricardian trade, which endogenizes changes in labor-demand elasticity, production and trade structure following a reduction of trade costs. It results in an unambiguous increase in both wages and employment, which is attributed to the more efficient allocation of production according to comparative advantage.

Eckel and Egger (2006) study in a two-country (North-North) general-equilibrium model with monopolistic competition how the unions’ bargaining power determines the share of firms which choose to become horizontally multinational when there is economic integration. Economic integration between the two completely symmetric countries is modeled by a sudden drop of trade and investment barriers from infinity to zero. Moreover, Eckel and Egger distinguish between the “short-run” effects for a given number of firms and the “long-run” effects after firm-
entry and -exit decisions (they neglect any other intertemporal aspects). Depending on the size of
the fixed cost disadvantage of multinational enterprises, they derive the possible shares of export-
ing and multinational firms after economic integration before and after the firm-entry and -exit
decision. The main result is that whenever economic integration raises the proportion of multi-
national firms, it reduces total unemployment (since the negative effect of outgoing investment is
dominated by the positive employment effect of incoming investment) and wages.

3 The Basic Model

3.1 Household Behavior

The world economy consists of two countries, the North and the South, indexed by \( i \in \{N, S\} \),
respectively. Each country has a fixed number of identical households, normalized to one. Let \( N_{0i} \)
denote the size of the population and also the labor force of country \( i \) at time zero, where we al-
low for \( N_{0N} \neq N_{0S} \). The number of household members in both countries is growing at the com-
mon rate \( n > 0 \), thus the population size in country \( i \) at time \( t \) equals \( N_{iti} = N_{0i}e^{nt} \).

The representative household maximizes the utility function

\[
U(t) = \int_0^\infty N_{0i}e^{-(\rho-n)t} \log u_i(t) \, dt \quad \text{for } i = N, S, \tag{1}
\]

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

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

subject to \( \int_0^1 p(j,\omega,t) x(j,\omega,t) \, d\omega = c_i(t) \). \( \lambda > 1 \) 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 \( t \), \( x(j,\omega,t) \) denotes per-
capita demand for a product with \( j \) quality improvements in industry \( \omega \) at time \( t \), and \( p(j,\omega,t) \) is
the corresponding goods price. Hence, as is standard in quality-ladder models, product quality
starts at \( \lambda^0 = 1 \) in any industry \( \omega \) and improves at discrete steps with each successful innovation
which is a stochastic process to be discussed later. The household optimization process comprises
two steps: to allocate labor income across consumer goods that enter (2) at each point in time,
where goods prices are treated as given, and to decide about the consumption expenditure path over time. Since the goods produced in each industry \( \omega \) differ only in their quality, and \( \lambda \) units of quality \( j \) are a perfect substitute for one unit of quality \( j + 1 \), only goods with the lowest quality-adjusted price \( p(\omega, t) \) are consumed. In addition, since products enter (2) symmetrically, each household spread consumption expenditure evenly across product lines. It results a unit-elastic demand function \( x_i(\omega, t) = c_i(t)/p(\omega, t) \) in each industry \( \omega \), where \( c_i(t) \) is consumption expenditure per capita in country \( i \) at time \( t \), and \( p(\omega, t) \) is the market price for the purchased product.

Given the static demand functions, the second step of the representative household’s optimization problem is to maximize

\[
\int_0^\infty N_0 e^{(\rho-n)\nu} \log c_i(t) \, dt \quad \text{for } i = N, S, \tag{3}
\]

subject to the intertemporal budget constraint

\[
FA_i(t) = W_i(t) + r(t) FA_i(t) - c_i(t) N_i(t) \tag{4}
\]

where \( FA_i(t) \) denotes the stock of financial assets owned by the household (that arise from the ownership of firms earning monopoly profits to be discussed later), \( W_i(t) \) is the household’s expected per-period wage income and \( r(t) \) is the instantaneous rate of return in the global market. The expected wage component \( W \) allows for unemployment which will arise for Northern production workers, to be explained later. The solution to this dynamic optimization problem is the familiar Euler equation (“Keynes-Ramsey rule”)

\[
\frac{\dot{c}_i(t)}{c_i(t)} = r(t) - \rho \quad \text{for } i = N, S. \tag{5}
\]

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-state results, we henceforth drop the time index for variables that remain constant in equilibrium.

### 3.2 Labor And Activities

Labor is the only factor of production and is immobile across countries. In the North, the labor force consists of specialized and general-purpose workers, with the fixed proportion of the former
given as $s_N \in (0, 1)$ and that of the latter given as $1-s_N$. In the North, there are three types of activities: innovation, manufacturing of final goods, and rent-protection. General-purpose workers can be employed in innovation or goods production, whereas specialized (lawyers, lobbyists) workers are only employed in rent protection activities (RPAs). In the South, there is only one type of labor used in manufacturing of final goods which is the only type of activity to begin with.

### 3.3 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 at all industries $\omega$ to discover the technology of producing next generation consumer goods, where each innovation improves the existing generation by a quality step of size $\lambda > 1$. 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. All producer firms engage in Bertrand price competition to offer the lowest quality-adjusted price for given state of technology $j$ and general-purpose wage rate $w_L \in ]1, \lambda[$, while the Southern wage rate is normalized to 1. The level of $w_L$ is determined by decentralized wage bargaining, to be discussed later.

In both countries, production of one unit of final goods requires one unit of general-purpose labor, regardless of the quality level of the manufactured goods. For each industry, there are two possible structures at any point in time. Whenever a Northern entrepreneur discovers a next gen-

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8 In Grieben and Şener (2007a), we discuss the empirical evidence on the significance of RPAs in a North-South context. Our labor assignment follows Dinopoulous and Syropoulos (2007). Its advantage is that it yields fully-endogenous growth (in the sense that the steady-state growth rate depends on all parameters of the model) with a parsimonious structure by creating a link between the innovation rate and the Northern wage rate for specialized relative to general-purpose workers in the simplest possible way. As we show in our companion paper Grieben and Şener (2007a), endogenizing the proportion of specialized workers $s_N$ by assuming just one type of Northern labor that is mobile across all three activities (manufacturing, R&D and RPAs) results in a steady-state growth rate that is only a function of a subset of the model’s parameters. In particular, any labor market institutions’ parameters that affect the (unique) wage rate have no impact on the steady-state growth rate anymore.
eration product, the resulting structure is a *Northern industry*, in which the Northern quality leader competes with Southern followers that have access to the discarded technology. Whenever a Southern entrepreneur acquires the technology of producing a current generation product (which for now occurs at an exogenous imitation – or ‘technology diffusion’ – rate $\mu$ and does not require any Southern R&D input), the resulting structure is a *Southern industry*. However, it would be implausible to assume that only one Southern firm appropriates the new technology obtained by costless diffusion, and has monopoly power thereafter. Therefore, we impose perfect competition between Southern firms in a Southern industry. The Northern incumbent has access to the same state-of-the-art technology, but cannot compete because of higher marginal costs. Northern (Southern) firms face an ad-valorem import tariff rate of $\tau_S$ ($\tau_N$) 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.\(^9\)

Consider the profits of the **Northern quality leader** who competes with Southern followers in both Northern and Southern markets.\(^{10}\)

**In the Northern market**, the Northern quality leader competes against Southern followers who 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 $p_N^L = \lambda(1 + \tau_N) - \epsilon$ with $\epsilon \to 0$ and drives the Southern followers out of the market. The profits of the Northern quality leader from sales in the Northern market are:

$$
\pi_N^L = \frac{c_NN_N}{\lambda(1 + \tau_N)} \left[ \lambda(1 + \tau_N) - w_L \right] = c_NN_N \left[ 1 - \frac{w_L}{\lambda(1 + \tau_N)} \right].
$$

\(^9\) In addition, contrary to this paper, Dinopoulos and Segerstrom (1999b) consider only ‘contingent’ tariffs, where “[…] each country imposes an ad valorem tariff only in those industries where a domestic firm has recently lost its global technological leadership to a foreign firm” (p. 193).

\(^{10}\) Northern followers’ unit cost is $w_L$ whereas the Southern followers’ unit cost is 1. Northern followers cannot compete with Southern followers in the Southern market if $w_L(1 + \tau_N) > 1$. This condition holds automatically given that $w_L > 1$ at the steady-state. Moreover, Northern followers cannot compete with Southern followers in the Northern market provided $w_L > 1 + \tau_N$, which we impose.
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, the Northern quality leader faces tariffs and again competes with Southern followers. This time though competition takes place in the local market of Southern followers; thus, under marginal cost pricing, they can offer a price of 1. The Northern quality leader faces an ad-valorem tariff rate of $\tau_S$. To capture the Southern market, the Northern firm must set its price such that the price faced by the Southern consumers does not exceed $\lambda$. This implies that the Northern firm’s limit price is $p^S_N = \lambda - \varepsilon$ with $\varepsilon \to 0$, of which the Northern firm receives only $\lambda/(1 + \tau_S)$. The profits of the Northern quality leader from sales in the Southern market are:

$$\pi^S_N = \frac{c_S N_S}{\lambda} \left( \frac{\lambda}{1 + \tau_S} - w_L \right).$$

For $\pi^S_N > 0$, we need $\tau_S < (\lambda/w_L) - 1$. Hence total profits from sales of Northern monopolists are:

$$\pi^p_N = \pi^N_N + \pi^S_N = c_N N_N \left[ 1 - \frac{w_L}{\lambda (1 + \tau_N)} \right] + c_S N_S \left( \frac{1}{1 + \tau_S} - \frac{w_L}{\lambda} \right). \quad (6)$$

Finally, profits of Southern imitators are competed away by perfect competition among Southern firms in both the Southern and the Northern market. This is because the technological knowledge from costless diffusion from the North cannot be appropriated by any single Southern firm.\(^{11}\) In the South, the supply price equals marginal costs, $p^S_S = 1$. In the North, the after-tariff supply price of Southern firms is $p^S_N = 1 + \tau_N$, whereas Northern firms could offer the same quality of goods at the marginal cost $w_L$. By our assumption $w_L > 1 + \tau_N$, Northern firms are priced out of their home market, and the Northern consumer has to bear to full burden of the domestic tariff.

While Northern quality leaders earn monopoly profits, they simultaneously expend resources to safeguard their monopoly positions against their rivals across the globe (e.g., by investing in patent litigations etc.). For this purpose, each Northern incumbent hires Northern specialized la-

\(^{11}\) This is in accord with the modeling in, e.g., Glass (2004, p. 875).
bor at a wage rate of $w_H$, which is determined by supply (which is fixed, given that the proportion of specialized workers $s_N$ is constant) and demand, to be determined later. The cost of performing $X(t)$ units of rent-protecting activities is $w_H\gamma X(t)$, where $\gamma$ is the unit labor requirement of such activities. Hence, a Northern incumbent’s profit flow net of rent protection costs then equals:

$$\pi_N = \pi_N^P - w_H \gamma X.$$

(7)

### 3.4 Technology Of Innovation And Optimal Innovation Decision

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 (innovation). The R&D technology is identical across Northern firms: by using general-purpose labor, the instantaneous probability of success (Poisson arrival rate) $\iota_j$ by firm $j$ is given as

$$t_j(\omega,t) = \frac{R_j(\omega,t)}{D(\omega,t)} \quad \text{with} \quad \dot{D}(\omega,t) = n_N \delta X(\omega,t),$$

(8)

where $R_j(\omega,t)$ represents the innovation intensity (determined by the number of R&D workers used and their productivity) of a typical Northern entrepreneur $j$ targeting industry $\omega$, and $D(\omega,t)$ measures the difficulty of conducting R&D in industry $\omega$ at time $t$. According to (8), R&D difficulty $D$ is modeled as a stock variable, where $n_N$ is the (endogenous, to be determined later) proportion of industries located in the North, $X(\omega,t)$ is the flow of rent-protecting activities (RPA) undertaken by the Northern incumbent in industry $\omega$ at time $t$, and $\delta$ measures the effectiveness of these RPA.\(^{12}\) 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 RPA which increases the stock of R&D difficulty in that industry by $\delta X(\omega,t)$. In order to allow for a constant innovation rate in a steady-state equilibrium, R&D difficulty must grow at the same rate as R&D labor input, hence $\dot{D}(\omega,t) = nD(\omega,t)$ is required. From this and (8), we get the following ex-

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\(^{12}\) The modeling of R&D difficulty $D$ as a stock variable follows Şener (2006b) which better captures the persistence of the institutional and legal framework surrounding IPR protection than the alternative modeling as a flow variable, which is the route taken by Dinopoulos and Syropoulos (2007). Moreover, since Southern firms do not engage in RPA, the stock approach of R&D difficulty is necessary to have R&D difficulty growing over time also in Southern industries.
pression of the stock of R&D difficulty along any steady-state growth path:

\[ D(\omega, t) = \frac{n_N \delta X}{n} . \]  

(9)

Since the \( \iota_j \) are independently distributed across firms and industries, the Poisson arrival rate for innovation at the industry level (which is ‘the’ Northern innovation rate) equals

\[ t(\omega, t) = \sum_j t_j(\omega, t) = \frac{R(\omega, t)}{D(\omega, t)} \text{ with } R(\omega, t) = \sum_j R_j(\omega, t) . \]  

(10)

General-purpose labor is hired for doing R&D in the North. The cost of conducting \( R_j \) units of innovative activity is \( w_L (1 - \sigma) a_i R_j \), where \( \sigma_i \) is a public R&D subsidy rate (financed by lump-sum taxation for simplicity), \( a_i \) 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

\[ \max_{R_j} \frac{v_N R_j}{D} dt - w_L (1 - \sigma) a_i R_j dt \]

yields

\[ v_N = w_L (1 - \sigma) a_i D , \]  

(11)

where \( v_N \) is the endogenous firm value of a successful Northern innovator.\(^{13}\)

### 3.5 The Stock Market

As usual in Schumpeterian growth models, savings of consumers 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 \( \pi_N dt \), face the risk of a complete capital loss of size \( v_N \) in case this firm is driven from the market which occurs with probability \( (t + \mu) dt \), where \( \mu \) is the – hitherto exogenous – Southern imitation rate. In addition, a previous

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\(^{13}\) As in Segerstrom (1998, p. 1298), the maximization problem simply implies that if \( v_N > w_L (1 - \sigma) a_i D \), \( R_j \to \infty \) would be optimal, if \( v_N < w_L (1 - \sigma) a_i D \), \( R_j = 0 \) would be optimal, and only if (11) holds, the optimal level of \( R_j \) would be positive and finite, although the exact level is indeterminate and only follows from the assumption of symmetric firms and the labor resource constraint.
incumbent has to pay liquidation costs $B$ when shutting down, where $B$ is indexed to the firm value $v_N$ in order not to become negligible in the long run.\footnote{Liquidation costs $B$ can consist of red-tape costs and redundancy payments to laid-off workers. If there are redundancy payments, these do not show up in the households’ budget constraint since there is perfect insurance of income within families. Technically, idiosyncratic shocks to wages, including redundancy payments, are embedded in the expected wage component $W_i$ in (4) which does not play a role in the f.o.c. of the consumer optimization problem. Since there is no frictional unemployment in this model, there is no intrinsic need for redundancy payments. Laid-off workers can immediately find a new job at the new incumbent or an entrepreneur firm. However, there is unemployment due to wage bargaining of a labor union, to be discussed later. For the analysis of frictional (“Schumpeterian”) unemployment in a neo-Schumpeterian growth model without scale effects, see Dinopoulos et al. (2007).} With probability $1-(t+\mu)dt$, there is neither Northern innovation nor Southern imitation during $dt$, and the incumbent experiences a capital gain $\hat{v}_N dt$ which occurs because of an extension of the market size due to population growth during the incumbency period of this firm. Consumers 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 any firm investing in innovative R&D 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:

$$
\pi_N dt - v_N (1 + B) (t + \mu) dt + \hat{v}_N [1 - (t + \mu) dt] dt = rv_N dt \tag{12}
$$

Solving (12) for $v_N$ and imposing $dt \to 0$ yields

$$
v_N = \frac{\pi_N}{r + (1 + B)(1 + \mu) - (\hat{v}_N/v_N)} \tag{13}
$$

as the appropriately discounted monopoly profits determining the value of an incumbent firm.

### 3.6 Optimal Rent Protection Decision By Northern Incumbents

Each Northern incumbent chooses its optimal level of RPA by maximizing the expected return on its stocks net of rent protection costs. Differentiating the LHS of (12) with respect to $t$ and substituting for $dt = -\pi(dX/X) < 0$ which follows from (9) and (10), yields the incremental gain in the expected rate of return due to increased $X$ as

$$
v_N (1 + B) \frac{dX}{X} dt + \hat{v}_N t \frac{dX}{X} dt dt .
$$
Setting this equal to the incremental expenditure on specialized labor used for RPA during \( dt \), 
\( \int w_H \gamma dX dt \), dividing by \( dt \), taking limits as \( dt \to 0 \) and simplifying finally yields the optimal RPA condition

\[
v_N t (1 + B) = w_H \gamma X. \tag{14}
\]

Hence the flow of RPA \( X \) increases with the firm value \( v_N \) (simply because there is more at stake) and the endogenous part of the replacement rate \( t \) (because this is the only part of the instantaneous probability of full capital loss at each point in time which can be influenced by RPA, while the Southern imitation rate is exogenously given), and \( X \) decreases with the cost of RPA (specialized wage rate and unit labor requirement \( \gamma \)). Finally, \( X \) increases with liquidation costs \( B \), hence equation (14) formalizes the notion that the presence of liquidation costs encourages incumbents to make an extra effort to prolong their monopoly power by raising the level of RPA.

Using (14) together with (7) and (6) in (13), gives the discounted Northern firm value as

\[
v_N = \frac{c_N N_N \left[ 1 - \frac{w_P}{\lambda (1 + \tau_S)} \right] + c_S N_S \left( \frac{1}{1 + \tau_S} - \frac{w_P}{\lambda} \right)}{r + (1 + B)(2t + \mu) - \dot{v}_N / v_N}. \tag{15}
\]

3.7 Balanced Trade

To avoid dealing with international capital flows in addition to trade flows, we impose a balance-of-trade (BOT) condition which determines the relative consumer expenditure levels for both countries: the value of exports net of tariffs must be equal between the North and the South. In our continuum of industries setting, this gives:

\[
n_N \frac{c_S N_S \frac{\lambda}{\lambda}}{1 + \tau_S} = (1 - n_N) \frac{c_N N_N \frac{1 + \tau_N}{1 + \tau_N}}{1 + \tau_N}, \tag{16}
\]

where the LHS (RHS) denotes the value of Northern (Southern) exports net of tariffs. To determine \( n_N \), the industry share located in the North, we note that Northern entrepreneurs capture industry leadership from Southern firms at a rate of \( \alpha (1 - n_N) \), while exogenous Southern imitation captures industry leadership from Northern firms at a rate of \( \mu n_N \). Constancy of industry shares in the steady state requires \( \alpha (1 - n_N) = \mu n_N \), which implies
By using (16) and defining the relative Southern population size as \( \eta_s \equiv N_S/N_N \), the above BOT condition can be rewritten as

\[
c_S = c_N \frac{\mu(1+\tau_S)}{\eta_s(1+\tau_N)} \tag{17}
\]

### 3.8 Labor Markets 1: Equilibrium Conditions

To close our model, we need to derive the labor market equilibria for both countries. We introduce “trade-union induced” unemployment in the Northern economy, which is a consequence of decentralized labor union wage bargaining. A Northern general-purpose labor market equilibrium requires that \((1 - s_N - u)N_N = L_N^e + L_N^r\) is always fulfilled, where \(u \equiv U/N_N\) denotes the trade-union induced Northern unemployment rate (to be determined in the following section), \(U\) is the total number of Northern unemployed workers, and \(L_N^R\) is Northern R&D employment.

The Northern demand for manufacturing labor is \(L_N^Y = n_N[c_N N_N/(1+\tau_N)\lambda] + c_S N_S/\lambda\), the Northern R&D labor demand is, using (10), \(L_N^R = a_1 R = a_1\mu D\), hence the Northern general-purpose labor market equilibrium condition is

\[
L_N = L_N^e + L_N^r = n_N \left( \frac{c_N N_N}{\lambda(1+\tau_N)} + c_S N_S \right) + a_1\mu D = (1-s_N-u)N_N. \tag{18}
\]

As is obvious from this equation, the Northern bargained wage rate \(w_L\) does not (directly) affect production labor demand since in our model, supply prices reflect competition, not production costs. Northern RPA labor demand \(L_N^X\) is \(n_N \gamma X\), hence the Northern specialized labor market equilibrium condition is

\[
L_N^X = n_N \gamma X = s_N N_N. \tag{19}
\]

The Southern demand for manufacturing labor is \((1-n_N)[c_S N_S + c_N N_N/(1+\tau_N)]\), hence given an

\[\text{(15)}\]

Another way to derive the BOT condition is to equate the value of spending net of tariff revenue to the value of output in each country.
exogenous (i.e., not labor-resource consuming) technology diffusion rate $\mu$, the only Southern labor market equilibrium condition is

$$\left(1 - n_N\right) \left( c_S N_S + \frac{c_N N_N}{1 + \tau_N}\right) = N_S.$$  \hspace{1cm} (20)

### 3.9 Labor Markets 2: Wage Bargaining In The North

There is decentralized wage bargaining between any new incumbent Northern firm and a centralized labor union who bargains on behalf of Northern general-purpose workers. The sequence of events is as follows. **First**, when an entrepreneur firm enters the market, it employs general-purpose workers at the going wage rate $w_L$ to perform R&D services. There is nothing to bargain between entrepreneurs and R&D workers due to free entry in R&D races and thus zero expected profits. **Second**, when the entrepreneur firm is successful in innovating, it has to hire production workers and bargain over their wage rate. This time, there are positive expected monopoly profits, and production cannot start without a wage agreement. This gives bargaining power to the union. The previous R&D workers of this firm either become R&D workers of the previous incumbent firm which now starts to invest in R&D again, or they become production workers in their old firm, or they can become unemployed (an outcome that can happen provided the bargained wage rate exceeds the free-market wage rate). When bargaining, the prospective production workers take the economy-wide innovation rate as given since it is beyond control of a single firm.\(^{16}\) **Third**, when the bargaining is settled, the firm starts production. The bargained wage rate, although determined individually between a single firm and the labor union, will be the same across all firms because they face a symmetric problem and have identical bargaining power. We abstract from insider power of workers, as in Lingens (2003, p. 96), i.e. the probability of finding a new job is independent of the individual employment history.

Importantly, the “right-to-manage” assumption (that firms adjust the employment level optimally after the wage rate has been bargained) does not play any role here. The Northern unskilled labor demand does not (directly) depend on $w_L$ since supply prices at home, $p^N_N = \lambda (1 + \tau_N)$, and

\[^{16}\]The same is true with respect to the economy-wide unemployment rate which will be derived as a function of the aggregate innovation rate. The individual firm’s innovation rate is also exogenous to the bargaining process since for producing firms, the innovation is a past event and it no longer invests in R&D in this industry.
abroad, \( P_N = \lambda \), are fixed by the Bertrand price competition with Southern follower firms. Therefore, there is no (direct) pass-through of higher Northern production costs to supply prices, which would reduce consumption and hence Northern general-purpose labor demand.

The bargained Northern general-purpose wage rate \( w_L \) is derived from the Nash maximand\(^\text{17}\)

\[
\Omega = \left( \frac{W_N}{r} - \overline{W}_N \right) ^\alpha (v_N - \overline{v}_N)^{1-\alpha} \rightarrow \max! w_L
\]

\( \alpha \in [0,1] \) is the relative bargaining power of the labor union, and \( W_N \equiv (w_L - w_{\text{min}})^\theta [(1 - s_N - u)N]^{\chi} \) is the expected excess-wage income received by the union members, where excess wage and employment levels are evaluated by the elasticities of the underlying utility function of the labor union, respectively. The minimum wage rate \( w_{\text{min}} > 1 \) is defined by the government. It will apply for the case \( \alpha = 0 \), and it therefore serves as the natural reference point for the labor union.\(^\text{18}\) \( \overline{W}_N \) is the workers’ discounted per-period income during the negotiations on \( w_L \) or during a strike – their ‘inside option’ (and not what they would get if they unilaterally quit the negotiations without agreement – their ‘outside option’\(^\text{19}\)), and \( \overline{v}_N \) is the discounted Northern firm’s profits during the negotiation or a strike. We assume that employed workers do not have any income during wage negotiations (i.e., we abstract from any strike funds of the labor union). Moreover,

---

\(^{17}\) The underlying labor union’s objective is a Stone-Geary type utility function \( U(w_L, L_N) = (w_L - w_{\text{min}})^\theta L_N^{\chi} \), where \( \theta \geq 0 \) and \( \chi \geq 0 \) represent, respectively, the union’s preference for excess wages and employment. As in Mezzetti and Dinopoulos (1991, p. 82), the labor union is called wage (employment) oriented if \( \theta > \chi (\chi > \theta) \). It will turn out below that \( \chi \) is completely irrelevant for the bargained wage rate, and hence for the entire steady-state equilibrium.

\(^{18}\) Lingens (2003) takes the competitive wage rate as the union’s reference point and derives this from the hypothetical situation of no wage bargaining (which amounts to setting \( \alpha = 0 \)). This appears problematic since in equilibrium, the competitive wage rate is not available as a real option. In the trade literature with unions (Mezzetti and Dinopoulos 1991, Zhao 1998, 2001), the competitive wage rate is derived from a second sector which is non-unionized. This turns it into a real option but complicates the analysis, and it removes unemployment from the model. Palokangas (1996, 2004, 2005) neglects such a reference point altogether, which has the downside that for \( \alpha = 0 \), the bargained wage rate becomes zero.

\(^{19}\) Palokangas (2004, p. 205, fn. 6), with reference to Binmore at al. (1986, p. 186-187), points out that taking the expected income outside the firm as the union’s reference point would not be correct since it “[…] is not in line with the microfoundations of the alternating offers game”. Instead, it is “[…] appropriate to identify the reference income with the income streams accruing to the parties in the course of the dispute”. The outside option for the workers (unemployment benefits, wage income elsewhere) if the firm and the labor union fail to agree on a wage rate is an irrelevant alternative and “[…] has no effect on the bargain, provided the bargain gives both parties more than they could get elsewhere” (Layard et al. 2005, p. 100). See also Cahuc and Zylberberg (2004, p. 389), or Hall and Milgrom (2007) on this argument.
possible one-time redundancy payments to those workers just laid off do not matter in this respect since they are not paid under the condition that the bargaining process takes another period, hence $\bar{w}_N = 0$. Similarly, $\bar{\nu}_N = 0$ since Northern firms cannot manufacture without agreement on $w_L$. Using all this in (21), and substituting (15) for $\nu_N$, yields the bargaining problem

$$\Omega = \left\{ \frac{(w_L - \min w)^{\mu}}{r} \left[ 1 - s_N - u \right] N_N \right\}^\alpha \left\{ \frac{c_N N_N \left( 1 - \frac{w_L}{\lambda(1 + \tau_N)} \right) + c_S N_S \left( \frac{1}{1 + \tau_S} - \frac{w_L}{\lambda} \right)}{r + (1 + B)(2t + \mu) - \bar{v}_N/v_N} \right\}^{1-\alpha} \rightarrow \max_{w_L}$$  \hspace{1cm} (22)

The first order condition is

$$\frac{\alpha \theta}{w_L - \min w} \left\{ c_N N_N \left[ 1 - \frac{w_L}{\lambda(1 + \tau_N)} \right] + c_S N_S \left( \frac{1}{1 + \tau_S} - \frac{w_L}{\lambda} \right) \right\} = (1 - \alpha) \left\{ c_N N_N \left[ \frac{1}{\lambda(1 + \tau_N)} \right] + c_S N_S \right\}$$ \hspace{1cm} (23)

which says that for maximizing the Nash bargaining product (22), the increase in the firms’ profits extraction by the labor union through a marginal increase in $w_L - \min w$, evaluated by the union’s share $\alpha$ in $\Omega$ and the union’s excess wage preference $\theta$ (LHS), must equal the increase in the firms’ production costs by this marginal increase in $w_L - \min w$, evaluated by the firm’s share $1 - \alpha$ in $\Omega$ (RHS).\footnote{20} By using the BOT condition (17) in (23) and simplifying terms, we find the negotiated Northern unskilled wage rate as\footnote{21}

$$w_L = \left\{ \begin{array}{ll}
\alpha \theta \left[ t(1 + \tau_N) + \mu \right] \\
\left[ 1 - \alpha(1 - \theta) \right] \left[ t + \mu(1 + \tau_S) \right]
\end{array} \right\} + \left( 1 - \alpha \right) \min w \quad \text{for} \quad \frac{\lambda \left[ t(1 + \tau_N) + \mu \right]}{t + \mu(1 + \tau_S)} \equiv \min w > \min w
\text{else.}
\right.$$

\hspace{1cm} (24)

For a given Northern innovation rate $t$ (to be determined below), this bargained wage rate has the following intuitively appealing features: it is increasing (decreasing) in $\tau_N$ ($\tau_S$) since Northern (Southern) protection benefits (hurts) Northern production workers by raising (reducing) firm profits, of which the labor union bargains a fraction; it is increasing in $\min w$ since this is the fallback position from which the labor union bargains; it is increasing in $\theta$ provided $\min w > \min w$

\footnote{20} Obviously, the second derivative of (22) with respect to $w_L$ is negative, hence the f.o.c. is also sufficient for a maximum.

\footnote{21} Note that (24) for the special case $\min w = 0$ would be obtained if we replaced the labor union’s reference wage rate $\min w$ in the definition of the expected excess-wage income $W_N$ in (21) by the expected income of a general-purpose worker per period, $(1 - u)w_L + ubw_L$, with $bw_L \in [0, w_L]$ denoting unemployment benefits per period. Hence, this alternative assumption is implicitly covered as the special case $\min w = 0$ of our analysis.
since for a non-binding minimum wage, a larger union’s excess wage preference raises the bargained wage rate. Furthermore, differentiation of (24) shows that it is unambiguously increasing in \( t \) and decreasing in \( \mu \). Finally, the liquidation costs \( B \) have only an indirect negative impact on \( w_L \) by reducing \( t \). For \( \tau_N = \tau_S = w^{\min} = 0 \), \( w_L \) is a fraction of the free-trade Northern firm’s limit price \( \lambda \), determined by the relative bargaining power \( \alpha \) and by \( \theta \). With free trade, \( w_L \) is independent of the innovation rate, hence the bargained wage rate does not respond to any replacement threat, simply because this model ignores frictional unemployment. For \( \tau_N = \tau_S = 0 \) and \( \alpha \to 1 \), \( w_L \) approaches \( \lambda \) which would imply zero profits for Northern incumbent firms. For the remainder of the paper, we normalize \( \theta \equiv 1 \) without loss of generality.

### 3.10 Steady-State Equilibrium

We solve the model for a balanced steady-state equilibrium where the endogenous variables \( c_N, c_S, u, t, n_N, w_L \) and \( w_H \) remain constant, and \( L^X_N(t), L^R_N(t), L^X_S(t), \pi_N(t), X(t), D(t) \) and \( v_N(t) \) all grow at a common rate of \( n \), and \( r = \rho \).

We first derive \( c_N \) by using (16) and the BOT condition (17) in the Southern labor market clearing condition (20), which yields

\[
c_N = \frac{\eta_S(t + \mu)(1 + \tau_N)}{\mu(t + \mu)(1 + \tau_S)}, \tag{25}
\]

which is unambiguously increasing in \( t, \eta_S \) and \( \tau_N \), and decreasing in \( \mu \) and \( \tau_S \). Using (25) in the BOT condition (17) again yields

\[
c_S = \frac{(t + \mu)(1 + \tau_S)}{t + \mu(1 + \tau_S)}, \tag{26}
\]

which is unambiguously increasing in \( t \) and \( \tau_S \), and decreasing in \( \mu \). Note that with free trade, \( c_S = w_S = 1 \). Hence the BOT condition implies “balanced asset ownership”: Northern people hold only assets of Northern firms and Southern people hold only assets of Southern firms.\(^2^2\) Since there is

\(^2^2\) We have shown in a paper with a similar setting (Grieben and Şener, 2007a) that the alternative assumption of an “unbalanced asset ownership” (i.e., allowing for cross ownership of assets) does not alter results.
perfect competition in the Southern imitation-based products, the value of Southern firms is equal to zero in this case.

Now we can reduce the Northern general-purpose labor market clearing condition (18) to an equation in only two endogenous variables, \( t \) and \( u \). Using (16) to substitute for \( n_N \), (17) to substitute for \( c_S \), (25) to substitute for \( c_N \), (9) to substitute for \( D \) and (19) to substitute for \( X \), gives, after simplifying, the Northern steady-state unemployment rate \( u^* \) as a decreasing function of the innovation rate:

\[
\frac{u^*}{1 - s_N} = t \left( \frac{n_S}{\lambda \mu} + \frac{a_i \delta s_N}{n \gamma} \right). \tag{27}
\]

To ensure \( u^* \geq 0 \), there is an obvious upper bound \( \hat{\eta}_S \) for the relative size of the Southern population \( \eta_S \). Under balanced trade, \( \eta_S > \hat{\eta}_S \) would create excessive Northern labor demand for export production which cannot be fulfilled anymore.\(^{24}\)

Next, we equate (11) to (14) solved for \( v_N \), and use (9) to substitute for \( D \), which gives the Northern specialized-labor wage rate as an increasing function of \( w_L \) and \( t \):

\[
w_H = w_L \left( \frac{1 - \sigma_t}{\sigma_I + \alpha_i} \right) \left( 1 + B \right) \left( 1 - \frac{n \gamma}{n \gamma} \right). \tag{28}
\]

\(^{23}\) From (24) with \( \theta = 1 \) and (27), the expected wage bill per Northern general-purpose worker is found as

\[
\frac{W_N}{N_N} = (1 - s_N - u) w_N = t \left( \frac{\eta_S}{\lambda \mu} + \frac{a_i \delta s_N}{n \gamma} \right) \left( 1 + \frac{\alpha_i (1 + t^*) + \mu}{t + \mu (1 + t^*)} \right) + (1 - \alpha) w^* N_N,
\]

on which several globalization forces have opposite effects. Northern (Southern) unilateral trade liberalization reduces (raises) the wage bill through their effects on firm profits, of which a fraction is bargained for the workers. An increase in the relative size of the Southern economy \( \eta_S \) (which is motivated and analyzed in Dinopoulos and Segerstrom 2007, Lu (2007), Grieben 2007, and in our companion paper Grieben and Şener, 2007a) raises the wage bill through increasing \( c_S \) under balanced trade, which raises production and R&D employment. An increase in the exogenous Southern imitation rate \( \mu \) (also analyzed in Arnold 2002 and in our companion paper Grieben and Şener, 2007b) reduces the wage bill by decreasing the share of Northern industries and hence production employment, and by reducing R&D profitability and hence R&D employment. Overall, it cannot be claimed that ongoing globalization in general makes it more difficult for Northern labor unions to bargain their share of the firm profits.

\(^{24}\) Note that there cannot be given a meaningful interpretation for the result \( u^* \to 1 \) if \( \eta_S = 0 \) and \( s_N \to 0 \). This is because assuming \( \eta_S = 0 \) implies a closed economy, in which case the bargaining outcome \( w_L \) cannot be determined. This is because if \( w_L \) was defined in a closed economy, the “Northern” quality leader with unit production cost \( w_L \) would charge the limit price \( \lambda w_L \), hence per-period profits \( \pi_N \) would be independent of \( w_L \). In the bargaining problem (22), this would mean that there are no conflicting interests on \( w_L \) between employer and employees, hence no maximum of the \( \Omega \) function in (22) exists, which is a contradiction to the assumption that \( w_L \) is defined.
To determine the steady-state innovation rate $i^*$, we set (15) equal to (11), use (17) to substitute for $c_S$, (25) to substitute for $c_N$, (24) to substitute for $w_L > w_{min}^N$, (9) to substitute for $D$, (19) to substitute for $X$, use $\theta = 1$, $r = \rho$ and $\dot{\gamma}_N/n_N = n$, which yields the free-entry in innovation (FEIN) condition with $i^*$ as an implicit function solely in exogenous parameters:

$$
\frac{\eta_S(t + \mu)}{\mu \lambda} \left\{ \frac{1}{\alpha + (1 - \alpha)w_{min}^N - \frac{\epsilon + \mu + (\epsilon + \tau_S)}{2(\epsilon + \tau_S) + \mu}} \right\} - \frac{(1 - \sigma_s) a_t}{n c_{NN}} = \frac{n^N}{\rho + (1 + B)(2t + \mu) - n}
$$

(29)

$$
\Rightarrow i^* = i^* \left( w_{min}^N, \alpha, \tau_N, \tau_S, \mu, B, \lambda, \eta_S, \sigma_s, \rho, n, \gamma, a_t, \delta, S_N \right).
$$

The LHS of (29) gives the discounted R&D benefit divided by $w_L$, and the RHS of (29) gives R&D costs divided by $w_L$. It is obvious from the terms in curly brackets on the LHS that $w_{min}^N < \dot{w}_{min}^N$ is required for obtaining a positive R&D benefit. As is demonstrated in the Appendix, the signs indicated below (29) follow from implicit differentiation under sufficiently low tariff rates\(^{25}\) if, and only if,

$$
\rho - n < (1 + B) \mu
$$

(30)
is fulfilled. This turns out to be the condition for stability of equilibrium and thus\(^ {26}\) will be maintained for the rest of this paper.

The remaining endogenous variables are determined recursively: $L_N^L$ follows from (18) for given $n_N, c_N$ and $c_S$; also from (18), $L_N^R$ follows for given $L_N^L$ and $u^*$, which also determines $D$ for given $i^*$; $X$ follows then from (9) for given $n_N$ and $D$, $L_N^R$ follows for given $n_N$ and $X$ from (19), and $\pi_N$ and $\nu_N$ are then also pinned down from (7) together with (6), and (15), respectively.

--

\(^{25}\) 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 boundaries cannot be determined.

\(^{26}\) Technically, this assumption – as well as the assumption of sufficiently low tariff rates – is necessary to ensure that the implicit function $f(i^*, \ldots) = 0$ derived from (29) is monotonously decreasing in $i^*$. Intuitively, an increase in $i$ must reduce the profitability of innovative R&D expenditure in order to yield a stable solution for $i$. Thus, the significance of condition (30) is to ensure existence and uniqueness of the steady-state equilibrium when studied in the neighborhood of free trade. As is demonstrated in the Appendix, when starting with the assumption $\tau_N = \tau_S = 0$, (29) can be solved explicitly for $i$. 

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nally, the common steady-state utility growth rate is derived as usual from (2) as \( g^* = \frac{\dot{u}_N}{u_N} = \frac{\dot{u}_S}{u_S} = \nu \log \lambda \).\(^{27}\)

The properties of the steady-state innovation and unemployment rates are very intuitive. A decrease in the **minimum wage rate** \( w^{\text{min}} \) raises \( \nu^* \). A lower minimum wage rate worsens the effective bargaining power of the union, and thereby leads to a lower Northern wage rate. This reduces both R&D and production costs, and thus increases \( \nu^* \). For the same reason, \( \nu^* \) is decreasing in the **bargaining power** \( \alpha \) of the labor union.

A decrease in the **Northern import tariff** \( \tau_N \) exerts multiple effects on R&D profitability. First, it forces the Northern incumbent to reduce its mark-ups in the domestic Northern market, lowering the profit flows \( \pi_N \). This is reinforced by reduction in \( c_N \) which is triggered by the fall in \( \tau_N \). With profit sharing in place, the firm can pass on the lower profits to workers in the form of lower bargained wages. This works to mitigate the fall in \( \pi_N \) by reducing both R&D and production costs. The net impact though is a reduction in R&D profitability and thus a lower Northern import tariff \( \tau_N \) leads to a lower \( \nu^* \).

A decrease in the **Southern import tariff** \( \tau_S \) can be analyzed similarly. A lower \( \tau_S \) increases \( \pi_N \) by increasing the after-tariff price enjoyed by the Northern incumbent in the foreign Southern market and also by triggering an increase in \( c_N \). This is mitigated by higher wages \( w_N \) (due to the profit sharing mechanism implied by bargaining) and lower \( c_S \) (due to the expenditure reducing impact of \( \tau_S \) on the South). The net impact is an increase in R&D incentives and thus a lower Southern import tariff \( \tau_S \) leads to a higher \( \nu^* \).

As is evident from (29), tariffs matter for the Northern steady-state innovation rate if, and only if, \( w^{\text{min}} > 0 \), provided \( \alpha < 1 \).\(^{28}\) If \( w^{\text{min}} = 0 \), both tariff rates enter R&D benefits and costs proportionally such that they cancel out. Hence, the role of the minimum wage rate in this model,

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\(^{27}\) Note that this steady-state growth rate differ from those obtained in ‘semi-endogenous’ growth models like Jones (1995) or Segerstrom (1998) in an important aspect: since it depends on tariffs \( \tau_N \) and \( \tau_S \), the minimum wage rate \( w^{\text{min}} \), R&D subsidies \( \sigma_t \) and liquidation costs \( B_t \), it can be influenced by public policies. An aspect that this growth rate shares with many semi-endogenous and fully endogenous growth models is, however, that a positive population growth rate \( n \) is necessary for obtaining positive growth. This feature is explained and defended at length by Jones (2005).

\(^{28}\) If \( \alpha \to 1 \), R&D benefits go to zero, and there is no positive steady-state innovation rate.
besides serving as a reference point for the labor union in bargaining and improving its effective bargaining power, is to drive a wedge between the effects of tariffs on discounted R&D benefits, and their effects on R&D costs. A decrease in \( \tau_N \) reduces discounted profits of a Northern quality leader from domestic sales by more than it reduces the marginal R&D-cost component \( w_L \) if \( w^{\text{min}} > 0 \), simply because the minimum-wage component of Northern general-purpose workers is insensitive to tariff changes. Conversely, a decrease in \( \tau_S \) increases discounted profits of a Northern quality leader from foreign sales by more than it increases the marginal R&D-cost component \( w_L \) if \( w^{\text{min}} > 0 \).

An increase in the Southern imitation rate \( \mu \) has several effects on \( \iota^* \). It raises the replacement rate and thereby reduces the rewards from innovating \( v_N \) in (13). This effect is further strengthened by the reduction in both \( c_N \) and \( c_S \), which decreases \( \pi_N \). The firm can pass the decline in its profit flows to workers and bargain for lower wages \( w_L \). However, this does not dominate the negative effects and the net profitability of R&D declines. Consequently, a higher Southern imitation rate \( \mu \) decreases \( \iota^* \).  

Larger liquidation costs \( B \) reduce \( \iota^* \) via two channels: first, it reduces \( v_N \) in (13) by increasing the capital loss of the firm when imitation or further innovation takes place. Second, incumbent firms react to a larger \( B \) by increasing their RPA expenditures, (14), which leads to a further decline in \( v_N \).

An increase in the size of innovations \( \lambda \) has an ambiguous effect on \( \iota^* \). On the one hand, it raises the mark-up rates enjoyed by the Northern incumbent. On the other hand, with profit sharing, it leads to a higher bargained wage rate \( w_L \), raising both R&D and production costs. The net effect on R&D incentives depends on the parameters.

An increase in the relative size of the Southern economy \( \eta_S \) increases \( c_N \) and hence generates larger profits from domestic sales in the North. This increases innovation incentives and thus \( \iota^* \). An increase in the R&D subsidy rate \( \sigma_I \) reduces marginal R&D costs and thus \( \iota^* \). An

\[ \text{Note that this result contrasts with the different findings in Helpman (1993), Arnold (2002) and our companion work Grieben and Şener (2007b), as is discussed in that latter paper.} \]

\[ \text{Of course a decrease in } v_N \text{ due to a higher } B \text{ ceteris paribus reduces RPA as can be seen in (14). This indirect effect of } B \text{ on the optimal level of RPA, however, is more than offset by the direct effect.} \]
increase in the interest rate $\rho$ (which equals the households’ time preference rate) reduces innovation incentives due a larger discount rate for monopoly firm profits expected by entrepreneurs investing in R&D. $i^*$ depends positively on the population growth rate $n$ for two reasons. A higher $n$ reduces the steady-state per capita R&D difficulty level. In addition, it implies a higher profit growth rate and a larger $v_N$ (as captured by the $-n$ term in the discount factor).

$i^*$ depends positively on the unit labor requirement $\gamma$ of RPA since the higher $\gamma$, the lower will be the stock of RPA as measured by $X$, hence the lower will be R&D difficulty $D$ and thus the higher will be $i$ for any given level of R&D activity $R$, see (10). A larger unit labor requirement of R&D $a_i$ (i.e., a lower R&D labor productivity) increases the required reward for innovating $v_N$ for R&D firms to break even, hence in (13) the endogenous part $i$ of the replacement rate must decline. More generally, following the interpretation given in Dinopoulos and Syropoulos (2007, p. 313), since the steady-state innovation rate is proportional to $\gamma/a_i$, it is “proportional to the relative price (the opportunity cost) of rent protection services expressed in units of R&D services”. A higher effectiveness $\delta$ of RPA reduces $i^*$ since it implies a higher R&D difficulty $D$, which reduces the marginal productivity of R&D workers. Finally, a larger proportion of specialized workers $s_N$ reduces $i^*$ since it implies a higher level of RPAs from (19), which works in the same way as an increase in $\delta$.

We now briefly discuss those determinants of the steady-state unemployment rate $u^*$ given in (27) which are of main interest. First, a decrease in the labor union’s bargaining power $\alpha$ or the minimum wage rate $w_{min}$ unambiguously reduces $u^*$ by increasing $i^*$. A higher $i^*$ raises production employment by increasing both the proportion of Northern industries $n_N$ and the level of workers demanded in each industry, $[c_N N_N/(1 + \tau_N)] + c_S N_S$. In addition, the higher R&D intensity $i^*$ directly raises R&D labor demand. There is no union impact on $u^*$ other than through raising $i^*$ since the bargained wage rate does not affect Northern supply prices. Second, Northern (Southern) unilateral trade liberalization $\tau_N \downarrow$ ($\tau_S \downarrow$) increases (decreases) Northern unemployment by reducing (raising) $i^*$. Note, however, that these results are tied to the existence of a positive minimum wage $w_{min}$, as we have discussed above. Third, an increase in the Southern imitation rate $\mu$ raises $u^*$ despite its negative impact on $w_L$ for two related reasons: it reduces the pro-
portion of Northern industries \( n_N \) both directly and indirectly, by decreasing \( \epsilon^* \). **Fourth**, an increase in liquidation costs \( B \) raises \( u^* \) by reducing \( \epsilon^* \). Note, however, that our model does not predict a negative growth-unemployment correlation throughout: while it does predict this for parameter changes in \( \mu, \alpha, w^{\text{min}}, \tau_N, \tau_S, B, \eta_S, \sigma, \) and \( \rho \) (which imply effects of opposite sign on \( \epsilon^* \) and \( u^* \)), the correlation is ambiguous for parameter changes in \( \lambda, n, \gamma, a, \delta, \) and \( s_N \).  

To further interpret our results for \( u \), the Appendix derives the hypothetical level of \( w_L \) that would prevail if there were no Northern wage bargaining and no (binding) minimum wage, i.e. the competitive unskilled wage rate as a function solely in \( \epsilon \):

\[
\hat{w}_L(t) = \frac{\lambda \left[ (1 + \tau_N) + \mu \eta_S(t + \mu)n \gamma \right]}{[t + \mu(1 + \tau_S)] \left[ \eta_S(t + \mu) n \gamma + \mu \lambda \left[ \rho + (1 + B)(2t + \mu) - n \right] (1 - \sigma) a \delta \eta_S \right]}.
\] (31)

From this result and (24) with \( \theta = 1 \), it follows for any given innovation rate \( \epsilon \) that \( u^* > 0 \) if

\[
\alpha > \frac{\frac{w^{\text{min}}}{\hat{w}_L(t) - w^{\text{min}}} - W^{\text{min}}}{\hat{w}_L(t) - w^{\text{min}}} \equiv \hat{\alpha} < 1 \iff w_L > \hat{w}_L(t),
\] (32)

i.e., there is positive Northern unemployment whenever the wage bargaining parameter \( \alpha \) exceeds the critical level at which the competitive wage rate \( \hat{w}_L \) is bargained, irrespective of the level of \( w^{\text{min}} \). **Conversely**, \( u^* = 0 \) if \( \hat{w}_L \geq w_L \geq w^{\text{min}} \), where the first inequality requires \( \alpha \leq \hat{\alpha} \). By help of (32), we can see another important role of the minimum wage in affecting unemployment, in addition to its directly negative effect via reducing innovation. As is derived in the Appendix, \( \partial \hat{\alpha} / \partial w^{\text{min}} < 0 \), i.e. an increase in the minimum wage rate makes trade-union induced unemployment more likely by reducing the critical value of the labor union’s bargaining power. Summarizing the main arguments, we have derived our

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31 For an extensive discussion of the growth-unemployment correlation in a job-matching framework, see Dinopoulos et al. (2007).

32 If \( w^{\text{min}} > \hat{w}_L \), there are two possibilities: \( w^{\text{min}} > w_L \) so that \( w^{\text{min}} \) is binding and there is minimum-wage unemployment, or \( w^{\text{min}} \leq w_L \) so that \( w^{\text{min}} \) is not binding and \( w_L \) applies. In any case, \( w_L > \hat{w}_L \) is sufficient to cause \( u^* > 0 \).
Proposition 1: With exogenous Southern imitation, a unique steady-state equilibrium with positive Northern unemployment exists for $\alpha > \bar{\alpha}$ and sufficiently low tariff rates, provided that condition (30) is fulfilled. Starting from that equilibrium,

i.) an increase in the relative size of the South $\eta_S$ increases Northern innovation and growth, and decreases Northern unemployment;

ii.) a decrease in the Northern import tariff rate $\tau_N$ reduces Northern innovation and growth, and increases Northern unemployment;

iii.) a decrease in the Southern import tariff rate $\tau_S$ increases Northern innovation and growth, and decreases Northern unemployment;

iv.) an increase in the Southern imitation rate $\mu$ reduces Northern innovation and growth, and increases Northern unemployment;

v.) a decrease in the labor union’s bargaining power $\alpha$ or the minimum wage rate $w_{\text{min}}$ increase Northern innovation and growth, and reduce Northern unemployment;

vi.) an increase in the liquidation costs $B$ (the R&D subsidy rate $\sigma$) reduces (increases) Northern innovation and growth, and increases (decreases) Northern unemployment.

4 An Extended Model With Endogenous Southern Imitation

4.1 How The Basic Model Changes

There is still just one type of Southern worker who can now perform either production or imitative R&D, and the Southern wage rate is still normalized to $w_S \equiv 1$. Southern firms do not engage in RPA. Southern imitation is modeled analogously to Northern innovation in section 2.4. The instantaneous probability of imitation success (Poisson arrival rate) $\mu_j$ by any Southern firm $j$ is given as

$$\mu_j(\omega, t) = \frac{M_j(\omega, t)}{D(\omega, t)}$$

(33)

where $M_j(\omega, t)$ represents the imitation intensity (determined by the number of R&D workers used
and their productivity) of a typical Southern entrepreneur \( j \) targeting industry \( \omega \). \( \hat{D} \) is given by (8) and \( D \) by (9). R&D difficulty is the same as for Northern innovation since imitation targets the same technology, and there are no specific imitation-deterring RPA of Northern firms.\(^{33}\) Therefore, the Poisson arrival rate for imitation at the industry level equals

\[
\mu(\omega,t) = \sum_j \mu_j(\omega,t) = \frac{M(\omega,t)}{D(\omega,t)} \quad \text{with} \quad M(\omega,t) = \sum_j M_j(\omega,t) .
\]

(34)

Since Southern entrepreneurs target only Northern industries, the economy-wide Southern imitation rate is given as \( m = \mu n_N \).

The cost of conducting \( M_j \) units of imitative activity in the South is \( a_\mu M_j \), where \( a_\mu \leq a_\iota \) is the unit labor requirement of imitation.\(^{34}\) Under free entry into imitation, expected profits from imitative R&D are competed away, and the maximization problem

\[
\max_{M_j} \frac{v_S M_j}{D} dt - a_\mu M_j dt
\]

yields

\[
v_S = a_\mu D .
\]

(35)

There is now a global stock market on which, in addition and similar to (13), the following no-arbitrage condition for investments in Southern R&D firms (which do not face the risk of imitation and do not have to pay any liquidation costs \( B \)) holds:

\[
v_S = \frac{\pi_S}{r + 1 - \left(\hat{v}_S / v_S\right)} .
\]

(36)

We derive optimal Northern RPAs in the same way as before but now take into account the endogeneity of the Southern imitation rate. Hence, RPAs change the replacement rate by \( dt + d\mu = -(r+\mu)(dX/X) \), and the Northern incumbent firm’s optimal rent protection expenditure (14) now

\(^{33}\) Grieben and Şener (2007a) distinguish between the cases of general RPA, performed by Northern workers of incumbent firms and targeted on both innovation and imitation simultaneously, and specific RPA. In the latter case, Northern incumbent firms hire Northern workers for innovation-deterring activities and Southern workers for imitation-deterring activities.

\(^{34}\) Mansfield et al. (1981) found that on average, imitation costs amount to 65 % of innovation costs.
becomes
\[ v_N (1 + B)(1 + \mu) = w_L' \gamma X. \tag{37} \]

This means that Northern quality leaders now invest in extra RPAs in order to discourage Southern imitative R&D as well. As a consequence, the discounted Northern firm value (15) slightly changes to
\[ v_N = \frac{c_N N_N \left[ 1 - \frac{w_L}{x(1+\tau_N)} \right] + c_S N_S \left( \frac{1}{1+\tau_S} - \frac{w_L}{x} \right)}{r + 2(1+B)(1+\mu) - \hat{v}_N / \hat{v}_N}. \tag{38} \]

Since the discount rate in \( v_N \) cancels when deriving the Nash bargaining solution, the bargained wage rate \( w_L \) from (24) does not change. Setting (38) equal to (11), and using \( r = \rho = \rho_N \) and \( \hat{v}_N / v_N = n \) yields the free-entry in innovation (FEIN) condition
\[ v_N = \frac{c_N N_N \left[ 1 - \frac{w_L}{x(1+\tau_N)} \right] + c_S N_S \left( \frac{1}{1+\tau_S} - \frac{w_L}{x} \right)}{\rho + 2(1+B)(1+\mu) - n} = \frac{w_L \left( 1 - \sigma \right) a_0 \delta s N_N}{n \gamma}. \tag{39} \]

Next, competition and pricing behavior of Southern firms change. The successful Southern imitating firm can engage in monopoly pricing and drive out Southern competitors in both the Northern and the Southern market, similar to a Northern technology leader. The leading Southern firm’s technology does no longer diffuse for free to its local competitors.

Consider the profits of the successful Southern imitator who competes with the Northern quality leader in both Northern and Southern markets (the followers in both regions, who can only offer one-step-inferior goods, are priced out). The Northern quality leader must charge at least the unit costs \( w_L \), hence on the Northern market, the Southern imitator charges the limit price \( p_N^S = w_L - \epsilon \) with \( \epsilon \to 0 \) and receives \( w_L / (1+\tau_N) \) of it, whereas \( w_L \) is the price faced by Northern consumers. On the Southern market, the Southern imitator charges \( p_S^S = w_L (1+\tau_S) - \epsilon \) with \( \epsilon \to 0 \). This pricing drives the Northern leader out of the markets in both countries. Hence the profits of the Southern quality leader from worldwide sales are:
\[ \pi_S = \pi_N^S + \pi_S^S = \frac{c_N N_N}{w_L} \left[ \frac{w_L}{1+\tau_N} - 1 \right] + \frac{c_S N_S}{w_L} \left[ \frac{w_L}{1+\tau_S} - 1 \right]. \tag{40} \]
Using (40) in (36) together with \( r = \rho \) and \( \dot{v}_s / v_s = n \), setting this equal to (35), and using (9) and (19) to substitute for \( D \) and \( X \), respectively, yields the free-entry in imitation (FEIM) condition

\[
\frac{c_N n_N \left( \frac{1}{1+\tau_N} - \frac{1}{\rho} \right) + c_S n_S \left[ 1 - \frac{1}{w_s (1+\tau_s)} \right]}{\rho + t - n} = a_\mu \delta s_N N_N n\gamma .
\]

The Southern labor market clearing condition (20) changes to

\[
\frac{1-n_N}{w_L} \left( c_N n_N + c_S N_S \right) + n_N a_\mu \mu D = N_S,
\]

where \( n_N a_\mu M = n_N a_\mu \mu D \) is the Southern R&D labor demand. Observe that the Northern general-purpose wage rate \( w_L \) now enters the Southern labor market clearing condition.

Finally, the BOT condition does not change since

\[
n_N \frac{c_S N_S}{\lambda} = (1-n_N) \frac{c_N n_N}{w_L} \frac{w_L}{1+\tau_N} = \frac{p_n}{(1+\tau_N)}
\]

boils down, after invoking (16), to (17) again.

### 4.2 The New Steady-State Equilibrium

We have the seven equations (16), (17), (18), (24), (39), (41), and (42) in the seven unknowns \( n, c_N, c_S, \mu, w_L, \) and \( u \). We first plug (16), (17) and (24) with \( \theta = 1 \) into (42), using \( D = \delta s_N N_N / (n\gamma) \), and solve this for \( c_N \) as a function of \( t \) and \( \mu \) only:

\[
c_N = \left[ \frac{n_S (t+\mu)}{\mu} - \frac{ia_\mu \delta s_N}{n\gamma} \right] t (1+\tau_N) \left[ \frac{\alpha \lambda}{t+\mu (1+\tau_s)} + \frac{(1-\alpha) w_{min}}{t (1+\tau_N) + \mu} \right].
\]

Observe that since \( c_N > 0 \) is required, which implies that we have to restrict \( (\mu, t) \) to the space \( \mu < \mu_{max} \equiv n_S n\gamma / (a_\mu \delta s_N - n\gamma) \). For \( \mu_{max} > 0 \), this implies a lower bound for the Northern innovation rate, \( t > t_{min} \equiv n_S n\gamma / (a_\mu \delta s_N) \). We now plug (16), (17), (24) with \( \theta = 1 \) and (43) into (39) and (41), respectively, which yields, after simplifying, two equations in the two unknowns \( t \) and \( \mu \).
\[
\frac{\eta_S(t + \mu)}{\mu \delta S_N} - \tau S_N = \left[ \frac{\rho + 2(1 + B)(t + \mu) - n}{(1 - \alpha)} \right] \left[ 1 - \frac{w_{\min}}{\lambda} \left( \frac{t + \mu(1 + \tau_S)}{t(1 + \tau_N) + \mu} \right) \right],
\]
\[
\frac{\eta_S(t + \mu)}{\mu \delta S_N} - \tau S_N = \left[ \frac{\rho + \tau - n}{\alpha \lambda - 1} \right] \left[ \frac{(1 - \alpha)w_{\min}}{t(1 + \tau_N) + \mu} \right] \left( \frac{t + \mu(1 + \tau_S)}{t(1 + \tau_N) + \mu} \right),
\]

Given the restriction \( w_{\min} < \tilde{w}_{\min} \) from (24), the RHS of (44) is positive so that the common LHS of both (44) and (45) are positive. Together with the requirement of the denominator of (45) being positive, for the existence of a steady-state equilibrium with a non-binding minimum wage,

\[
\frac{1 - \alpha \lambda}{1 - \alpha} > \frac{w_{\min}}{\lambda w_{\min}} \left( \frac{t + \mu(1 + \tau_S)}{t(1 + \tau_N) + \mu} \right) \equiv \frac{\lambda w_{\min}}{w_{\min}} < \lambda
\]

must be fulfilled.\(^{35}\)

The curve for the FEIN condition (44) is downward sloping in \((t, \mu)\)-space: an increase in \( \mu \) increases the RHS and decreases the LHS of (44). An equilibrium with free entry in innovation is restored by a decrease in \( t \), which – for sufficiently low tariff rates \( \tau_N \) and \( \tau_S \) – lowers the RHS of (44)\(^{36}\) and raises the LHS provided that \( \mu > \mu_{\min} = \eta_S n \gamma/(\alpha \mu \delta S_N) = t_{\min} \). The curve for the FEIM condition (45) is also downward sloping in \((t, \mu)\)-space for sufficiently low tariffs. To see this, note first that an increase in \( \mu \) lowers the LHS unambiguously. Second, although an increase in \( \mu \) also lowers the RHS for positive tariffs, this latter effect vanishes as tariffs go to zero. Third, a decline in \( t \) reduces the RHS irrespective of tariff levels, while it raises the LHS of (45) for \( \mu > \mu_{\min} \). The negative slope of both the FEIN- and the FEIM-curve is intuitive. For the FEIN-curve, we require stability in the sense that an increase in \( t \) should reduce the profitability of further innovation, which implies that discounted R&D benefits tend to fall short of R&D costs. To restore

\(^{35}\) The first inequality in (46) implies \( \alpha > \tilde{\alpha} \equiv (\tilde{w}_{\min} - \tilde{w}_{\min})/(\tilde{\lambda}(\tilde{w}_{\min} - \tilde{w}_{\min})) \), with \( \tilde{\alpha} > 0 \) if, and only if, \( \tilde{w}_{\min} < \left[ \alpha(1 + \tau_N) + \mu \right]/\left[ t + \mu(1 + \tau_N) \right] \). Hence, for a sufficiently low minimum wage, the union’s bargaining power must exceed a critical value \( \tilde{\alpha} > 0 \) in order to sustain an equilibrium with free entry in Southern imitation. Otherwise, a Vernon-type product cycle for given \( w_S = 1 \) would be no longer supported since a too low \( \alpha \) would result in a too low \( w_L \).

\(^{36}\) The exact condition for a decrease in \( t \) to reduce the RHS of (44) when tariffs go to zero is \( \lambda > w_{\min} \), which is condition (24) for the case of free trade.
the FEIN condition, \( \mu \) has to decline since the net effect of this is to increase R&D benefits again, as we have explained before for the model with exogenous \( \mu \). The same way of reasoning explains the negative slope of the FEIM-curve.

To decide which curve is steeper in absolute terms, we derive the elasticity of the RHS of both equations with respect to \( \iota \) for \( \tau_N = \tau_S = 0 \). The RHS of (44) is more elastic with respect to changes in \( \iota \) than the RHS of (45) if

\[
\alpha > \alpha_{\text{crit}}^{\text{F}} \equiv \frac{a_{\mu} \left(1 - \frac{w_{\text{min}}}{\lambda}\right) + 2(1 + B)(1 - \sigma_i)a_i \left(1 - w_{\text{min}}\right)}{\left(1 - \frac{w_{\text{min}}}{\lambda}\right) \left[a_{\mu} + \lambda 2(1 + B)(1 - \sigma_i)a_i\right]} < 1. \tag{47}
\]

\( \alpha_{\text{crit}}^{\text{F}} \) becomes negative – hence irrelevant as a restriction in (47) – for

\[
\alpha_{\text{crit}}^{\text{F}} < 0 \iff w_{\text{min}} > \tilde{w}_{\text{min}} \equiv \frac{a_{\mu} + 2(1 + B)(1 - \sigma_i)a_i}{a_{\mu} + 2(1 + B)(1 - \sigma_i)a_i} > 1. \tag{48}
\]

We have therefore to distinguish two cases. In case one, we have \( 1 < \tilde{w}_{\text{min}} \leq w_{\text{min}} < \hat{w}_{\text{min}} \iff \alpha_{\text{crit}}^{\text{F}} \leq 0 \), hence for any relevant \( \alpha > 0 \), a smaller decrease in \( \iota \) would be required in the FEIN condition to balance a marginal rise in \( \mu \) than in the FEIM condition, hence the FEIN curve is flatter than the FEIM curve. This situation is illustrated as “case A” in Figure 1 below. In case two, we have \( 1 < w_{\text{min}} < \tilde{w}_{\text{min}} < \hat{w}_{\text{min}} \iff \alpha_{\text{crit}}^{\text{F}} > 0 \). This allows for two subcases: either \( \alpha > \alpha_{\text{crit}}^{\text{F}} > 0 \), such that “case A” is relevant again, or \( \alpha_{\text{crit}}^{\text{F}} \geq \alpha > 0 \), which is illustrated as “case B” in Figure 1 below. \( ^{38} \)

**Here: Figure 1 (A) and 1 (B)**

From Figure 1 and equations (44) and (45), we can immediately derive three comparative-static results. **First**, when \( \alpha \) decreases, \( \mu \) must rise for any given \( \iota \) to restore the FEIN condition such that the curve for FEIN shifts to the right, and – for sufficiently low tariff rates – \( \mu \) must decrease

\[ ^{37} \text{It is straightforward to show } \alpha_{\text{crit}}^{\text{F}} > 0 \text{ for } \tau_N = \tau_S = 0. \text{ Furthermore, for later use we note that } \partial \alpha_{\text{crit}}^{\text{F}} / \partial B < 0 \text{ and } \partial \alpha_{\text{crit}}^{\text{F}} / \partial \sigma_i > 0. \]

\[ ^{38} \text{For } \alpha = \alpha_{\text{crit}}^{\text{F}} \text{ the FEIN curve is still steeper than the FEIM curve; while a marginal increase in } \mu \text{ reduces the (identical) LHS by the same amount, it also marginally increases the RHS of (44) and marginally reduces the RHS of (45). Since the RHS of (44) and (45) are equally elastic with respect to changes in } \iota \text{ in this case, a (marginally) larger reduction of } \iota \text{ would be required to restore the FEIN condition (44).} \]
for any given $\iota$ to restore the FEIM condition such that the curve for FEIM shifts to the left. Obviously, a decrease in $\alpha$ raises the steady-state value of $\iota$ and reduces the steady-state value of $\mu$ for $\alpha > \alpha^{\text{crit}}$ (case A), and vice versa for $0 < \alpha < \alpha^{\text{crit}}$ (case B). Second, a decrease in $w_{\text{min}}$ has qualitatively the same effects as a decrease in $\alpha$. Third, a decrease in $\tau_{\text{N}}$ (Northern unilateral trade liberalization) has qualitatively the opposite effects as a decrease in $\alpha$ or $w_{\text{min}}$, while a decrease in $\tau_{\text{S}}$ (Southern unilateral trade liberalization) has qualitatively the same effects as a decrease in $\alpha$ or $w_{\text{min}}$.

Finally, we plug (16), (17) and (43) into the Northern general-purpose labor market equilibrium condition (18), use (9) and (19) to substitute for $D$ and $X$, respectively, and solve this for $u$, which yields in the steady-state equilibrium

$$u^* = 1 - S_N - \iota^* \left\{ \frac{\eta_S}{\mu^*} - \frac{i^* a_{\mu} \delta s_N}{(i^* + \mu^*) n \gamma} \right\} \left[ \alpha + \frac{(1 - \alpha) w_{\text{min}}}{\lambda} \cdot \frac{t + \mu (1 + \tau_S)}{t (1 + \tau_N) + \mu} + \frac{\alpha \delta s_N}{n \gamma} \right].$$  

(49)

Note that the first term in brackets on the RHS of (49) is positive for $\mu < \mu_{\text{max}}$. As for the case with exogenous $\mu$, the Appendix derives the hypothetical competitive wage rate that would apply if there were no wage bargaining and no (binding) minimum wage, as a function of $\iota$ and $\mu$:

$$\tilde{w}_L (\iota, \mu) = \frac{\lambda \left[ t (1 + \tau_N) + \mu \right]}{t + \mu (1 + \tau_N)} \left\{ 1 - \frac{\rho + 2 (1 + B) (t + \mu) - n (1 - \sigma) a_{\mu} \delta s_N}{\frac{\eta_S (\tau_S) \mu}{\mu} - a_{\mu} \delta s_N} \right\}. $$  

(50)

From this result and (24) with $\theta = 1$, it follows for any given $\iota$ and $\mu$ that $u^* > 0$ if

$$\alpha > \frac{\rho + 2 (1 + B) (t + \mu) - n (1 - \sigma) a_{\mu} \delta s_N}{\frac{\eta_S (\tau_S) \mu}{\mu} - a_{\mu} \delta s_N} - w_{\text{min}} \quad \equiv \tilde{\alpha} < 1 \quad \iff \quad w_{\text{L}} > \tilde{w}_L (\iota, \mu).$$  

(51)

Since $w_{\text{min}} < \tilde{w}_L$, it is $\partial u^*/\partial \alpha < 0$ for given $\iota^*$ and $\mu^*$. A decrease in $w_{\text{min}}$ or $\tau_{\text{S}}$, and an increase in $\tau_{\text{N}}$, have qualitatively the same unemployment effects as a decrease in $\alpha$. Next, for $\tau_{\text{N}} = \tau_{\text{S}} = 0$, it is
\[
\frac{\partial u^*}{\partial \tau_N} = \alpha + \frac{(1-\alpha)w_{\text{min}}}{\lambda} \left[ \frac{\eta_S}{\mu^* (i^* + \mu^*)^2 n\gamma} \right] i^* a_{\mu} \delta s_N > 0,
\]

\[
+ \frac{\delta s_N}{(i^* + \mu^*)^2 n\gamma} \left[ \alpha + \frac{(1-\alpha)w_{\text{min}}}{\lambda} i^* \mu^* a_{\mu} - (i^* + \mu^*)^2 a_\alpha \right] < 0,
\]

where the sign of the term in curly brackets follows unambiguously from \( i^* \mu^* < (i^* + \mu^*)^2 \) and \( a_\mu \leq a_\alpha \). Finally, again for \( \tau_N = \tau_S = 0 \), it is

\[
\frac{\partial u^*}{\partial \mu^*} = \alpha + \frac{(1-\alpha)w_{\text{min}}}{\lambda} \left[ \frac{\eta_S}{(i^* + \mu^*)^2 n\gamma} \right] > 0,
\]

where the sign follows from \( \mu^* < \mu_{\text{max}}^* \) and \( \mu^*/(i^* + \mu^*) < 1 \). Collecting the arguments, provided \( 0 < \alpha \leq \alpha^{\text{crit}} \) (case B in Figure 1), it follows

\[
\frac{du^*}{d\alpha} = \frac{\partial u^*}{\partial \alpha} + \frac{\partial u^*}{\partial i^*} \frac{\partial i^*}{\partial \alpha} + \frac{\partial u^*}{\partial \mu^*} \frac{\partial \mu^*}{\partial \alpha} < 0,
\]

whereas for \( \alpha > \alpha^{\text{crit}} \) (case A in Figure 1), the sign of \( du^*/d\alpha \) is ambiguous because of \( \partial i^*/\partial \alpha < 0 \) and \( \partial \mu^*/\partial \alpha > 0 \). Summarizing the main arguments of this section, we have derived our

**Proposition 2:** With endogenous Southern imitation and sufficiently low tariff rates, a unique steady-state equilibrium with a non-binding Northern minimum wage and positive unemployment exists for \( \alpha > \hat{\alpha} \), provided that condition (46) is fulfilled. Starting from that equilibrium,

i. a decrease in the Northern import tariff \( \tau_N \) (\( \tau_S \)) reduces (raises) the Northern innovation rate, raises (reduces) the Southern imitation rate, and has an ambiguous effect on the Northern unemployment rate if \( \alpha > \alpha^{\text{crit}} \);

ii. a decrease in the Northern import tariff \( \tau_N \) (\( \tau_S \)) raises (reduces) the Northern innovation rate, reduces (raises) the Southern imitation rate, and reduces (raises) the Northern unemployment rate if \( 0 < \alpha \leq \alpha^{\text{crit}} \);
iii. A decrease in the labor union’s bargaining power $\alpha$ or the minimum wage rate $w_{\text{min}}$ raise the Northern innovation rate, reduce the Southern imitation rate, and have an ambiguous effect on the Northern unemployment rate if $\alpha > \alpha^{\text{crit}}$;

iv. A decrease in the labor union’s bargaining power $\alpha$ or the minimum wage rate $w_{\text{min}}$ reduce the Northern innovation rate, raise the Southern imitation rate, and raise the Northern unemployment rate if $0 < \alpha \leq \alpha^{\text{crit}}$;

$\alpha^{\text{crit}}$ is decreasing in liquidation costs $B$ and increasing in R&D subsidies $\sigma_r$.

We first explain the results iii. and iv. A decrease in $\alpha$ or $w_{\text{min}}$ mainly triggers two general-equilibrium effects, one of which working towards a decrease in Southern imitation and an increase in Northern innovation, the other working in exactly opposite direction. On the one hand, the resulting decline in $w_L$ reduces Northern production and R&D costs, both of which tend to improve Northern innovation incentives. Moreover, Southern firms’ supply prices $p_S^N$ and $p_S^S$ decline, which decreases Southern firms’ profits, which reduces imitation incentives. On the other hand, (43) reveals that a lower $\alpha$ or $w_{\text{min}}$ reduces $c_N$ and, invoking the BOT condition (17), also $c_S$. This can easily be seen from the Southern labor market equilibrium condition (42): given $n_N$ and $\mu$, a decrease in $w_L$ increases demand for Southern production workers, hence consumption expenditure must decline to equalize labor demand and labor supply again. This reduces Northern firms’ profits and hence innovation incentives, thus $\iota$ tend to decline. A decline in the Northern innovation rate raises Southern discounted profits from imitation by prolonging the incumbency period of Southern firms, which induces an increase in the Southern imitation rate $\mu$. The initial level of $w_L$ determines the strength of this second effect working through the Southern labor market equilibrium condition: the lower $w_L$ (i.e., the lower $\alpha$ or $w_{\text{min}}$), the larger is the required decline in $c_N$ and $c_S$ for any given further decline in $w_L$. This explains why a decrease in $\alpha$ or $w_{\text{min}}$ reduces $\iota$ and increases $\mu$ for $\alpha \leq \alpha^{\text{crit}}$, and vice versa for $\alpha > \alpha^{\text{crit}}$.

With respect to results i. and ii. of Proposition 2, the arguments run parallel to those on a decrease in $\alpha$ or $w_{\text{min}}$. A decrease in $\tau_N$ reduces $w_L$ by reducing Northern profits from home sales $\pi_N^N$, i.e. there is less to be bargained with the labor union for given $\iota$, $\mu$, $c_N$ and $c_S$ (direct competition effect). Again, on the one hand, this reduces Northern production and R&D costs (which
tends to increase $i$ and hence to decrease $\mu$ as well as Southern firms’ supply prices $p^S_N$ and $p^N_S$. This deterioration of the Southern terms of trade reduces Southern firms’ profits and hence their imitation incentives. A decrease in the Southern imitation rate raises Northern firms’ discounted profits by prolonging the quality leaders’ incumbency period. On the other hand, inspection of (43) reveals that a decrease in $\tau_N$ reduces $c_N$ for given $i$ and $\mu$, but increases $c_S$ by the BOT condition (17). The Southern labor market clearing condition (42) implies that for given $n_N$ and $\mu$, a decrease in $w_L$ must result in a net decline in consumption expenditure for goods produced in the South, $c_Nn_N + c_Sn_S(1+\tau_S)$, in order to clear the Southern labor market. As before, this second effect tends to decrease $i$ and therefore increase $\mu$. Again, the strength of this second effect depends crucially on the initial level of $w_L$, and hence on the level of $\alpha$. For $\alpha \leq \alpha^{\text{crit}}$, i.e. a sufficiently low $w_L$, the second effect dominates the first, hence a further decline in $w_L$, triggered by a decline in $\tau_N$, reduces $i$ and increases $\mu$, while the opposite result holds for $\alpha > \alpha^{\text{crit}}$. For a decrease in $\tau_S$, all arguments are just reversed. For the reason discussed before when analyzing the model with exogenous Southern imitation, tariffs matter only for $i$ and $\mu$ if $w^{\text{min}} > 0$.

A decrease in $B$ or an increase in $\sigma_i$ reduce the RHS of (44), hence for sufficiently low tariffs, an increase in $\mu$ is required for any given $i$ to restore the FEIN condition. This implies in Figure 1 a rightward shift of the FEIN curve, which increases (decreases) $\mu^*$ and decreases (increases) $i^*$ for $0 < \alpha \leq \alpha^{\text{crit}}$ ($\alpha > \alpha^{\text{crit}}$).\(^{39}\) Moreover, for $0 < \alpha \leq \alpha^{\text{crit}}$ ($\alpha > \alpha^{\text{crit}}$), the decrease (increase) in $i^*$ is accompanied by an increase (decrease) in $u^*$. Stated differently, an increase in $\alpha^{\text{crit}}$ (achieved by a lower $B$ or a higher $\sigma_i$) is conducive for growth and Northern employment as long as $\alpha > \alpha^{\text{crit}}$, and a decrease in $\alpha^{\text{crit}}$ (achieved by a higher $B$ or a lower $\sigma_i$) is conducive for growth and Northern employment as long as $0 < \alpha < \alpha^{\text{crit}}$, which establishes our

\textbf{Proposition 3:} The growth-maximizing and unemployment-minimizing job-protection and R&D-subsidy policy is to adjust $B$ and $\sigma_i$ such that $\alpha^{\text{crit}}$ equals $\alpha$.

\(^{39}\) Of course, the direct impact of a decrease in $B$ or an increase in $\sigma_i$ is to improve Northern innovation incentives, which is reflected in the upward shift of the FEIN curve for any given level of $\mu$. If the FEIM curve is relatively elastic ($0 < \alpha \leq \alpha^{\text{crit}}$), however, then the endogenous adjustment of $\mu$ results in a net decrease in $i$. For example, any increase in $i$ ceteris paribus raises $w_L$, which not only increases Northern R&D costs but also improves Southern terms of trade. The increase in Southern export prices (with corresponding decrease in Southern export quantities) frees up some Southern labor for imitation. More Southern imitation implies a higher replacement rate for Northern incumbent firms, which reduces innovation incentives.
Hence, whether the government should raise or reduce $\alpha^{\text{crit}}$ depends crucially on whether $0 < \alpha \leq \alpha^{\text{crit}}$ (sufficiently weak labor union) or $\alpha > \alpha^{\text{crit}}$ (sufficiently strong labor union). Our model suggests that Northern countries with sufficiently strong labor unions (which is more likely the case for continental Western Europe) should have a low level of job protection $B$ and a high level of R&D subsidies $\sigma_i$. This is because for $\alpha > \alpha^{\text{crit}}$, the FEIN curve is more elastic than the FEIM curve, hence stimulating Northern innovation by decreasing $B$ or increasing $\sigma_i$ actually does increase the Northern steady-state innovation rate, and therefore reduces the Northern unemployment rate. Conversely, Northern countries with sufficiently weak labor unions (which is more likely the case for the US) should have a high level of job protection and a low level of R&D subsidies. This is because for $\alpha \leq \alpha^{\text{crit}}$, the FEIM curve is more elastic than the FEIN curve, hence stimulating Northern innovation by decreasing $B$ or increasing $\sigma_i$ is counterproductive since its general-equilibrium effect is to decrease $\iota$ and to increase $\mu$, and it therefore increases the Northern unemployment rate.

5 Conclusions

In this paper, we have analyzed the impact of various forms of globalization as well as institutional changes in the Northern labor market on growth and employment in a North-South product-cycle model with fully endogenous scale-free growth, where the Northern wage rate is bargained by a labor union. We distinguish between the cases of exogenous and endogenous Southern imitation and highlight the importance of this distinction for our results. We find that with exogenous Southern imitation, globalization originating from the South – except for an increase in the imitation rate – benefits the North in terms of growth and employment, but globalization originating from the North harms the North in terms of growth and employment. A weaker Northern labor union or a lower Northern minimum wage rate also raise Northern growth and reduce Northern unemployment. All of these findings are independent of the level of the bargaining power of the Northern labor union. With endogenous Southern imitation, we get qualitatively the same results for a sufficiently strong Northern labor union, but opposite results for a sufficiently weak Northern labor union: globalization originating from the South (North) then hurts (benefits) the North in terms of growth and employment. Finally, a further weakening of the
Northern labor union’s bargaining power or a reduction in the Northern minimum wage rate also hurt the North in terms of growth and employment for a sufficiently weak Northern labor union.

The Northern government can use economic policies (change job protection by changing liquidation costs $B$, or change R&D subsidies $\sigma$) to adjust the critical level $\alpha^{crit}$ of the labor union’s bargaining power $\alpha$, and this will affect growth and employment in a predictable way. The general policy suggestion from this model is to have low (high) job protection and high (low) R&D subsidies if the labor unions are sufficiently strong (weak), which is more likely to be the case in continental Western Europe (the US). Interestingly, our model suggests that there is no tradeoff between growth- and employment-supporting economic policies in the long run: by driving $\alpha^{crit}$ towards $\alpha$ via appropriate changes in $B$ or $\sigma$, the government can raise steady-state growth and reduce steady-state unemployment at the same time. Moreover, no globalization force reduces the ability of the Northern government to conduct these policies.

Appendix

Comparative Statics For The Model With Exogenous Southern Imitation

To apply the implicit function theorem, we rewrite (29) as

$$f(t^*, w_{min}^{\text{min}}, \ldots) = \frac{\eta_S(t + \mu)}{\mu \lambda} \left\{ \frac{1}{\alpha + (1 - \alpha) w_{min}^{\text{min}}} \frac{1 + \mu (1 + \tau_{S})}{\lambda (t(1 + \tau_{S}) + \mu)} - 1 \right\}$$

$$- (1 - \sigma_t) q_{\delta S} \left[ \rho + (1 + B)(2t + \mu) - n \right]^{\eta \gamma} = 0.$$  \hspace{1cm} (A.1)

We then derive, after collecting terms,

$$\frac{\partial t^*}{\partial w_{min}^{\text{min}}} = - \frac{\partial f(\cdot)}{\partial w_{min}^{\text{min}}} = \frac{(1 + \mu)(1 + \tau_{S})}{\eta \gamma \rho} \left[ A - \frac{\mu (1 - \sigma_t) \delta \tau_{S} 2(1 + B)}{\eta \gamma \rho} \right] + \frac{(1 + \mu)(1 - \alpha) w_{min}^{\text{min}} \delta \tau_{S} \tau_{Y} (1 + \tau_{Y})}{\lambda (t(1 + \tau_{S}) + \mu)^2},$$  \hspace{1cm} (A.2)

where

$$C \equiv \alpha + (1 - \alpha) w_{min}^{\text{min}} \cdot \frac{t + \mu (1 + \tau_{S})}{\lambda [t(1 + \tau_{S}) + \mu]}, \quad A \equiv \frac{1}{C} - 1.$$
The numerator of (A.2) is positive, and the second term in the denominator converges to zero when tariffs go to zero. Therefore, \(\partial i^*/\partial w^\text{min} < 0\) follows for sufficiently low tariff rates if the first term in the denominator of (A.2) is negative. Using (A.1) and \(\tau_N = \tau_S = 0\) in A, this condition can be written as
\[
\frac{\mu \lambda (1 - \sigma_t) a_i \delta s_N \left[ \rho + (1 + B)(2t + \mu) - n \right]}{\eta_S (t + \mu) n\gamma} < \frac{\mu \lambda (1 - \sigma_t) a_i \delta s_N (2 + B)}{\eta_S n\gamma},
\]
which reduces to condition (30) in the main text. Under the same assumptions, it is
\[
\frac{\partial i^*}{\partial \tau_N} = -\frac{\partial f(\cdot)/\partial \tau_N}{\partial f(\cdot)/\partial i^*} = \frac{C^2 \left[ A - \frac{\mu \lambda (1 - \sigma_t) a_i \delta s_N (2 + B)}{\eta_S n\gamma} \right] + \frac{\rho + (1 + B)(2t + \mu) - n}{A^2 \left[ (1 + \tau_N) + \mu \right]^2} > 0 \quad (A.3)
\]
and
\[
\frac{\partial i^*}{\partial \tau_S} = -\frac{\partial f(\cdot)/\partial \tau_S}{\partial f(\cdot)/\partial i^*} = \frac{C^2 \left[ A - \frac{\mu \lambda (1 - \sigma_t) a_i \delta s_N (2 + B)}{\eta_S n\gamma} \right] + \frac{\rho + (1 + B)(2t + \mu) - n}{A^2 \left[ (1 + \tau_S) + \mu \right]^2} < 0. \quad (A.4)
\]
For \(\tau_N = \tau_S = 0\), (29) can be solved explicitly for
\[
i^* \bigg|_{\tau_N = \tau_S = 0} = \frac{\eta_S (1 - \alpha) n\gamma \left(1 - \frac{w^\text{min}}{\alpha} \right) - \left[ \alpha \lambda + (1 - \alpha) w^\text{min} \right] \left[ \rho + (1 + B) \mu - n \right] (1 - \sigma_t) a_i \delta s_N}{2(1 + B)(1 - \sigma_t) a_i \delta s_N \left[ \alpha \lambda + (1 - \alpha) w^\text{min} \right] - \frac{\eta_S (1 - \alpha) n\gamma \left(1 - \frac{w^\text{min}}{\alpha} \right)}{\mu}}, \quad (A.5)
\]
and all other comparative-static results of (29) are straightforward from this. Note that for \(i^* > 0\) both numerator and denominator of (A.5) must be positive. They cannot be both negative since this would imply \(\rho - n + \mu(1+B) > 2\mu(1+B)\), which is a contradiction to (30). Hence, condition (30) is also required under free trade to ensure \(i^* > 0\). The condition that the numerator of (A.5) must be positive is equivalent to
\[
\frac{\eta_S}{\alpha} \left[ \frac{\lambda}{\alpha \lambda + (1 - \alpha) w^\text{min}} - 1 \right] > \frac{(1 - \sigma_t) a_i \delta s_N}{\rho + (1 + B) \mu - n} \frac{n\gamma}{\mu}, \quad (A.6)
\]
where the LHS of (A.6) is the discounted R&D benefit for $\tau_N = \tau_S = 0$ and $t \to 0$ from the FEIN condition (29). This ensures a positive innovation rate under the actual discount rate $\rho + (1+B) - n$ for R&D benefits. The condition that the denominator of (A.5) must be positive is equivalent to

$$\frac{ny}{\alpha \lambda (\frac{\lambda}{\alpha} w^m - 1)} < \left(1 - \sigma \right) a_i \delta s_N \frac{n \gamma}{n \gamma}.$$  (A.7)

Hence the difference $(1+B)\mu - (\rho - n) > 0$ from the stability condition (30) must be large enough to switch the inequality sign when replacing the discount rate for R&D benefits in (A.6).

**Deriving The Competitive Wage Rate For The Model With Exogenous Southern Imitation**

From (11), it is $w_L = v_N/[(1-\sigma)a,D]$. Using (15) together with $r = \rho$ and $v_N = n$ to substitute for $v_N$, (9) and (19) to substitute for $D$, (17) to substitute for $c_S$, and (25) to substitute for $c_N$, yields

$$\tilde{w}_L = \frac{n_y (r+\rho (1+\tau_S))}{\mu (1+\tau_S)} \left[1 - \frac{\delta_S}{\delta} \left( \frac{\mu}{n(1+\tau_S)} + \frac{\mu (1+\tau_S)}{\delta} \right) \right].$$

Simplifying and solving this for $\tilde{w}_L$ yields (31).

**Deriving The Competitive Wage Rate For The Model With Endogenous Southern Imitation**

From (11), it is $w_L = v_N/[(1-\sigma)a,D]$. Using (38) together with $r = \rho$ and $v_N = n$ to substitute for $v_N$, (9) and (19) to substitute for $D$, (17) to substitute for $c_S$, and (42) to substitute for $c_N$, yields

$$1 = \frac{n_y (r+\rho (1+\tau_S))}{\mu (1+\tau_S)} \left[1 - \frac{\delta_S}{\delta} \left( \frac{\mu (1+\tau_S)}{\delta} \right) \right].$$

Solving this for $\tilde{w}_L$ yields (50).

**Proof That $\partial \tilde{\alpha} / \partial w^\text{min} < 0$**

We can rewrite (32) as

$$\tilde{\alpha} = \frac{1}{(1-w^\text{min}Y)(1+X)} - \frac{w^\text{min}Y}{1-w^\text{min}Y},$$  (A.8)
where

\[ Y = \frac{t + \mu(1 + \tau_s)}{\lambda[1 + \tau_S + \mu]} > 0 \quad \text{and} \quad X = \frac{\mu\lambda(1-\sigma_j)\alpha d_s \left[ \rho + (1 + B)(2t + \mu) - \eta \right]}{n\gamma\eta_s(t + \mu)} > 0. \]

Hence, we have

\[ \frac{\partial \bar{\alpha}}{\partial w_{\min}} = -\frac{YX}{(1 - w_{\min} Y)^2 (1 + X)} < 0. \]  

(A.9)

**Literature**


Eckel, Carsten and Egger, Hartmut (2006): *Wage Bargaining and Multinational Firms in General Equi-


Case A: $\alpha > \alpha^{\text{crit}}$

Case B: $0 < \alpha \leq \alpha^{\text{crit}}$

Figure 1: Steady-state effects of a decrease in the labor union’s bargaining power $\alpha$ (or a decrease in the minimum wage $w_{\text{min}}$, or an increase in $\tau_N$, or a decrease in $\tau_S$)