Labor Unions, Globalization, and Mercantilism

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Abstract

We analyze the growth and welfare effects of globalization in a dynamic Schumpeterian North-South product-cycle model. Economic growth is driven by R&D activities of Northern entrepreneurs. Top Northern production technologies are imitated by the South. In the North, there is wage bargaining between a labor union and firms, and a minimum wage rate exists. Unilateral Northern trade liberalization reduces the rate of innovation, increases Northern unemployment, and reduces both Northern and Southern per-capita welfare. The effects are reversed in the case of unilateral Southern trade liberalization. Hence, wage bargaining above a given minimum wage promotes mercantilist behavior of developed countries.

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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 and communication costs, along with opening up of some countries to trade and investment flows for the first time.[1] During this recent wave of globalization, the labor unions' impact on the labor markets of developed countries has remained surprisingly robust and persistent, especially in Continental European countries. Although the unionization rates have shown a downward trend since the 1980s for most OECD countries, the coverage of collective bargaining has remained relatively stable around or above 70% for most Continental European Countries (Nickell 2003, pp. 21-22, Nickell et al. 2005, pp. 6-7). Notably, the coordination of union wage bargaining, which captures the extent to which the negotiating parties take into account the possible negative employment effects of the bargained wage rate, has decreased in most OECD countries (see Nickell 2003, p. 22, and Ortigueira 2008).

There is a vast theoretical trade literature that studies the impact of various aspects of globalization on labor markets with unions.[2] Surprisingly, however, almost all of the papers in this literature use static models without incorporating economic growth and dynamic trade patterns.[3] In the meanwhile, the literature on growth and labor unions has been confined to closed-economy settings (e.g., Lingens, 2003, and Palokangas 1996, 2004). Hence, the question of how trade liberalization affects growth, employment and welfare in a setting with a unionized labor market remains open to investigation.

In this paper we tackle with this question by constructing a dynamic North-South trade model with union wage bargaining and R&D driven Schumpeterian growth. We examine the impact of globalization

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[1] See Wacziarg and Welch (2008) for evidence on the integration of large and previously closed economies with the global economy. See Tang (2006, Figures 2 and 3) for evidence on the decline in transport and communication costs. See Grieben and Şener (2009, Table 1) for evidence on falling tariff rates across the globe. Rodrik (1994) provides evidence on a significant wave of unilateral trade liberalization of many developing countries since the early 1980s.

[2] This literature includes, but is not restricted to, Mezzetti and Dinopoulos (1991), Huizinga (1993), Driffill and van der Ploeg (1995), Zhao (1995, 1998, 2001), Naylor (1998, 1999), Skaksen and Sørensen (2001), Gaston (2002), Egger and Egger (2003), Skaksen (2004), Andersen (2005), Andersen and Skaksen (2007), Lommerud et al. (2009), and Eckel and Egger (2009).

[3] 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 by Palokangas (2005). He uses a symmetric multi-country framework, where countries are connected by technology spillovers (but with no trade in goods). Palokangas studies the effects of globalization by considering an increase in cross-country technology spillovers.

on bargained wages, employment, innovation, and long-run welfare, where the latter two are ignored by most of the existing macroeconomic literature on labor unions.[4]

In our model the world economy consists of a continuum of industries. Northern entrepreneurs participate in industry-specific R&D races to innovate higher quality products. Successful innovators manufacture their top quality products using Northern labor and become global monopolists. Over time, Northern technologies can be imitated in the South where production costs are lower. With each Southern imitation success, industry production shifts from the North to the South. Further Northern innovation moves the corresponding industry back to the North. Consequently, the North exports newly-invented goods, and the South exports imitated products ("product-cycle trade").[5] The governments in both regions impose advalorem tariffs on imported products. Trade is balanced in equilibrium. We remove the scale effects on innovation by introducing R&D difficulty, the level of which is determined endogenously by the Rent Protection Activities (RPAs) of Northern producers. In the North, a centralized Northern labor union bargains with Northern firms over the wage rate of Northern production workers.[6] The objective of the labor union is to maximize the expected excess wage income over a given minimum wage set by the government.[7] The union will bargain for a wage rate that is higher than the competitive wage level and this leads to unemployment.

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[4] More generally, an extensive body of literature has emerged investigating the globalization effects on labor markets, partly also using a dynamic growth framework. One focus in this literature has been on wage inequality and/or unemployment, and distinguishing the impact of globalization from that of various forms of biased technological change (Davis 1998b, Dinopoulos and Segerstrom 1999, Arnold 2002, Ethier 2005, Grieben 2005, Moore and Ranjan 2005, and Şener 2001, 2006). Other papers focus on whether the effects of labor market rigidities in one country spill over to other countries (Davis 1998a, Meckl 2006, Alessandria and Delacroix 2008, Helpman and Itskhoki 2009). The growth and employment consequences of changes in labor market institutions in two-country models with Schumpeterian growth have been studied in Grieben (2004) and Şener (2006), while Grieben (2009) investigates the globalization effects in a North-South Schumpeterian growth model at various degrees of Northern labor market rigidities.

[5] Different versions of product-cycle trade have recently been proposed: in Gustafsson and Segerstrom (2009), product cycles are one-way only from North to South, where manufacturing of imitated products never moves back to the North. In Şener and Zhao (2009), the Northern stage of production is skipped altogether for some products, such that Northern newly invented goods are immediately produced in the South only ("iPod cycle").

[6] This is the main distinguishing feature relative to the baseline setting of our companion paper Grieben and Şener (2009), where wage rates are determined competitively. In that paper, we considered two variations of the institutional set-up for RPAs and an extension with a low-tech Southern sector that does not have technological progress. We found that tariffs do not matter for steady-state innovation and growth ("tariff-neutrality" result) in all settings, except for the case with a Southern low-tech sector.

[7] Minimum wages "*are applied in more than 90 per cent of ILO member states*" (ILO 2008, p. 34) and are becoming a more prevalent feature of the labor markets in developed countries recently, where, according to ILO (2008, p. 36, Table 2), the average annual increase of minimum wages in real terms within the period 2001 − 2007 was 3.8 %. It turns out that the existence of a positive minimum wage rate is crucial for our main results.

In our comparative-static analysis, we concentrate on changes in three different globalization parameters: the Southern imitation rate, the relative size of the Southern population which captures the presence of the South in the world trade markets, and import tariffs. In addition, we investigate the effects of changes in three Northern labor market policy parameters: the union's bargaining power, the minimum wage rate, and employment-protection costs for Northern firms.

We find that an increased Southern presence in the world economy increases Northern innovation and thus worldwide growth, and decreases Northern unemployment. The same results are obtained for unilateral Southern trade liberalization. However, the opposite results (declining growth and rising unemployment) follow from increased Southern imitation and unilateral Northern trade liberalization. A higher union bargaining power, an increase in the minimum-wage rate, or an increase in employment-protection costs for Northern firms reduce Northern innovation and increase Northern unemployment.

Our welfare analysis implies that for any given Southern import tariff rate it is optimal for the Northern policy maker to choose the highest Northern import tariff rate feasible. Moreover, the benefits of Northern protectionism in terms of both Northern and Southern per-capita welfare are increasing in the level of Northern labor market rigidities. In the meanwhile, for any given Northern tariff rate, it is optimal for the Southern policy maker to choose the lowest Southern tariff rate feasible. Moreover, the benefits of Southern trade liberalization in terms of both Northern and Southern per-capita welfare are also increasing in the level of Northern labor market rigidities. We establish these results analytically for Northern welfare and numerically for Southern welfare. In a cooperative equilibrium aimed at maximizing global welfare, we find that the policy decisions remain the same: the North chooses the highest feasible tariff rate and the South chooses the lowest feasible tariff rate.

It follows that our model provides an explanation for the apparent mercantilism at the WTO negotiations of Northern developed countries (i.e., to favor trade liberalization of Southern trade partner countries, but to oppose own tariff reductions) with persistent labor market rigidities. We note that our arguments rely on the dynamic welfare gains implied by the resulting increase in the Northern steady-state innovation rate, a point which has been ignored in the static literature. Furthermore, our explanation does not hinge on a terms-of-trade effect, a mechanism that has been emphasized by Bagwell and Staiger (1999) but heavily criticized by Ethier (2004, 2007).

In our companion paper Grieben and Şener (2009) with perfectly flexible labor markets in both the North and South, we find that tariffs are neutral on Northern innovation and growth. In the current setting, where we allow for rigidities in the Northern labor market and keep the Southern labor market flexible, we find that higher Northern tariffs raise the innovation rate whereas higher Southern tariffs reduce it. Taken

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together, the results of these two papers uncover the role of labor market institutions in determining the long-term growth effects of unilateral trade liberalization in Schumpeterian models, which has been largely neglected in the existing literature. We should note however that both in Grieben and Şener (2009) and in this paper, bilateral trade liberalization raises long-run growth. Hence, this finding appears to be a robust outcome of these Schumpeterian settings.

The remainder of this paper is organized as follows. Section 2 presents our basic model, derives the steady-state equilibrium, analyzes its properties including welfare results, and provides a numerical simulation of our model. Section 3 compares our main results with related literature. Section 4 concludes.

2 The Basic Model

2.1 *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 population size and also the labor force size of country i at time zero. The number of household members in both countries grows at the common rate $n > 0$; thus, the population size in country i at time t equals $N_{ti} = N_{0i}e^{nt}$.

The representative household maximizes the utility function

$$F_i(t) = \int_0^\infty N_{0i} e^{-(\rho-n)t} \log f_i(t)\, dt \qquad \text{for } i = N, S, \tag{1}$$

where $\rho > n$ is the subjective discount rate. The function $\log f_i(t)$ stands for the instantaneous logarithmic utility function of each household member and is given by

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

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

The household optimization process consists of two steps. The first step is to allocate consumption expenditure across products to maximize $f_i(t)$ for given product prices. Since products in a typical industry ω differ only in their quality, and λ units of quality j are a perfect substitute for one unit of quality $j + 1$,

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households purchase in each industry only the product with the lowest quality-adjusted price. In addition, since products enter (2) symmetrically, each household spreads its consumption expenditure evenly across product lines. It thus follows that per-capita demand for each industry's product is $x_i(\omega,t) = c_i(t)/p(t)$ where c_i is per-capita consumption expenditure in country i, and $p(t)$ is the price of the purchased good.

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

$$\int_0^\infty N_{0i} e^{-(\rho-n)t} \log c_i(t) dt \qquad \text{for } i = N, S, \tag{3}$$

subject to the intertemporal budget constraint

$$\dot{FA}_i(t) = WI_i(t) + r(t) FA_i(t) - c_i(t) N_i(t), \tag{4}$$

where $FA_i(t)$ denotes the stock of financial assets owned by the household, $WI_i(t)$ is the household's expected wage income and $r(t)$ is the instantaneous rate of return in the global market. The expected wage component $WI_i(t)$ accounts for unemployment which will arise for Northern workers. The solution to this dynamic optimization problem gives the familiar Euler equation ("Keynes-Ramsey rule")

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

At the steady-state equilibrium, c_i will be constant; thus $r(t) = \rho$. Since we focus on steady-states and consider structurally-identical industries, we henceforth drop the time index t and the industry index ω.

2.2 Labor and Activities

Labor is the only factor of production and is immobile across countries. In the North, the labor force consists of 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 workers (lawyers, lobbyists) are only employed in Rent Protection Activities (RPAs), the activities that are undertaken by incumbent firms to deter the innovation efforts targeted at their products.[8] In the South, there is only one type of labor used in manufacturing of final

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[8] RPAs are first introduced in a closed economy endogenous growth setting by Dinopoulos and Syropoulos (2007). Grieben and Şener (2009) discuss the empirical evidence on RPAs in a North-South context. Our labor assignment follows Dinopoulos and Syropoulos (2007) and Grieben and Şener (2009). As is discussed in the latter paper, its advantage is that it yields fully-endogenous growth (in the sense that the steady-state growth rate depends on all

goods which is the only type of activity (Appendix R.1, which is available upon request, extends the model for endogenous imitation of Northern state-of-the-art products as a second type of activity of Southern labor).

2.3   Product Markets

The world economy consists of a continuum of structurally-identical industries indexed by $\omega \in [0,1]$. In each industry, Northern entrepreneurs participate in R&D races to discover the technology of producing next-generation products, whose quality is $\lambda > 1$ times higher than the current-generation product. Whenever a higher quality product is discovered in the North, a new R&D race starts and the technology of producing the previous-generation product becomes common knowledge to all firms in the global economy. In the global product markets, firms engage in Bertrand price competition to offer the lowest quality-adjusted price given their state of technology and regional labor costs. In the North, workers are represented by a labor union and wages are determined by decentralized wage bargaining. In the South, competitive labor market conditions apply. We normalize the Southern wage rate to 1 and denote the Northern wage rate of general-purpose labor as $w_L \in {]}1, \lambda{[}$. 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. The governments of both regions impose ad-valorem tariffs on imported goods. We denote by $\tau_N \geq 0$ the tariff rate imposed by the North and by $\tau_S \geq 0$ the tariff rate imposed by the South.

For each industry, there are two possible structures at any point in time. Whenever a Northern entrepreneur discovers a next-generation product, the resulting structure is a *Northern industry*, in which the Northern quality leader competes with Southern followers who have access to the previous-generation technology. Whenever the technology of producing a current-generation product leaks to the South, all Southern firms gain access to the current-generation technology. The resulting structure is a *Southern industry*, in which the Northern quality leader competes with Southern followers.[9]

Consider first the profits of firms in a Northern industry. In the Northern market, the Southern followers face an ad-valorem tariff rate τ_N. By pricing at marginal cost and accounting for the Northern tariff rate, the followers can offer their goods to Northern consumers at a price $1+\tau_N$. In this case, the Northern

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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.

[9] 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.

quality leader charges the limit price $p_N^N = \lambda(1+\tau_N) - \varepsilon$ with $\varepsilon \to 0$ and drives the Southern followers out of the market. The profits of the Northern quality leader from sales in the Northern market are:

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

In the Southern market, the Northern quality leader faces an ad-valorem tariff rate τ_S. Under marginal cost pricing, the Southern followers can offer a price of 1. To capture the Southern market, the Northern quality leader must set its price such that the price faced by the Southern consumers does not exceed λ. This implies that the Northern leader charges the limit price $p_N^S = \lambda - \varepsilon$ with $\varepsilon \to 0$, of which the Northern firm receives only $\lambda/(1+\tau_S)$.[10] The profits of the Northern quality leader from sales in the Southern market are:

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

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

$$\pi_N^P = \pi_N^N + \pi_N^S = c_N N_N \left[1 - \frac{w_L}{\lambda(1+\tau_N)}\right] + c_S N_S \left(\frac{1}{1+\tau_S} - \frac{w_L}{\lambda}\right). \tag{6}$$

Consider now the profits of firms in a Southern industry. In the Southern market, the Southern followers can charge $p_S^S = 1$ and price out the Northern quality leader who can offer a price of $w_L(1+\tau_S) > 1$ by charging at marginal cost. In the Northern market, the Southern followers can offer an after-tariff product price of $p_S^N = 1+\tau_N$. Under the restriction that $w_L > 1+\tau_N$, which we maintain, the Northern quality leader who can offer its product at w_L is again priced out. Consequently, in Southern industries only Southern firms prevail by charging marginal cost and they earn zero profits. Hence, in Southern industries, Bertrand pricing with many firms effectively replicates the perfectly competitive outcome.[11]

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[10] It immediately follows that Northern quality leaders cannot benefit from export taxes: for any export price exceeding λ, Southern consumers would switch to local goods although these are of inferior quality. This implication will be important when we later argue that this model is able to explain actual mercantilist behavior of Northern countries at WTO trade rounds, which includes the observation that export taxes are not used to improve terms of trade.

[11] This is in accord with the modeling in, e.g., Glass (2004), Sayek and Şener (2006), and Şener and Zhao (2009). As is well known from standard textbooks in trade theory, the Southern government has no incentive to offer export subsidies to its competitive exporting industries, given that WTO rules allow the Northern government to react by

While Northern quality leaders earn monopoly profits, they simultaneously expend resources for RPAs, i.e. to safeguard their monopoly positions against their Northern rivals (e.g., by investing in trade secrecy, patent enforcement through litigation, lobbying the government to influence intellectual property legislation and etc.). For this purpose, each Northern incumbent hires Northern specialized labor at a wage rate of w_H. The cost of performing $X(t)$ units of RPAs is $w_H \gamma X$, where γ is the unit labor requirement of such activities. Hence, a Northern incumbent's profit flow net of rent protection costs then equals:

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

2.4   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. The R&D technology is identical across Northern firms. The instantaneous probability of innovation success (the Poisson arrival rate) by firm j is given as

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

where I_j represents the innovation intensity of a typical Northern entrepreneur j targeting industry ω, and D measures the difficulty of conducting R&D in industry ω at time t. According to (8), R&D difficulty D is modeled as a stock variable, where n_N is the proportion of industries located in the North, X is the flow of RPAs undertaken by the Northern incumbent in industry ω at time t, and δ measures the effectiveness of these RPAs. The equation of motion for D in (8) implies that whenever an industry is registered as a Northern industry – the probability of which is equal to n_N in equilibrium – Northern incumbents undertake RPAs which increase the stock of R&D difficulty in that industry by δX. For a constant steady-state innovation rate, R&D difficulty must grow at the same rate as the labor force, hence $\dot{D} = nD$ is required. From this and (8), we obtain the steady-state stock of R&D difficulty:

$$D = n_N \delta X / n .\tag{9}$$

Since innovation success is independently distributed across firms and industries, the Poisson arrival rate for innovation at the industry level (which is 'the' Northern innovation rate) equals

$$\iota = \sum_j \iota_j = I / D \qquad \text{with} \qquad I = \sum_j I_j .\tag{10}$$

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imposing countervailing duties, thereby effectively collecting the Southern export subsidies while leaving consumers and producers in both countries unaffected. Again, this implication will be important when we later use this model to explain actual mercantilist behavior of Northern countries at WTO trade rounds, which includes the observation that countervailing-duty laws exist.

Entrepreneurs participating in R&D races hire general-purpose labor to perform R&D. The cost of conducting I_j units of R&D activity is $w_L(1-\sigma_t)a_t I_j$, where σ_t is a public R&D subsidy rate (financed by lump-sum taxation for simplicity), and a_t is the unit labor requirement of R&D. Imposing the usual free-entry assumption for R&D races, expected profits from R&D are competed away, and the maximization problem

$$\max_{R_j} \frac{v_N I_j}{D} dt - w_L(1-\sigma_t)a_t I_j dt$$

yields

$$v_N = w_L(1-\sigma_t)a_t D, \tag{11}$$

where v_N is the firm value of a successful Northern innovator.

2.5 The Stock Market

The savings of consumers are channeled to firms investing in R&D by means of a global stock market. Over a small time period dt, the stockholders of a Northern quality leader operating in a Northern industry receive dividend payments $\pi_N dt$. With probability $(\iota + \mu)dt$, successful innovation or imitation takes place and the Northern firm is driven out of the market. The stockholders face the risk of a complete capital loss of size v_N. When shutting down, the firm has to pay liquidation costs proportional to its valuation Bv_N, where $0 < B < 1$. With probability $1 - (\iota + \mu)dt$, neither Northern innovation nor Southern imitation takes place, and the firm experiences a capital gain $\dot{v}_N dt$. Consumers can engage in complete diversification of their asset portfolio to eliminate the industry-specific risk of unsuccessful R&D efforts, hence in an arbitrage-free asset market equilibrium, the expected return from a stock issued by the Northern firm 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:

$$\pi_N dt - v_N(1+B)(\iota+\mu)dt + \dot{v}_N\left[1-(\iota+\mu)dt\right]dt = rv_N dt. \tag{12}$$

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

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

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

2.6   Optimal Rent Protection Decision by Northern Incumbents

Substituting D from (9) into (10), we derive $\iota(X) = In/n_N \delta X$, which clearly shows that an increase in RPAs X diminishes the threat of replacement faced by the incumbent as it reduces ι. The incumbent avoids the capital loss v_N and realizes the change in its valuation $\dot{v}_N$ by the extent of the decline in ι per unit of time. In the meanwhile each unit of RPA costs $w_H \gamma$ per unit of time. When choosing the optimal level of X, the Northern incumbent weighs the marginal gains against the marginal costs. Formally, the firm chooses X to maximize the expected returns on its stocks

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

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

$$X = \iota v_N (1+B)/(w_H \gamma). \tag{14}$$

Intuitively, the optimal level of RPAs X increases with the firm value v_N (since there is more at stake) and the replacement rate due to innovation ι (the instantaneous probability of full capital loss at each point in time), and it decreases with the unit cost of RPAs $w_H \gamma$. 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 RPAs.

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

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

2.7   Balanced Trade

We impose a balance-of-trade (BOT) condition to determine the relative consumer expenditure levels for both countries. More specifically, the BOT implies that the value of exports net of tariffs must be equal between the North and the South. In our continuum-of-industries setting, this gives:

$$n_N \underbrace{\frac{c_S N_S}{\lambda}}_{=x_S N_S} \underbrace{\frac{\lambda}{1+\tau_S}}_{=p_N^S/(1+\tau_S)} = (1-n_N) \underbrace{\frac{c_N N_N}{1+\tau_N}}_{=x_N N_N} \underbrace{\frac{1+\tau_N}{1+\tau_N}}_{=p_S^N/(1+\tau_N)} \,,$$

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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 $\iota(1-n_N)$, while Southern firms capture industry leadership from Northern firms at a rate of μn_N. Constancy of industry shares in the steady state requires $\iota(1-n_N) = \mu n_N$, which implies

$$n_N = \frac{\iota}{\iota + \mu} \quad . \tag{16}$$

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

$$c_R = \frac{\iota \eta_S (1 + \tau_N)}{\mu (1 + \tau_S)} \qquad \textbf{BOT}, \tag{17}$$

where $c_R \equiv c_N/c_S$ denotes the relative North-South consumption expenditure. We note the following relationships for future use:

- c_R is increasing in $\iota/\mu = n_N/n_S$: an increase in the relative proportion of Northern industries n_N/n_S raises the relative size of Northern exports, thereby increasing the relative Northern income available for consumption;

- c_R is increasing in τ_N: a lower Northern import tariff τ_N reduces the prices of Southern exports in the Northern market, thereby increasing the amount of Southern exports and relative Southern income available for consumption;

- c_R is decreasing in τ_S: a lower Southern import tariff τ_S increases the Northern firms' profit margins net of tariffs, thereby increasing Northern export revenues and relative Northern income available for consumption;

- c_R is increasing in η_S: a larger relative size of the Southern market raises the relative export revenues of the North, thereby increasing relative Northern income available for consumption.

2.8 Labor Markets 1: Equilibrium Conditions

To close our model, we derive the labor market equilibria for both countries. In the North, decentralized wage bargaining can lead to trade-union induced unemployment. The general-purpose labor market equilibrium requires that $(1-s_N-u)N_N = L_N$ is always fulfilled, where $u \equiv U/N_N$ denotes the Northern unemployment rate, U is the total number of Northern unemployed workers, and L_N is Northern employment.

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The Northern demand for manufacturing labor is $n_N\{c_N N_N/[(1+\tau_N)\lambda]+c_S N_S/\lambda\}$, the Northern R&D labor demand is, using (10), $a_t I = a_t \iota D$; hence the Northern general-purpose labor market equilibrium condition is

$$L_N = \frac{n_N}{\lambda}\left(\frac{c_N N_N}{1+\tau_N}+c_S N_S\right)+a_t \iota D = (1-s_N-u)N_N. \tag{18}$$

Obviously, the Northern bargained wage rate w_L does not (directly) affect Northern production labor demand. The reason is that due to global Bertrand price competition, product prices are proportional to the marginal cost of the lowest-cost producers, which happen to be the Southern producers with marginal cost $w_S \equiv 1$.

Northern RPA labor demand is $n_N \gamma X$, hence the Northern specialized labor market equilibrium condition is

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

The Southern demand for manufacturing labor is $(1-n_N)[c_S N_S + c_N N_N/(1+\tau_N)]$. Given that Southern imitation does not require any resources, the Southern labor market (SLM) equilibrium condition is

$$(1-n_N)\left(c_S N_S + \frac{c_N N_N}{1+\tau_N}\right)=N_S \qquad \textbf{SLM}. \tag{20}$$

2.9   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 R&D race, 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**, if the entrepreneur becomes successful in innovating, it has to bargain with the production workers before any production starts. This is because there are positive expected monopoly profits and workers are represented by a labor union. In the meanwhile, the previously employed R&D workers of the successful innovator can find employment (either in a new R&D firm or in a producing firm which may as well be the successful innovator) or they can become unemployed (if the bargained wage rate exceeds the competitive wage rate). When bargaining, the prospective production workers take the industry-wide innovation rate as given since it is

beyond control of a single firm.[12] **Third**, after the wage bargaining is settled, the firm decides about the level of manufacturing employment and starts production.[13] 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.

The bargained Northern general-purpose wage rate w_L is derived from the Nash maximand

$$\Omega = \left(\frac{W_N}{r} - \overline{W}_N\right)^{\alpha} \left(v_N - \overline{v}_N\right)^{1-\alpha} \to \max_{w_L}! \tag{21}$$

$\alpha \in [0,1[$ is the relative bargaining power of the labor union, and $W_N \equiv (w_L - w^{min})^{\theta}[(1 - s_N - u)N_N]^{\chi}$ 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.[14] The minimum wage rate $w^{min} > 1$ is set by the government, and we assume that w^{min} is credibly enforced by law such that it serves as the natural reference point for the labor union.[15] $\overline{W}_N$ 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*'[16]), and

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[12] 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. This is the standard Arrow inertia effect.

[13] Since the Northern firms' production labor demand (18) does not (directly) depend on w_L, there is no pass-through of higher Northern production costs to product prices, which would reduce consumption and hence the individual Northern firm's general-purpose labor demand. Thus, in our setting it does not matter whether the firm is granted the "right to manage" employment ex-post or ex-ante wage bargaining.

[14] The underlying labor union's objective is a Stone-Geary type utility function $U(w_L, L_N) = (w_L - w^{min})^{\theta}L_N^{\chi}$, where $\theta \geq 0$ and $\chi \geq 0$ represent, respectively, the union's preference for excess wages and employment, cf. Mezzetti and Dinopoulos (1991, p. 82).

[15] Lingens (2003) takes as the union's reference wage the competitive wage rate derived from a hypothetical situation with no wage bargaining. This requires truly heroic rationality of labor unions since the competitive wage rate cannot be observed in such a setting, while the minimum wage rate can be observed (by looking into the text of law) even without actually being paid to anybody. In the trade literature with unions (Mezzetti and Dinopoulos 1991, Zhao 1998, 2001), the union's reference wage is derived from a second sector that is perfectly competitive and non-unionized. This modeling renders the reference wage a real and observable option but complicates the analysis and 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.

[16] 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*

$\overline{v}_N$ 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, 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 $\overline{W}_N = 0$. Similarly, $\overline{v}_N = 0$ since Northern firms cannot manufacture without agreement on w_L. Using these identities in (21), and substituting for v_N from (15) simplifies the bargaining problem to

$$\Omega = \left\{ \frac{\left(w_L - w^{\min}\right)^{\theta}\left[\left(1 - s_N - u\right)N_N\right]^{\chi}}{r} \right\}^{\alpha} \left\{ \frac{c_N N_N\left[1 - \frac{w_L}{\lambda(1+\tau_N)}\right] + c_S N_S\left(\frac{1}{1+\tau_S} - \frac{w_L}{\lambda}\right)}{r + (1+B)(2\iota + \mu) - \dot{v}_N/v_N} \right\}^{1-\alpha} \underset{w_L}{\to \max!} \qquad (22)$$

The first order condition is

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

which implies that the increase in the firm's profits extraction by the labor union through a marginal increase in $w_L - w^{\min}$, evaluated by the union's share α in Ω and the union's excess wage preference θ (LHS), must equal the increase in the firms' production costs by this marginal increase in $w_L - w^{\min}$, evaluated by the firm's share $1-\alpha$ in Ω (RHS).[17] For the remainder of the paper, we normalize $\theta \equiv 1$ without loss of generality. By using the BOT condition (17) in (23) and simplifying terms, we find the negotiated Northern unskilled wage rate as

$$w_L = \frac{\alpha\lambda\left[\iota(1+\tau_N)+\mu\right]}{\iota + \mu(1+\tau_S)} + (1-\alpha)w^{\min} \quad \forall \alpha \in [0,1], \quad \text{given } \frac{\lambda\left[\iota(1+\tau_N)+\mu\right]}{\iota + \mu(1+\tau_S)} \equiv w^{\max} > w^{\min}, \qquad (24)$$

where $w^{\max}$ is the maximum wage rate that would apply for $\alpha \to 1$, which leaves zero profits for Northern incumbent firms and thus would destroy any innovation incentives of entrepreneurs. For the rest of the paper we maintain $w^{\max} > w_L > w^{\min}$ to study the impact of bargaining on employment and growth in a meaningful way.

Obviously, the bargained wage rate w_L is increasing in the labor union's bargaining power α and the fallback value $w^{\min}$. To explain the remaining properties of w_L in (24), we rewrite (23) with $\theta \equiv 1$ as fol-

more than they could get elsewhere" (Layard et al. 2005, p. 100). See also Cahuc and Zylberberg (2004, p. 389), or Hall and Milgrom (2008) on this argument.

[17] Obviously, the second derivative of (22) with respect to w_L is negative, hence the f.o.c. is also sufficient for a maximum.

lows:

$$\alpha\left(R - w_L Q\right) = \left(1 - \alpha\right) Q\left(w_L - w^{\min}\right) \qquad \Leftrightarrow \qquad w_L = \alpha \frac{R}{Q} + \left(1 - \alpha\right) w^{\min},$$

where $R \equiv c_N N_N + c_S N_S/(1+\tau_S)$ denotes the total sales revenues per Northern industry, and $Q \equiv c_N N_N/[\lambda(1+\tau_N)] + c_S N_S/\lambda$ denotes the total quantity produced per Northern industry. It follows that R/Q is the average revenue received by Northern firms on both markets. Obviously, w_L is increasing in R/Q because a higher average revenue expands the size of the pie over which firms and workers bargain. Using the BOT condition (17), R/Q can be written as a function of $c_R \equiv c_N/c_S$:

$$\frac{R/\left(c_S N_S\right)}{Q/\left(c_S N_S\right)} = \frac{\lambda\left(\frac{c_R}{\eta_S} + \frac{1}{1+\tau_S}\right)}{\frac{c_R}{\eta_S\left(1+\tau_N\right)} + 1}.$$

A decrease in τ_N has three effects on the Northern bargained wage rate w_L. The first two are triggered by the reduction in the relative North-South expenditure c_R, which follows from the BOT condition (17). First, a lower c_R implies a reduction in Northern total sales revenues relative to Southern consumption expenditure $R/(c_S N_S)$, which reduces the average revenue R/Q received by Northern firms and hence w_L. Second, a lower c_R implies a reduction in Northern total quantity produced relative to Southern consumption expenditure $Q/(c_S N_S)$, which raises the average revenue R/Q received by Northern firms and hence w_L. The third effect is triggered by the direct impact of Northern tariffs on prices. A lower τ_N reduces the price charged in the Northern market and thus raises the total quantity sold relative to $c_S N_S$. This reduces the average revenue R/Q received by Northern firms and hence w_L. As can immediately be seen from the reduced form (24), the first and third effects dominate the second, and the net effect is a decrease in w_L. Hence, with wage bargaining, our model establishes a positive link between Northern import tariffs and Northern general-purpose wages, ceteris paribus. A decrease in τ_S simply reverses all three effects and thus increases w_L.

An increase in the Northern innovation rate ι raises c_R, which raises both revenues $R/(c_S N_S)$ and production quantity $Q/(c_S N_S)$ relative to Southern consumption expenditure. For positive tariff rates, the revenue effect dominates the quantity effect, and hence w_L increases with higher ι. The reasoning for why w_L declines with higher μ is analogous. We summarize our results in

Lemma 1: *The bargained wage rate w_L is increasing in α, $w^{\min}$, τ_N, and ι; it is decreasing in τ_S and μ.*

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2.10 Steady-State Equilibrium

We solve the model for an interior steady-state equilibrium where the endogenous variables c_N, c_S, $u \in (0, 1)$, ι, n_N, w_L and w_H are non-negative and remain constant. $\pi_N(t)$, $\pi_N^N(t)$, $\pi_N^S(t)$, $X(t)$, $D(t)$ and $v_N(t)$ are also non-negative and grow at a common rate of n, and $r = \rho$.

We first derive reduced-form expressions for c_N and c_S by using (16) and the BOT condition (17) in the Southern labor market clearing condition (20). This yields

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

which is unambiguously increasing in ι, η_S and τ_N, and decreasing in μ and τ_S. Also, we find

$$c_S = \frac{(\iota + \mu)(1 + \tau_S)}{\iota + \mu (1 + \tau_S)} , \tag{26}$$

which is unambiguously increasing in ι and τ_S, and decreasing in μ.[18]

To explain the properties of (25) and (26), we plot the BOT condition (17) and the SLM condition (20) in (c_N, c_S) space in Figure 1. The BOT curve is upward sloping, capturing the $c_R \equiv c_N/c_S$ ratio implied by balanced trade for given ι. The SLM curve is downward sloping, capturing the trade-off between c_N and c_S in the context of Southern resource equilibrium for a given level of ι.

A lower Northern tariff rate τ_N leads to a decrease in c_R, turning the BOT curve clockwise. The increased demand for Southern exports triggered by the lower τ_N boosts labor demand in the South. Restoring equilibrium requires a fall in c_N for given c_S, which turns the SLM curve counterclockwise around the abscissa intercept $1/n_S$. Clearly, the net effect is that c_N goes down, and it follows from (26) that the effects on c_S exactly cancel out such that c_S remains constant.

A lower Southern tariff rate τ_S increases c_R, turning the BOT curve counterclockwise. Southern tariffs have no influence on the SLM condition. Thus, the net effects are that c_S declines and c_N increases.

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[18] Note that with free trade, $c_S = w_S = 1$. Hence the BOT condition is equivalent to "balanced asset ownership": Northern people hold only assets of Northern firms and Southern people hold only assets of Southern firms. Since there is perfect competition in Southern imitation-based products, the value of Southern firms and thus the value of Southern assets is equal to zero.
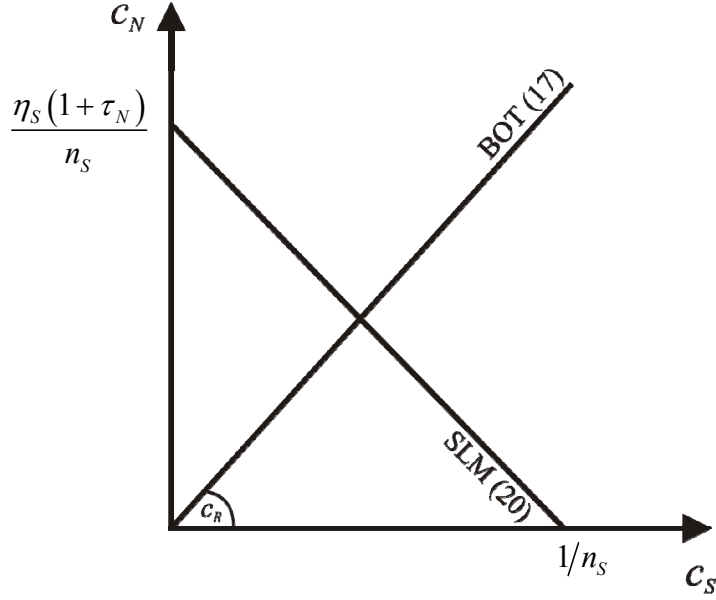
Figure 1: The determination of $c_N(\iota)$ and $c_S(\iota)$

An increase in the relative size of the Southern market η_S raises c_R, turning the BOT curve counterclockwise. A higher η_S also implies a relative expansion of Southern resources. For a given c_S, this allows for an increase in c_N and turns the SLM curve clockwise around the abscissa intercept $1/n_S$. Obviously, the net effect is that c_N increases, and it follows from (26) that the effects on c_S exactly cancel out such that c_S remains constant.

A higher Southern imitation rate μ leads to a decrease in c_R, turning the BOT curve clockwise. As the share of Southern industries n_S increase with the higher μ, the demand for Southern labor increases. For a given c_S, restoring the Southern labor market equilibrium requires a lower c_N. Hence, the SLM curves shifts down. As a result, c_N decreases, and it follows from (26) that the net effect on c_S is negative as well. Finally, a higher innovation rate ι triggers the exact opposite forces and thereby leads to higher levels of both c_N and c_S.

Now we can reduce the Northern general-purpose labor market clearing condition (18) to an equation in only two endogenous variables, ι 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:

$$u^* = 1 - s_N - \iota^* \left(\frac{\eta_S}{\lambda\mu} + A_\iota \right) > 0, \tag{27}$$

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where $A_t \equiv a_t \delta s_N / (n\gamma)$ captures the effective resource requirement per unit of R&D (so that ιA_t is the per-capita R&D labor demand). Since we impose $w_L > w^{comp}$ (to be validated by our later numerical simulation), it follows $u^* > 0 \ \forall \ \alpha \in \ ]0, 1]$.[19]

Next, we substitute v_N from (11) into (14) and use (9) to substitute for D. This gives the Northern specialized-labor wage rate as an increasing function of w_L and ι:

$$w_H = w_L \left(1 - \sigma_\iota\right) A_t \iota^2 \left(1 + B\right) / s_N . \tag{28}$$

To determine the steady-state innovation rate ι^*, 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, (9) to substitute for D, (19) to substitute for X, and use the steady-state results $r = \rho$ and $\dot{v}_N / v_N = n$. This yields the *free-entry in innovation* (*FEIN*) condition as an implicit function that pins down ι^* solely in terms of exogenous parameters:

$$\frac{\dfrac{\eta_S \left(\iota + \mu\right)}{\mu\lambda} \left[\dfrac{1}{\alpha + \left(1 - \alpha\right)\frac{w^{\min}}{w^{\max}}} - 1 \right]}{\rho + \left(1 + B\right)\left(2\iota + \mu\right) - n} = \left(1 - \sigma_\iota\right) A_t \qquad \textbf{FEIN}(\iota) \tag{29}$$

$$\Rightarrow \quad \iota^* = \iota^* \begin{pmatrix} w^{\min}, \alpha, B, \tau_N, \tau_S, \mu, \eta_S \\ \ - \quad \ - \ - \ \ + \ \ - \ - \ \ + \end{pmatrix}.$$

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. As is demonstrated in Appendix A, the signs indicated below (29) follow from implicit differentiation under sufficiently low tariff rates[20] if, and only if,

$$\rho - n < \left(1 + B\right)\mu \tag{30}$$

is fulfilled. This turns out to be the condition for stability of equilibrium[21] and thus will be maintained for the rest of this paper.

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[19] The competitive wage rate w^{comp} is the wage rate that clears the labor market under no bargaining. Any higher bargained wage rate $w_L > w^{comp}$ (which justifies the existence of a trade union) raises R&D and production costs without increasing revenues of successful entrepreneurs, which unambiguously reduces R&D incentives. The resulting decrease in ι reduces R&D and production labor demand (the latter by reducing the share of Northern industries, inter alia) in the North, which implies $u^* > 0$ in equilibrium.

[20] 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.

[21] Technically, this assumption – as well as the assumption of sufficiently low tariff rates – is necessary to ensure that the implicit function $f(\iota^*, \ldots) = 0$ derived from (29) is monotonously decreasing in ι^*. Intuitively, an increase in ι must reduce the profitability of innovative R&D expenditure in order to yield a stable solution for ι. Thus, the sig-

The remaining endogenous variables are determined recursively for given ι^* in the following order. u^* follows from (27), w_L^* follows from (24), n_N^* follows from (16), c_N^* and c_S^* follow from (25) and (26), v_N^* follows from (15), π_N^{P*} follows from (6), w_H^* follows from (28), X^* follows from (14), and D^* follows from (9). Finally, the common steady-state utility growth rate is derived as usual from (2) as $g^* = \dot{f}_N/f_N = \dot{f}_S/f_S = \iota^* \log \lambda$.

The properties of the steady-state innovation and unemployment rates are very intuitive. A decrease in the minimum wage rate w^{min} raises ι^*. A lower minimum wage rate worsens the effective bargaining power of the union, and thereby leads to a lower Northern wage rate w_L. This reduces both R&D and production costs, and thus increases ι^*. For the same reason, ι^* is decreasing in the bargaining power α of the labor union. A larger liquidation cost B reduces ι^* via two channels: first, it reduces v_N in (13) by increasing the capital loss of the firm when imitation or further innovation take place. Second, incumbent firms react to a larger B by increasing their RPA expenditure in (14), which leads to a further decline in v_N.

A decrease in the Northern import tariff τ_N exerts multiple effects on R&D profitability. First, it forces the Northern incumbent to reduce its markup in the domestic market, lowering the profit flows π_N. This is reinforced by the reduction in c_N which is triggered by the fall in τ_N. With profit sharing in place, the firm can pass on the lower profits to workers in the form of a lower bargained wage rate w_L (Lemma 1). This works to mitigate the fall in π_N by reducing both R&D and production costs. Provided that w_L contains an exogenous component like w^{min} (to be discussed in more detail further below), the net impact is a reduction in R&D profitability and thus a lower Northern import tariff τ_N leads to a lower ι^*.

A decrease in the Southern import tariff τ_S can be analyzed similarly. A lower τ_S increases π_N by increasing the after-tariff price enjoyed by the Northern incumbent in the Southern market and also by triggering an increase in c_N. This is mitigated by a higher bargained wage rate w_L and lower c_S. Again, provided that w_L contains an exogenous component like w^{min}, the net impact is an increase in R&D incentives, and thus a lower Southern import tariff τ_S leads to a higher ι^*.[22]

An increase in the Southern imitation rate μ has several effects on ι^*. It raises the replacement rate and thereby reduces the rewards from innovating v_N in (13). This effect is further strengthened by the re-

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ductions in both c_N and c_S, which decrease π_N. The firm passes the decline in its profit flows to workers and bargains for a lower wage rate w_L (Lemma 1). However, this does not dominate the negative effects and the net profitability of R&D declines. Consequently, a higher Southern imitation rate μ decreases ι^*. An increase in the relative size of the Southern economy η_S increases c_N and hence generates larger profits from domestic sales in the North. This increases innovation incentives and thus ι^*.[23]

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 α or the minimum wage rate w^{min} unambiguously reduces u^* by increasing ι^*. A higher ι^* raises production employment by increasing the proportion of Northern industries n_N and the levels of per-capita consumption expenditure, c_N and c_S. These effects work to boost the demand for Northern labor in manufacturing. In addition, the higher R&D intensity ι^* directly raises R&D labor demand. There is no union impact on u^* other than through raising ι^* since the bargained wage rate does not affect Northern supply prices. Second, an increase in liquidation costs B raises u^* by reducing ι^*. Third, Northern (Southern) unilateral trade liberalization $\tau_N \downarrow$ ($\tau_S \downarrow$) increases (decreases) Northern unemployment by reducing (raising) ι^*.[24] Fourth, an increase in the Southern imitation rate μ raises u^* since it reduces the proportion of Northern industries n_N both directly and indirectly, by decreasing ι^*. This unemployment-generating effect is reinforced by the decline in c_N and c_S triggered by the higher μ. Fifth, an increase in η_S reduces u^* directly by expanding the Southern consumption expenditure per unit of Northern labor $c_S\eta_S$, and indirectly by increasing c_N and ι^*. Summarizing the main arguments, we have derived our[25]

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[23] A higher η_S captures the increased Southern presence in the world trading system and is thus considered as one form of globalization (see Dinopoulos and Segerstrom 2007, and Lu 2007). In our companion paper with flexible labor markets, Grieben and Şener (2009), we found the same results as in here: a higher η_S raises ι^*. However, when we differentiated between innovation-deterring and imitation-deterring activities as Northern-resource-using and Southern-resource-using activities, respectively, we found that a higher η_S can actually lower the rates of innovation and worldwide growth.

[24] It should be noted that a lower τ_N's direct impact is to increase Northern labor demand by lowering the mark-up price charged by Northern producers in the North. However, this effect is exactly nullified by the reduction in c_N which is triggered by the lower τ_N, see equations (18) and (25). A lower τ_S also exerts competing effects on Northern labor demand by increasing c_N and decreasing c_S, see equations (25) and (26). These two effects exactly cancel out as well. Hence, tariff changes affect u^* only via their impact on ι^*.

[25] In Appendix R.1, we check the robustness of our results by endogenizing the Southern imitation rate. We find that this leads to a more differentiated view on the growth and employment effects of globalization. While the effects of changing import tariffs on innovation and growth are unaffected from endogenizing the Southern imitation rate, the effects of an increased presence of the South on the world trade markets are reversed.

Proposition 1: *Starting from a unique steady-state equilibrium with an interior solution and sufficiently low tariff rates, we find that the following changes lead to faster Northern innovation and worldwide growth and lower Northern unemployment:*

    i.)   *an increase in the relative size of the South η_S;*

    ii.)   *an increase in the Northern import tariff rate τ_N;*

    iii.) *a decrease in the Southern import tariff rate τ_S;*

    iv.) *a decrease in the Southern imitation rate μ;*

    v.)   *a decrease in the labor union's bargaining power α or the minimum wage rate w^{min};*

    vi.) *a decrease in the liquidation costs B;*

    vii.) *an increase in the R&D subsidy rate σ_t.*

As we show in Appendix B, when the competitive wage rate w^{comp}, given in (B.1), is used instead of w_L to derive the FEIN condition (29), then tariffs would not matter anymore for the steady-state innovation rate ι^*, hence the "tariff-neutrality" result of our companion paper Grieben and Şener (2009) would be reestablished.

To explain why tariffs do matter under wage bargaining, we note that the bargained wage rate w_L given in (24) contains a rigid component $w^{min} > 0$ which drives a wedge between tariff effects on discounted R&D benefits and those on R&D costs. Consider for example Northern trade liberalization. A decrease in τ_N reduces the discounted profits of a Northern quality leader from domestic sales by more than it reduces the marginal R&D-cost component w_L, simply because the minimum-wage component of w_L is insensitive to tariff changes. Conversely, a decrease in τ_S increases the discounted profits of a Northern quality leader from foreign sales by more than it increases the marginal R&D-cost component w_L. The consequences of these tariff effects for mercantilist attitudes of the North are analyzed in detail in section 2.11 below.

Unemployment benefits can play a role similar to minimum wages in our context. Nickell (2003, p. 19, Table 4) provides evidence of a clear upward trend of unemployment benefit replacement ratios within the period 1960 – 1999 in many OECD countries. If the expected per-period income $E[w_L] \equiv (1-u)w_L + ubw_L$ is considered by the labor union as the reference wage income in the wage bargaining problem (21) instead of w^{min}, with $b \in \left]0,1\right[$ denoting an unemployment benefit parameter, then the resulting steady-state solutions for the bargained wage rate $\hat{w}_L$ and the innovation rate $\hat{\iota}$ would be those given in (24) and (29) with $w^{min} = 0$ imposed, respectively. Hence, tariff neutrality would apply again. However, if we assume instead that the per-period unemployment benefit is independent of the bargained wage rate (such that $E'[w_L] \equiv (1-u)w_L + ub$ is taken as reference value in (21) instead of w^{min}), then the resulting steady-state solutions for the bargained wage rate w_L' and the innovation rate ι' would be qualitatively identical to

those in our actual framework, only with w^{min} being replaced by b in (24) and (29), respectively. In that case, b would take over the role of w^{min} in terms of driving a wedge between the effects of any changes in tariff rates τ_N and τ_S on discounted R&D benefits, and their effects on R&D costs. Hence, for tariff neutrality to break down, the reference wage income must contain at least one term that is independent of the bargained wage rate itself, may it be w^{min} or b. Actually, for breaking the tariff-neutrality result it would be sufficient to have only a fraction of w^{min} or b being independent of w_L, e.g. $w^{min} \equiv \beta w_L + (1 - \beta)m$, with $\beta \in \,]0,1[$ and $m > 0$ being exogenous. We summarize these findings in

> **Proposition 2:** *Tariff changes can only have an impact on Northern steady-state innovation and unemployment rates as described in Proposition 1 if the reference wage considered by the labor union in the bargaining problem (21) contains an element (like a minimum wage rate w^{min} or a fixed unemployment benefit b) that is independent of the bargained wage rate itself.*

2.11 Steady-State Welfare Analysis

As we show in Appendix R.3 (available upon request), Northern per-capita steady-state welfare can be expressed as a function

$$F_N = \frac{1}{\rho}\left[\frac{\iota \log(\lambda)}{\rho} + (1-n_N)\log\left(\frac{c_N}{p_S^N}\right) + n_N \log\left(\frac{c_N}{p_N^N}\right)\right], \tag{31}$$

which consists of static and dynamic components. The dynamic welfare component is $\iota \log \lambda$. In the continuum of industries, quality improvements arrive at a rate of ι, and each improvement raises the consumer's utility by $\log \lambda$. The static welfare component is the logarithm of purchased goods summed over industries. In a fraction $1 - n_N$ of industries, the Northern consumer faces a price of $p_S^N = 1+\tau_N$ and purchases c_N/p_S^N units. In the remaining fraction n_N of the industries, she faces a price of $p_N^N = \lambda(1+\tau_N) > p_S^N$ and buys c_N/p_N^N units.

Unilateral trade liberalization by the North has competing welfare effects on the components of (31). First, a decrease in τ_N reduces the frequency of quality improvements ι and generates a dynamic welfare loss. Second, the lower ι decreases c_N as seen in equation (25), causing a static welfare loss. Finally, the lower ι raises $1 - n_N$ and thus reduces the consumers' exposure to relatively high-priced Northern products, causing a static welfare gain. We note that a lower τ_N has no direct effect on quantities consumed c_N/p_N^N and c_N/p_S^N since a decline in τ_N decreases c_N and the relevant product price proportionally.

There is no terms-of-trade effect of a lower τ_N since the Northern net-of-tariff import price $p_S^N/(1+\tau_N) = 1$ does not change.

Unilateral trade liberalization by the South also exerts competing effects, mostly working in the opposite direction. First, a decrease in τ_S increases ι and generates a dynamic welfare gain. Second, the higher ι raises c_N as seen in equation (25), causing a static welfare gain. Third, the higher ι reduces $1 - n_N$, causing a static welfare loss. Finally, a lower τ_S increases both c_N/p_N^N and c_N/p_S^N by increasing c_N without affecting Northern product prices. This causes a static welfare gain. The increase in c_N is triggered by a Northern terms-of-trade improvement due to the rise in the Northern net-of-tariff export price $\lambda/(1+\tau_S)$.

Using (16) to substitute for n_N, $p_S^N = 1+\tau_N$, $p_N^N = \lambda(1+\tau_N)$, and (25) to substitute for c_N in (31) gives, after rearranging terms,

$$F_N = \frac{1}{\rho}\left\{\iota\log(\lambda)\left(\frac{1}{\rho} - \frac{1}{\iota+\mu}\right) + \log\left[\frac{\iota\eta_S(\iota+\mu)}{\mu[\iota+\mu(1+\tau_S)]}\right]\right\} \qquad \rightarrow \quad \max_{\tau_N}! \qquad (32)$$

The relevant f.o.c. of the Northern government, after simplifying, is

$$\frac{\partial F_N}{\partial \tau_N} = \frac{1}{\rho}\left\{\log(\lambda)\left[\frac{1}{\rho} - \frac{\mu}{(\iota+\mu)^2}\right] + \frac{\iota^2 + \mu(1+\tau_S)(2\iota+\mu)}{\iota(\iota+\mu)[\iota+\mu(1+\tau_S)]}\right\}\underbrace{\frac{\partial \iota}{\partial \tau_N}}_{>0} = 0. \qquad (33)$$

Clearly

$$(\iota+\mu)^2 > \rho\mu \qquad (34)$$

is sufficient for (33) to yield a corner solution that implies to choose the highest feasible $\tau_N = \tau_N^{\max}$ that is consistent with an interior steady-state equilibrium.[26] Our numerical simulation below shows that condition (34) is indeed fulfilled for a wide range of plausible parameter values.[27] This establishes that the Northern government favors protectionism to maximize its steady-state welfare as captured by (32).

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[26] According to our assumption of section 2.3, $\tau_N < w_L - 1$ should set the upper bound for τ_N. However, since the steady-state innovation rate ι^* is increasing in τ_N, and the steady-state unemployment rate u^* is decreasing in ι^*, the effective upper bound $\tau_N^{\max}$ for τ_N is where it has increased ι^* to the level ι^{max} that implies $u^* = 0$ in (27). For the benchmark parameters of our simulation below, this latter restriction is the more binding one.

[27] Note that since we do not directly optimize over ι (which would give the social-planner solution), we study here a constrained optimum where the market allocation mechanism for the various flows of labor is allowed for (i.e.,

The Northern government cannot directly choose τ_S; however, during trade negotiations it can push for the level of τ_S that maximizes its welfare. To find this level, we derive the relevant f.o.c.

$$\frac{\partial F_N}{\partial \tau_S} = \frac{1}{\rho}\left\{\log(\lambda)\left[\frac{1}{\rho} - \frac{\mu}{(\iota+\mu)^2}\right] + \frac{\iota^2 + \mu(1+\tau_S)(2\iota+\mu)}{\iota(\iota+\mu)[\iota+\mu(1+\tau_S)]}\right\}\underbrace{\frac{\partial\iota}{\partial\tau_S}}_{<0} - \frac{\mu}{\rho[\iota+\mu(1+\tau_S)]} < 0, \tag{35}$$

for which (34) is again a sufficient condition. This shows that the North favors the lowest feasible $\tau_S = \tau_S^{\min}$ that is consistent with an interior steady-state equilibrium.[28] This establishes the second part of North's "mercantilist" behavior. Contrary to (33), there is a static welfare gain that is independent of a change in the innovation rate: the last term in (35) captures the positive terms-of-trade effect from increasing the Northern net-of-tariff export price $\lambda/(1+\tau_S)$.

Note the crucial role of the Northern minimum wage rate for our results: since tariff rates affect the steady-state innovation rate only for $w^{min} > 0$, the Northern representative consumer would be indifferent in terms of steady-state utility with respect to τ_N according to (33), but would still prefer $\tau_S = \tau_S^{\min}$ according to (35), if $w^{min} = 0$ instead. Hence, besides retarding growth and causing unemployment by itself, minimum wages (as well as unemployment benefits unrelated to w_L, as argued before) have the additional downside that they promote the kind of mercantilist behavior that we regularly observe at WTO trade rounds, and that makes trade agreements so difficult to achieve in practice.

Similarly, Southern per-capita steady-state welfare can be expressed as

$$F_S = \frac{\frac{\iota\log(\lambda)}{\rho} + (1-n_N)\log\left(\frac{c_S}{p_S^S}\right) + n_N\log\left(\frac{c_S}{p_N^S}\right)}{\rho} = \frac{\iota\log(\lambda)\left(\frac{1}{\rho} - \frac{1}{\iota+\mu}\right) + \log\left[\frac{(\iota+\mu)(1+\tau_S)}{\iota+\mu(1+\tau_S)}\right]}{\rho}, \tag{36}$$

where we use (16) to substitute for n_N, $p_S^S = 1$, $p_N^S = \lambda$, and (26) to substitute for c_S. Obviously, (36) does not directly depend on τ_N but is unambiguously increasing in ι, hence Southern per-capita steady-state welfare is also maximized for $\tau_N = \tau_N^{\max}$, where again terms-of-trade considerations do not play a role. A higher τ_N generates effects similar to those observed for F_N. First, it increases ι, a dynamic welfare gain.

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(29) is taken to substitute for ι in (34) to check for the corner solution). Since ι is increasing in τ_N, the solution to (32) amounts to maximizing the rate of innovation in the decentralized economy.

[28] Since ι^* is decreasing in τ_S, and u^* is decreasing in ι^*, the effective lower bound $\tau_S^{\min}$ for τ_S is where it has increased ι^* to the level ι^{max} that implies $u^* = 0$ in (27). For the benchmark parameters of our simulation below, we find that $\tau_S^{\min} > 0$ holds.

The higher ι increases c_S as seen in equation (26), a static welfare gain. Finally, the higher ι raises n_N, a static welfare loss. Maximizing (36) with respect to τ_S yields a long expression of ambiguous sign.[29] Our numerical analysis reveals, however, that among the feasible set of τ_S that is consistent with $\iota^* > 0$ and $1 > u^* \geq 0$, choosing $\tau_S = \tau_S^{min}$ maximizes Southern steady-state welfare for reasonable parameter values.[30] From this it follows that when starting from $\tau_S > \tau_S^{min}$, a steady-state welfare-maximizing Southern government wants to unilaterally liberalize trade in order to benefit from the induced growth push in the North, which more than outweighs the resulting negative terms-of-trade effect.

Overall, terms-of-trade effects play a minor role in determining the net welfare impact of tariff changes for either country, compared to the dynamic effects triggered by a change in the innovation rate: first, for both countries, there is no terms-of-trade effect of a lower τ_N at all. Second, for the North, the positive terms-of-trade effect of a lower τ_S works into the same direction as the positive dynamic welfare effect, and, as obvious from (35), is not even needed to ensure $\partial F_N/\partial \tau_S < 0$, provided that condition (34) is fulfilled. Third, for the South, the negative terms-of-trade effect of a lower τ_S is dominated by the positive welfare effects that follow from a higher Northern innovation rate.

In the following numerical analysis we also show that in a cooperative equilibrium aimed at maximizing global welfare, both countries would agree to choose $\tau_N = \tau_N^{max}$ and $\tau_S = \tau_S^{min}$. Hence we can establish

> **Proposition 3:** *The maximum Northern tariff rate τ_N^{max} and the minimum Southern tariff rate τ_S^{min} that are consistent with an interior steady-state equilibrium maximize both Northern and Southern steady-state welfare per capita individually, as well as population-weighted steady-state world welfare.*

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[29] A decrease in τ_S has two effects on Southern welfare: first, it directly reduces c_S (negative terms-of-trade effect from increasing the Southern net-of-tariff import price $\lambda/(1+\tau_S)$) which implies a static welfare loss. Second, it raises ι which, besides causing the usual dynamic welfare gain, triggers two further static welfare effects: a welfare gain by indirectly raising c_S, and a welfare loss by increasing the share n_N of relatively high-priced Northern products in the Southern consumption basket.

[30] This is shown in the Mathematica© Appendix to this paper, which is available on the authors' websites (http://cms.uni-konstanz.de/wiwi/grieben/ and http://minerva.union.edu/senerm/).

2.12 Numerical Simulation of the Steady-State Equilibrium

The purpose of deriving our steady-state equilibrium also numerically is fourfold: first, we demonstrate that for reasonable parameter values that are consistent with available empirical evidence, a steady-state equilibrium that fulfills all imposed restrictions indeed exists. Second, we verify that condition (34) is clearly satisfied in this equilibrium, thereby supporting our claims on welfare-maximizing tariff choices from the previous section. Third, we demonstrate that not only from a Northern perspective, but also in a cooperative equilibrium aimed at maximizing a population-weighted per-capita world welfare, choosing the highest feasible $\tau_N = \tau_N^{\max}$ and the lowest feasible $\tau_S = \tau_S^{\min}$ is optimal. Fourth, we provide a marginal welfare analysis to show that both Northern and Southern per-capita welfare gains from raising τ_N and reducing τ_S are increasing in the level of Northern labor market rigidities, as measured by the levels of B, α and w^{min}.

The choice of our benchmark parameter values as shown in Table 1 below is justified as follows: The size of innovations, $\lambda = 1.25$, measures the gross mark up (the ratio of the price to the marginal cost) enjoyed by innovators and is estimated as ranging between 1.05 and 1.4 (see Basu 1996 and Norrbin 1993). The subjective discount rate ρ is set at 0.07 to reflect a real interest rate of 7 percent, consistent with the average real return on the US stock market over the past century as calculated by Mehra and Prescott (1985). The world population growth rate $n = 0.012$ is calculated as the annual rate of world population growth of middle-income (2008 GNI per capita between \$976 and \$11,905) and high-income (2008 GNI per capita \$11,906 or more) countries between 1990 and 2008, as defined by the World Bank (2009). The ratio of Southern to Northern population $\eta_S = N_S/N_N$ is set at 3.93, which is calculated as the ratio of the working age population in middle-income countries to that in high-income countries, again following the World Bank (2009). The choice of the innovation subsidy rate σ_t at 30% follows the estimate for the effective US R&D subsidy rate 1991 reported in Impullitti (2009). The remaining parameters (A_t, s_N, α, w^{min}, μ, τ_N, τ_S, and B) are chosen with the objective in mind to generate reasonable values for endogenous variables, in particular to generate a growth rate $g = t\log\lambda$ between 0.5% (following Denison 1985) and 2% (the average U.S. GDP per capita growth rate from 1950 to 1994 reported in Jones, 2005). The proportion of specialized labor s_N is set at 0.002 to generate a wage differential w_H/w_L that is significantly greater than 1 since it is reasonable to assume that specialized lobbyists are in low supply and earn more than the general-purpose workers. Furthermore, our parameter choices ensure to get a reasonable unemployment rate below 20%, a reasonable industry distribution between the North and the South (i.e. without any region claiming more than 90% of the industries), and a reasonable union wage premium over the corresponding

reference wage, $(w_L - w^{min})/w^{min}$ in our model, around 10% (estimates for this measure range from 6% for West Germany to 18 percent in US, see Blanchflower and Freeman 1992).

Table 1: Numerical steady-state equilibrium and marginal welfare analysis

Benchmark parameters: $\lambda = 1.25$, $\rho = 0.07$, $n = 0.012$, $N_N = 1$, $N_S = 3.93$, $\alpha = 0.5$, $s_N = 0.002$, $A_\iota = 1$, $\sigma_\iota = 0.3$, $w^{min} = 1.05$, $\mu = 0.2633$, $\tau_N = \tau_S = 0.01$, $B = 0.04$

Endogenous variables	Benchmark solution	$\tau_N = \tau_S =$ 0.0095	$B =$ 0.044	$\alpha =$ 0.502	$w^{min} =$ 1.051
Innovation rate ι	0.07132	0.07288	0.06820	0.06731	0.06613
Northern industry share n_N	0.21313	0.21678	0.20572	0.20359	0.20075
Bargained wage rate w_L	1.14644	1.14666	1.14635	1.14671	1.14679
Relative specialized wage w_H/w_L	1.85135	1.93314	1.69941	1.64906	1.59201
Union wage premium $(w_L - w^{min})/w^{min}$	0.09185	0.09206	0.09176	0.09210	0.09114
Unemployment rate u	0.07510	0.05494	0.11548	0.12698	0.14218
Northern per-capita consumption expenditure c_N	1.06672	1.08996	1.01998	1.00667	0.98907
Southern per-capita consumption expenditure c_S	1.00211	1.00204	1.00204	1.00202	1.00199
Share of R&D in total workforce $s_{R\&D} \equiv A_\iota \iota$	0.07132	0.07288	0.06820	0.06731	0.06613
Share of manufacturing in total workforce $s_M \equiv 1 - s_N - u - s_{R\&D}$	0.85158	0.87019	0.81432	0.80371	0.78969
Utility growth rate $g = \iota \log\lambda$	0.01591	0.01626	0.01522	0.01502	0.01476
Northern per-capita welfare F_N	3.34894	3.72316	2.59031	2.36896	2.07265
Southern per-capita welfare F_S	2.59851	2.65685	2.47898	2.44501	2.40017
Northern welfare elasticity $dlogF_N/dlog\tau_N$	0.83831	0.71321	1.05918	1.15284	1.31712
Northern welfare elasticity $dlogF_N/dlog\tau_S$	−3.07740	−2.56307	−4.06548	−4.48322	−5.21274
Southern welfare elasticity $dlogF_S/dlog\tau_S$	−0.62617	−0.57779	−0.64414	−0.65090	−0.66392

Notes: Here we provide the main results of our Mathematica© Appendix, which is available from the authors' websites. We analyze the variation of only one labor market parameter at a time. The conditions (30), (A.6), (A.7), $1+\tau_S < \lambda/w_L$ and $1+\tau_N < w_L$ for the existence of a unique interior steady-state equilibrium are fulfilled throughout, as is also condition (34) for corner solutions in the welfare maximization problems (33) and (35). For the benchmark parameters, it results $\iota^{comp} = 0.07712$, $w^{comp} = 1.14576$, $w^{max} = 1.24288$, and the maximum feasible innovation rate consistent with $u \geq 0$ is $\iota^{max} = 0.07712$. In general, the benchmark parameters and outcomes are in line with the recent related theoretical growth literature that employ numerical simulations, e.g. Dinopoulos and Segerstrom (1999), Jones (2002), Lundborg and Segerstrom (2002), Sayek and Şener (2006), Şener (2006, 2008), Segerstrom (2007), and Impullitti (2009).

For a wide range of parameters around the benchmark outcome in the first column, condition (34) is clearly fulfilled, hence Northern per-capita welfare is maximized by choosing $\tau_N = \tau_N^{max}$ and $\tau_S = \tau_S^{min}$. Furthermore, we derived the optimal tariff structure when the aim is to maximize cooperatively a population-weighted world welfare per capita. Consistent with the findings for each individual country, the optimal cooperative solution is again to choose $\tau_N = \tau_N^{max}$ and $\tau_S = \tau_S^{min}$, as is illustrated in Figure 2.
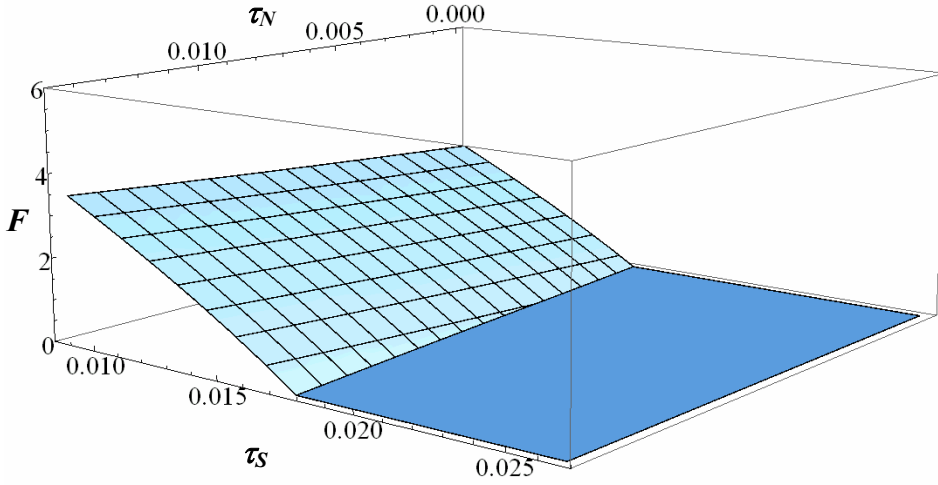
Figure 2: Cooperative maximization of population-weighted world welfare per capita

Parameters: $\lambda = 1.25$, $\rho = 0.07$, $n = 0.012$, $N_N = 1$, $N_S = 3.93$, $\alpha = 0.5$, $s_N = 0.002$, $A_\iota = 1$, $\sigma_\iota = 0.3$, $w^{min} = 1.05$, $\mu = 0.2633$, $B = 0.04$. The population-weighted per-capita world welfare is $F \equiv [1/(1+\eta_S)]F_N + [\eta_S/(1+\eta_S)]F_S$. Calculations are from the Mathematica$^{©}$ Appendix which is available on the authors' websites.

Given the reciprocity principle in actual WTO trade negotiations, such a cooperative outcome will not be feasible in practice. The second column in Table 1 therefore shows the effects of a simultaneous and equi-proportionate cut in both tariff rates. While more rigid Northern labor market institutions ana-lyzed in the other columns force both Northern manufacturing and R&D workers into unemployment (which reduces ι, c_N, g, F_N, and F_S), bilateral trade liberalization reallocates unemployed workers into both Northern manufacturing and R&D employment, which raises ι, c_N, g, F_N, and F_S. Hence for our empiri-cally plausible set of benchmark parameters, symmetric bilateral trade liberalization with equi-propor-tionate tariff cuts at the margin is clearly preferable to the status quo.

The Northern welfare elasticity with respect to τ_N, $dlogF_N/dlog\tau_N = (dF_N/F_N)/(d\tau_N/\tau_N)$, equals 0.8383 in the benchmark case, which implies that for $B = 0.04$, a 10% increase in τ_N (from 0.01 to 0.011) would raise Northern per-capita steady-state welfare by 8.38%. As the marginal welfare analysis in Table 1 shows, the Northern welfare elasticities with respect to both τ_N and τ_S are substantially increasing in the levels of Northern labor market rigidities B, α, and w^{min}. Moreover, higher Northern rigidities promote

Southern trade liberalization, since the Southern welfare elasticity with respect to τ_S, $dlogF_S/dlog\tau_S$, is also increasing in B, α, and w^{min} (all these elasticity results hold for a wider range of rigidities as is shown in the Mathematica© Appendix). Hence we can establish

> **Proposition 4:** *Starting from a unique steady-state equilibrium with an interior solution and sufficiently low tariff rates, the Northern steady-state per-capita welfare gains of Northern protectionism ($\tau_N \uparrow$) and both the Northern and Southern steady-state per-capita welfare gains from Southern trade liberalization ($\tau_S \downarrow$) are increasing in the level of Northern labor market rigidities B, α, and w^{min}.*

In other words, Northern mercantilist behavior is more pronounced when the Northern labor market is more rigid. We finally note another advantage of bilateral trade liberalization: after the simultaneous decrease in tariffs, Northern incentives for protectionism, as measured by $dlogF_N/dlog\tau_N$, decline.

3   Comparison with Related Literature

3.1   *Explaining Mercantilism*

Krugman (1997) characterizes the GATT negotiations as reflecting mercantilist behavior that cannot be justified by any economic reasoning. He claims that, when neglecting the optimal-tariff argument that has little relevance in reality, "*The economist's case for free trade is essentially a unilateral case: a country serves its own interests by pursuing free trade regardless of what other countries may do*" (p. 113). Our analysis casts doubt on the validity of Krugman's claim by considering the effects of labor market rigidities.[31]

Bagwell and Staiger (1999), by contrast, defend the principle of reciprocity that is typically applied in GATT or WTO trade rounds as leading to welfare improvements for the economies of all negotiating governments. This is because "*[...] a unilateral liberalization effort is unappealing [...] as a consequence of the associated deterioration in the terms of trade*", while "*a negotiated mutual reduction in tariffs that conforms to the principle of reciprocity results in a higher trade volume without a terms-of-trade loss for either government*" (p. 226).[32]

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[31] Labor market imperfections are actually not a necessary condition to counter Krugman's claim: in our companion paper Grieben and Şener (2009) we show that even with perfectly flexible labor markets, unilateral Southern trade liberalization reduces Northern innovative activity and the worldwide steady-state growth rate in an asymmetric setting where product-cycle and interindustry trade coexist.

[32] In Appendix R.4 (which is available upon request) we demonstrate that the total trade volume is increasing in ι,

Observe that terms-of-trade effects (only for changes in τ_S) and trade-volume effects (of ambiguous sign) are embodied but largely irrelevant in our welfare analysis in section 2.11. Instead, dynamic effects that work through changes in the innovation rate ι are driving the welfare results. These dynamic welfare effects are completely outside the scope of Bagwell and Staiger (1999).

Ethier (2004, 2007) offers a critique on Bagwell and Staiger's "Received Theory" of explaining the reciprocity principle in trade negotiations solely by focusing on terms-of-trade externalities. Ethier (2007) argues that the "Received Theory" is dramatically inconsistent with empirical evidence of actual multilateral trade agreements: "*[...] For over four decades, successive GATT rounds have produced trade agreements that do not prevent terms-of-trade manipulation while trade theorists have produced theories of trade agreements in which such prevention is the sole object*" (p. 606). Ethier (2007, section 8) proposes a political-economy theory that is based on the protection-for-sale model of Grossman and Helpman (1994) of trade agreements, where terms-of-trade issues are completely out of the picture. Only political-economy considerations remain to bring theory in line with empirical evidence again, namely to explain that, first, export taxes are not observed although trade negotiations would allow to use them, and second, that we observe countervailing-duty laws being implemented. However, Ethier (2007, p. 621) also challenges the existing empirical evidence for the protection-for-sale model. Our paper offers an alternative explanation for the apparent mercantilism in trade negotiations that does also not rely on terms-of-trade effects but instead emphasizes the growth-promoting effects of Northern tariffs when there are union wage bargaining and a minimum wage rate in the North. Moreover, as argued earlier, in the framework of this paper, the Northern government has no incentive to set export taxes but a strong incentive to react by means of countervailing-duty laws to any Southern export subsidies. All this is consistent with the empirical evidence emphasized by Ethier (2004, 2007).

3.2   *Interactions Between Trade and Labor Market Policies*

Our model captures the substitutability between Northern labor market and trade policies. For example, in Northern countries with rigid labor markets, there may be pressure to use protectionism (increase in τ_N) to unwind the negative welfare effects of higher minimum wages or vice versa. This is in line with the theoretical findings of Costinot (2009) who analyzes a small open economy with search frictions, where a welfare-maximizing government chooses optimal trade taxes across industries. He concludes that "*In a*

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whereas for a given level of ι it moves in an ambiguous direction with changes in τ_S and remains neutral to changes in τ_N. We show that unilateral Northern trade liberalization unambiguously reduces the total trade volume while unilateral Southern trade liberalization has an ambiguous effect on it, and thus bilateral trade liberalization by equal proportions, i.e. $d\tau_N = d\tau_S = d\tau < 0$, has also an ambiguous net effect on the total trade volume.

cross-section of industries, parameters which are positively correlated with unemployment – workers'
bargaining power [...] – should also be positively correlated with trade taxes" (p. 1013). This is also con-
firmed by empirical evidence of Matschke and Sherlund (2006) who find a positive correlation between
unionization rates and trade taxes across industries. Our model shows that these results also apply for the
aggregate Northern economy in a two-country North-South framework.

3.3   Growth Impact of Stronger Labor Unions

The negative growth impact of stronger labor unions in our model contrasts sharply with the findings of
Palokangas (1996) and Lingens (2003). In a first-generation endogenous growth setting which still fea-
tures the counterfactual scale effect, they distinguish between high-skilled and low-skilled workers, and
innovative R&D is only done by the former. Only the low-skilled wage rate is bargained above the com-
petitive level. Competition on product markets is such that if the labor union is able to bargain a higher
low-skilled wage rate, this increase in production costs is passed on to consumer prices. This reduces con-
sumption demand and hence necessarily reduces unskilled employment. Given the additional assumption
that high-skilled and low-skilled workers are weakly substitutable (i.e., complements) in manufacturing,
this reduces the productivity of high-skilled workers in manufacturing, decreases their competitive wage
rate, and hence reduces marginal R&D costs. Consequently, some high-skilled workers are reallocated
towards R&D which finally raises economic growth.

Our paper differs in all these respects. We assume homogenous labor for production and R&D activi-
ties (hence the degree of substitutability is not an issue) and derive a unique bargained wage rate for those
workers. Moreover, product prices are pinned down in terms of the Southern wage rate. Under the Nash
equilibrium of the Bertrand pricing game, Northern firms engage in limit pricing and charge a mark up
over the marginal cost of the Southern follower firms. In essence, our modeling captures the relevance of
the South in determining manufactured goods prices by explicitly incorporating the threat of competition
coming from the South. This renders Northern product prices independent of the Northern bargained wage
rate and thereby mutes the direct negative employment effect of a stronger union through product prices.
Instead, our model offers an indirect negative employment effect that works through a reduction of North-
ern innovation activity, which reduces demand for both R&D and manufacturing labor, as a lower innova-
tion rate reduces the proportion of Northern manufacturing industries in the global economy. Finally, we
derive our results in a fully-endogenous growth model without scale effects taking seriously the Jones
(1995a, b) critique.

4 Conclusions

We have analyzed the long-run economic growth and welfare consequences of various globalization forces in a scale-free North-South endogenous growth model with union wage bargaining in the North. We find that Southern unilateral trade liberalization raises Northern firms' profits by more than it increases the bargained wage rate. This raises the Northern innovation rate and implies a permanent increase in product quality growth for both countries. In steady-state welfare simulations, we find that the dynamic gains triggered by faster Northern innovation play a dominant role and determine the net change in welfare in the presence of other static welfare effects. Consequently, the higher Northern innovation rate boosts the steady-state welfare of both countries. By contrast, Northern unilateral trade liberalization reduces Northern firms' profits by more than it reduces the bargained wage rate. This reduces the innovation rate and thus the steady-state welfare levels for both countries, while raising Northern unemployment. Thus, our North-South model with an asymmetric labor market structure suggests that at the WTO meetings, Northern countries with unionized labor markets would optimally pursue mercantilist behavior whereas Southern countries with flexible labor markets would optimally pursue trade liberalization. We reach these results without relying on terms-of-trade arguments, which is in line with Ethier's (2004, 2007) critique of the "Received Theory" of trade negotiations as exemplified by Bagwell and Staiger (1999).

Northern labor market rigidities are shown to be harmful on two grounds. First, a stronger labor union, a higher minimum wage and higher shutting-down costs for Northern firms have *direct* adverse effects by reducing worldwide growth and welfare, and increasing Northern unemployment. Second, the Northern incentives for protectionism (as measured by the Northern welfare elasticity with respect to changes in the Northern import tariff) are increasing in the level of Northern labor market rigidities. This is an obstacle for reaching a trade agreement at WTO negotiations where the reciprocity principle applies. Since we demonstrate numerically that bilateral trade liberalization at the margin raises worldwide growth and welfare and hence is clearly preferable to the status quo, Northern labor market rigidities are also *indirectly* harmful by handicapping welfare-increasing bilateral trade agreements at the margin. We are keen to point out that our findings do not advocate protectionism by advanced countries with labor market rigidities. If a normative conclusion is to be drawn from this paper, it should rather be to reduce labor market rigidities.

Further related research can complement our analysis on two grounds. First, from a theoretical perspective, one can incorporate FDI and outsourcing into the model and investigate the effects of globalization that materialize through these channels. Second, from an empirical perspective, one can test our result of an inverse relationship between labor market flexibility and protectionist attitudes. This requires finding

a reasonable proxy for the protectionist attitude of governments. Kee et al. (2009)'s trade restrictiveness indicators could provide such measures. Such an empirical study can also complement Dutt et al. (2009), who find a positive relationship between protection and unemployment using a model that focuses on the static effects of trade liberalization in a standard Ricardian framework with frictional labor markets.

Appendices

Appendix A: Comparative Statics

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

$$f\left(\iota^{*}, w^{min}, \ldots\right) = \frac{\eta_S\left(\iota+\mu\right)}{\mu\lambda}\left\{\frac{1}{\alpha+\left(1-\alpha\right)w^{min}\cdot\frac{\iota+\mu\left(1+\tau_S\right)}{\lambda\left[\iota\left(1+\tau_N\right)+\mu\right]}}-1\right\}-\left(1-\sigma_\iota\right)A_\iota\left[\rho+\left(1+B\right)\left(2\iota+\mu\right)-n\right]=0. \text{(A.1)}$$

We then derive, after collecting terms,

$$\frac{\partial\iota^{*}}{\partial w^{min}} = -\frac{\partial f\left(\cdot\right)/\partial w^{min}}{\partial f\left(\cdot\right)/\partial\iota^{*}} = \frac{\frac{\left(\iota+\mu\right)\left(1-\alpha\right)\left[\iota+\mu\left(1+\tau_S\right)\right]}{\lambda\left[\iota\left(1+\tau_N\right)+\mu\right]}}{C^2\left[A-\frac{\mu\lambda\left(1-\sigma_\iota\right)A_\iota 2\left(1+B\right)}{\eta_S}\right]+\frac{\left(\iota+\mu\right)\left(1-\alpha\right)w^{min}\mu\left[\tau_N+\tau_S\left(1+\tau_N\right)\right]}{\lambda\left[\iota\left(1+\tau_N\right)+\mu\right]^2}}, \tag{A.2}$$

where

$$C \equiv \alpha+\left(1-\alpha\right)\frac{w^{min}}{w^{max}}<1, \quad A \equiv \frac{1}{C}-1>0.$$

The numerator of (A.2) is positive, and the second term in the denominator converges to zero when tariffs go to zero. Therefore, $\partial\iota^{*}/\partial w^{min}<0$ 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

$$\frac{\mu\lambda\left(1-\sigma_\iota\right)A_\iota\left[\rho+\left(1+B\right)\left(2\iota+\mu\right)-n\right]}{\eta_S\left(\iota+\mu\right)} < \frac{\mu\lambda\left(1-\sigma_\iota\right)A_\iota 2\left(1+B\right)}{\eta_S},$$

which reduces to condition (30) in the main text. Under the same assumptions, it is

$$\frac{\partial\iota^{*}}{\partial\tau_N} = -\frac{\partial f\left(\cdot\right)/\partial\tau_N}{\partial f\left(\cdot\right)/\partial\iota^{*}} = \frac{\frac{\left(\iota+\mu\right)\left(1-\alpha\right)w^{min}\iota\left[\iota+\mu\left(1+\tau_S\right)\right]}{\lambda\left[\iota\left(1+\tau_N\right)+\mu\right]^2}}{C^2\left[A-\frac{\mu\lambda\left(1-\sigma_\iota\right)A_\iota 2\left(1+B\right)}{\eta_S}\right]+\frac{\left(\iota+\mu\right)\left(1-\alpha\right)w^{min}\mu\left[\tau_N+\tau_S\left(1+\tau_N\right)\right]}{\lambda\left[\iota\left(1+\tau_N\right)+\mu\right]^2}}>0, \tag{A.3}$$

$$\frac{\partial \iota^*}{\partial \tau_S} = -\frac{\partial f(\cdot)/\partial \tau_S}{\partial f(\cdot)/\partial \iota^*} = \frac{\dfrac{-(\iota+\mu)(1-\alpha)w^{\min}\mu}{\lambda[\iota(1+\tau_N)+\mu]}}{C^2\left[A - \dfrac{\mu\lambda(1-\sigma_\iota)A_\iota 2(1+B)}{\eta_S}\right] + \dfrac{(\iota+\mu)(1-\alpha)w^{\min}\mu[\tau_N + \tau_S(1+\tau_N)]}{\lambda[\iota(1+\tau_N)+\mu]^2}} < 0. \tag{A.4}$$

For $\tau_N = \tau_S = 0$, (29) can be solved explicitly for

$$\iota^*\Big|_{\tau_N=\tau_S=0} = \frac{\eta_S(1-\alpha)\left(1-\frac{w^{\min}}{\lambda}\right) - \left[\alpha\lambda + (1-\alpha)w^{\min}\right]\left[\rho + (1+B)\mu - n\right](1-\sigma_\iota)A_\iota}{2(1+B)(1-\sigma_\iota)A_\iota\left[\alpha\lambda + (1-\alpha)w^{\min}\right] - \dfrac{\eta_S(1-\alpha)\left(1-\frac{w^{\min}}{\lambda}\right)}{\mu}}, \tag{A.5}$$

and all other comparative-static results of (29) are straightforward from this.[33] Note that for $\iota^* > 0$, both numerator and denominator of (A.5) must be positive.[34] They cannot be both negative since this would imply

$$2\mu(1+B)(1-\sigma_\iota)A_\iota\left[\alpha\lambda + (1-\alpha)w^{\min}\right] < \eta_S(1-\alpha)\left(1-\frac{w^{\min}}{\lambda}\right)$$

$$< (1-\sigma_\iota)A_\iota\left[\alpha\lambda + (1-\alpha)w^{\min}\right]\left[\rho - n + (1+B)\mu\right] \quad \Leftrightarrow \quad 2\mu(1+B) < \rho - n + (1+B)\mu,$$

which is a contradiction to (30). Hence, condition (30) is also required under free trade to ensure $\iota^* > 0$. The condition that the numerator of (A.5) must be positive is equivalent to

$$\frac{\dfrac{\eta_S}{\lambda}\left[\dfrac{\lambda}{\alpha\lambda + (1-\alpha)w^{\min}} - 1\right]}{\rho + (1+B)\mu - n} > (1-\sigma_\iota)A_\iota, \tag{A.6}$$

where the LHS of (A.6) is the discounted R&D benefit for $\tau_N = \tau_S = 0$ and $\iota \to 0$ from the FEIN condition (29). This ensures a positive innovation rate under the actual discount rate $\rho + (1+B)(2\iota + \mu) - n$ for R&D

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[33] The steady-state innovation rate ι^* also depends negatively on the interest (households' time preference) rate ρ and the unit resource requirement for R&D $A_\iota \equiv a_\iota \delta s_N / (n\gamma)$; it depends positively on the population growth rate n and the R&D subsidy rate σ_ι, while the net impact of a change in λ on ι^* is ambiguous.

[34] Since $A_\iota \to \infty$ for $n \to 0$, dividing both numerator and denominator of (A.5) by A_ι and then setting $n = 0$ shows immediately that a positive steady-state innovation rate is not defined for zero population growth. In our model, RPAs lead to accumulation of R&D difficulty stock over time. Thus, supporting a constant and positive innovation rate requires expanding resources for R&D, which in turn requires positive population growth. However, if we introduce a constant depreciation rate $\sigma > 0$ for R&D difficulty, a positive steady-state innovation rate would no longer require positive population growth $n > 0$. In this case, the equation of motion for R&D difficulty will be $\dot{D} = n_N \delta X - \sigma D$ instead of (8). With $n = 0$, setting $\dot{D} = 0$ would imply $D = s_N N_N \delta / (\sigma\gamma)$, a constant R&D difficulty and positive steady-state growth. This result is in line with Dinopoulos and Syropoulos (2007), where RPAs are instead modeled as a flow variable. However, it contrasts with the general class of semi-endogenous growth models discussed in Jones (2005, p. 1073), where R&D difficulty is linked exogenously to innovation and growth comes to a halt with zero population growth.

benefits. The condition that the denominator of (A.5) must be positive is equivalent to

$$\frac{\frac{\eta_S}{\lambda}\left[\frac{\lambda}{\alpha\lambda+(1-\alpha)w^{\min}}-1\right]}{2(1+B)\mu}<(1-\sigma_t)A_t.$$

(A.7)

Hence for existence and uniqueness of our steady-state equilibrium, we need (30), (A.6) and (A.7) to be fulfilled.

Appendix B: Steady-State Equilibrium with Competitive Wage Rate

We can derive the competitive wage rate as a function solely in ι, that is, the level of w_L that would prevail if $w^{min} < w^{comp}$ and if there were no Northern wage bargaining. From (11), it is $w_L = v_N/[(1-\sigma_t)a_tD]$. Using (15) together with $r = \rho$ and $\dot{v}_N/v_N = n$ to substitute for v_N, (9) and (19) to substitute for D, (17) to substitute for c_S, (25) to substitute for c_N, simplifying and solving this free-entry in innovation (FEIN) condition for w^{comp} yields

$$w^{comp} = \frac{\lambda\left[\iota(1+\tau_N)+\mu\right]\eta_S(\iota+\mu)}{\left[\iota+\mu(1+\tau_S)\right]\left\{\eta_S(\iota+\mu)+\mu\lambda\left[\rho+(1+B)(2\iota+\mu)-n\right](1-\sigma_t)A_t\right\}}$$

$$\Leftrightarrow \frac{w^{comp}}{w^{\max}} = \frac{1}{1+\frac{\mu\lambda\left[\rho+(1+B)(2\iota+\mu)-n\right](1-\sigma_t)A_t}{\eta_S(\iota+\mu)}},$$

(B.1)

where w^{max} is given as before in (24). If the competitive wage rate applies, the Northern labor markets must clear, so that the steady-state innovation rate corresponding to that situation can be derived from setting $u^* = 0$ in (27):

$$\iota^{comp} = \frac{1-s_N}{\frac{\eta_S}{\lambda\mu}+A_t}.$$

(B.2)

Note that if follows from (B.2) that our model turns into a semi-endogenous growth framework for competitive wage setting: ι^{comp} cannot be influenced by any public policies as long as Southern imitation remains exogenous. The interpretation of ι^{comp} is straightforward: it increases for a lower share s_N of specialized workers engaged in rent protection, a lower share of general-purpose workers employed in manufacturing (which is positively related to $\eta_S/(\lambda\mu)$), and a lower effective unit resource requirement for R&D A_t. Note in particular that as in the baseline setting of Grieben and Şener (2009), tariffs are neutral for the steady-state innovation rate under competitive wage determination. Any profit-increasing tariff changes (i.e. an increase in τ_N that raises the profits from Northern domestic sales, or a decrease in τ_S that raises the

profits from Northern exports) are mitigated by a corresponding increase in w^{comp}, and the resulting general-equilibrium effects associated with changes in w^{comp}, c_N, and c_S completely nullify the initial positive tariff stimulus, and similarly for profit-decreasing tariff changes. We note that ρ, n, B, and σ_t do not affect ι^{comp} either. Hence, a similar nullification effect is at work regarding these parameters.

Finally, it follows from (27) and (B.2) that the equilibrium innovation rate ι^* falls short of the innovation rate under competitive wage setting ι^{comp} whenever there is positive unemployment:

$$\frac{u^*}{\frac{\eta_S}{\lambda\mu} + A_t} = \iota^{comp} - \iota^* . \tag{B.3}$$

This is the case whenever $w_L > w^{comp}$.

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