GLOBALIZATION WITH LABOR MARKET FRICTIONS AND NON-SCALE GROWTH

Wolf-Heimo Grieben

This version: 8th March 2006

Abstract. We analyze the interaction between globalization and labor market frictions in a dynamic general equilibrium North-South non-scale growth model with endogenous Northern innovation and endogenous Southern imitation. The employment, growth and relative-wage effects of globalization are shown to depend qualitatively on the degree of Northern labor market frictions. We demonstrate that Northern countries with particular severe labor market frictions benefit from globalization in terms of employment and growth. We also analyze whether stricter intellectual property rights protection in the South, rising R&D subsidies in the North or an increase in Northern labor market flexibility alleviate or aggravate globalization effects.

JEL Codes: F12, F43, O31, O34

Key words: Globalization, Quality-Ladder Model, Non-Scale Growth, Frictional Unemployment, Firing Costs

Wolf-Heimo Grieben
Department of Economics
University of Konstanz
Universitaetsstr. 10, Box D 146
78457 Konstanz
Germany
Phone: +49-(0)7531-88-5192
Fax: +49-(0)7531-88-4076
Email: heimo.grieben@uni-konstanz.de

1 Introduction

Factor prices are determined in general equilibrium. Therefore, wages of US or European workers are not 'set in Beijing' (Freeman, 1995). Instead, factor and product market conditions in all open countries connected by trade determine together the equilibrium wage rates in both developed Northern countries and in developing Southern countries. Thus, in face of rising competition (e.g., by imitating Northern production technologies) from low-wage countries like China or India, Northern wage rates do not have to decline to those Southern levels, and Southern wage rates are also endogenously determined in general equilibrium. In this paper we go one step further and ask the following question: how do the effects of 'globalization' – defined as an increase in the economic size of the open South – on Northern R&D-driven growth, the Southern imitation rate, Northern unemployment and the North-South wage gap depend on the degree of Northern labor market frictions, as measured by a unified job-finding rate and firing costs? We also analyze how these economic variables are affected by stricter intellectual property rights protection (IPRP) in the South, rising R&D subsidies in the North, a decrease in firing costs or an increase in the job-finding rate. The framework used to tackle these issues is a two-country (North-South) quality ladder model, which features a Vernon-type product cycle, neo-Schumpeterian non-scale growth with endogenous Northern innovation and endogenous Southern imitation.

The effects of globalization and stricter IPRP have recently been studied in similar frameworks by Dinopoulos and Segerstrom (2005a,b), Şener (2005), or Dinopoulos et al. (2005). However, they all assume a perfectly flexible Northern labor market, whereas other studies stress that labor market rigidities could be harmful for open economies. A standard textbook argument says that the international division of labor (which is speeding up during the current wave of globalization) is unambiguously beneficial for the welfare of countries open to trade if, and only if, factor and product prices are sufficiently flexible, see also Sinn (2004). Furthermore, it is commonly accepted that adjustment costs for firms – e.g., because of the existence of closing-down or firing costs – and for workers – e.g., because they undergo a period of unemployment before they find a new job in a different industry – could result in welfare-reducing globalization effects even under flexible factor and goods prices. This standard hypothesis is reflected in recent studies of Angrist and Kugler (2003), who provide evidence on the negative employment effects (aggravated by labor and product market rigidities) of non-EU immigration to EU countries, and Arnold (2002), further discussed below. However, we will argue in this paper that these labor market adjustment costs will affect the *endogenous* globalization pressure from Southern developing countries (here: their imitation rate) in general equilibrium. We will show that accounting for these feedback effects from Northern labor market frictions to the Southern imitation incentives can *qualitatively* change the effects of globalization and economic policies (like stricter IPRP and rising Northern R&D subsidies) in general equilibrium. Hence, the central new feature of this paper is that it introduces a theoretical link from labor market frictions in the North to the globalization pressure coming from the South, and the main new finding is that Northern countries with significant labor market frictions for both firms and workers will *benefit* from globalization in terms of growth and employment.

Recently, some papers have analyzed aspects of globalization within endogenous growth models with labor market frictions, including Arnold (2002), Şener (2001, 2004), and Grieben (2004). Arnold (2002) generalizes the North-South product-cycle model of Helpman (1993) in order to analyze the effects of rising Southern imitation on Northern growth and unemployment. In particular, he focuses on how these effects depend on the degree of Northern labor market flexibility, as measured by a unified job-finding rate. He finds that for a high (low) degree of labor market flexibility, rising Southern imitation stimulates (impedes) Northern growth, whereas for an intermediate degree of labor market flexibility, this relationship is hump-shaped. Furthermore, whenever rising Southern imitation reduces Northern growth, it also raises Northern unemployment. Arnold's findings suggest that Northern countries with more flexible labor markets (like the US) will be better prepared to adjust to rising competition from the South than countries with relative large labor market frictions (like some continental European countries). This accords with the view shared by many economists that in Northern countries with severely inflexible labor markets, globalization forces will ultimately result in an innovation and growth problem in addition to rising unemployment.

We use a modified version of Arnold's way of modeling the Northern labor market. Our model differs from his setting in three important respects. First, we analyze a semi-endogenous non-scale growth model (with vertical innovations), whereas his model belongs to the first generation of endogenous growth models (with horizontal innovations) and hence features scale effects. As a consequence, in our model, growth effects of globalization or economic policies will only be temporary. Second, we fully model the consumption and production side of the Southern economy, and thereby we derive the Southern imitation rate *endogenously*. As a consequence, instead of analyzing directly the effects of an increase in the Southern imitation rate, we look at the effects of globalization (as defined above) which *may* result in increasing Southern imitation. Third, we introduce firing costs as a second labor market imperfection. As a consequence, we are able to analyze joint effects and the interplay of two different labor market imperfections. For example, we show that globalization has markedly different effects in a Northern country with large firing costs and a high job-finding rate as compared to a Northern country with low firing costs and a low job-finding rate.

Şener (2001) builds a neo-Schumpeterian North-North non-scale growth model with skilled and unskilled labor, an endogenous education decision, and matching unemployment for the unskilled. He analyzes the effects of trade liberalization between the two completely symmetric countries on growth, unemployment, the skilled-unskilled wage differential, and skill upgrading. Inter alia, when analyzing the case of a R&D technology similar to the one used in this paper, he finds that trade liberalization permanently raises the within-country skilled-unskilled wage differential, has no effect on the long-run unemployment rate of the unskilled, permanently increases the proportion of skilled workers, reduces the aggregate steady-state unemployment rate, and temporarily spurs innovation and growth. On the one hand, our model is simpler since we abstract from different types of workers and an education choice. On the other hand, our model is more complicated since we model asymmetric countries and add endogenous imitation. Şener (2004) offers a neo-Schumpeterian non-scale growth model that also features an endogenous education decision. However, this is a North-North model with asymmetric labor market institutions (flexible-wage US and rigid-wage Europe), where the European wage rigidity generates unemployment. Şener aims to explain the empirically observed facts of rising European unemployment, rising skill premium (more pronounced in the US), skill upgrading among workers, and rising R&D intensities. He finds that a combination of global technical progress in R&D technologies and an institutional response in Europe that raises the relative wage of unskilled labor can explain these empirical findings. Trade liberalization cannot help to explain these facts qualitatively, but it magnifies the quantitative effects of exogenous technological or institutional shocks. Grieben (2004) proposes a neo-Schumpeterian North-South non-scale growth model with an endogenous education decision and Northern wage rigidity. That paper analyzes the effects of a further compression of the relative wage and rising unemployment benefits for Northern unskilled workers as well as increasing education subsidies for skill upgrading, unemployment, wage inequality and growth in the North. Moreover, that paper emphasizes the relevance of North-South trade and incomplete Northern specialization for the labor market effects obtained in the model.

Our model adopts the basic framework from Dinopoulos and Segerstrom (2005a) – henceforth referred to as DS – who in turn build upon Grossman and Helpman (1991). DS develop a North-South neo-Schumpeterian product-lifecycle model with non-scale growth driven by endogenous Northern innovation, and with endogenous Southern imitation. Globalization takes the form of the entry of a large Southern developing country (the newly industrialized South) like China into the world free-trade markets, where new Southern firms compete with the established Northern firms on the markets for qualitatively diversified consumer goods. The entry of the South is technically modeled as a discontinuous rise in the Southern population size. On the one hand, this form of globalization improves incentives for Northern quality follower firms to engage in R&D by raising the market size to which these firms (once they become quality leaders) can sell their products. On the other hand, this form of globalization "steals the business" of established Northern quality leader firms whose products are driven from the world market since they are imitated at lower wage costs by new Southern quality leaders. With intersectoral mobility of workers in *perfectly flexible labor markets*, the flow of production jobs from the North to the low-wage South implies that more Northern workers are available for doing R&D in quality follower firms, which results in a temporary rise in the Northern growth rate above its steady-state level. Since R&D difficulty rises with the innovation rate, this positive growth effect peters out in the long run, and the steady-state rates of innovation and growth are not affected. Finally, since globalization raises the reward for Southern imitation *by more* than the reward for Northern innovation, the relative Southern wage rate increases in the new steady-state North-South trade equilibrium. Therefore, DS (2005a) conclude that globalization benefits Northern consumers in terms of a temporary innovation and growth push but hurts them in terms of a declining wage rate (absolute *and* relative to the South), which decreases global income inequality.[1] We generalize the model of DS (2005a) by introducing firing costs and frictional unemployment.

We find that the effects of globalization (and of all economic policy changes) on Northern employment and growth as well as on North-South wage inequality depend qualitatively on the degree of the Northern labor market flexibility. We derive critical threshold levels for firing costs and the job-finding rate and show that if *both* measures for labor market adjustment costs indicate strong inflexibility, Northern consumers experience a 'double dividend' from globalization: they benefit from globalization in terms of employment *and* quality growth. This is no longer true for countries with either asymmetric (i.e., only one measure for labor market adjustment costs indicates strong inflexibility) or no significant labor market adjustment costs. Hence, our model does not support the popular view, as exemplified by Arnold (2002), that consumers in developed countries with significant labor market frictions necessarily benefit less from globalization in terms of employment and growth than consumers in developed countries with more flexible labor markets.[2] Similar in spirit to our findings are the results of Schmidt et al. (1994): in their static model with skilled and unskilled domestic labor and unskilled immigration, it is precisely the labor market inflexibility introduced by a monopoly union determining wage rates which opens up the possibility for low-skilled immigration (another facet of globalization) to raise domestic employment and output. The reasoning is that in the case of skilled-unskilled complementarity and the labor union taking care also of skilled labor income, the replacement threat to native unskilled workers induces the union to decrease the unskilled wage rate (even if it does not take

---

1 In a similar model by Dinopoulos and Segerstrom (2005b), where the transfer of technical knowledge from the North to the South is not created by Southern imitation but by adaptive R&D investments of Northern multinational firms (FDI, employing Southern workers), an increase in the size of the open South does not affect long-run North-South wage inequality. The reason for this difference in results relative to DS (2005a) is that globalization, although increasing the technology transfer to the South, does not change profits of Northern firms that simply switch production location – the increase in profits due to lower wage costs in the South is exactly offset by the incurred adaptive R&D costs. In yet another North-South product-cycle model with non-scale neo-Schumpeterian growth by Dinopoulos et al. (2005), where innovative Northern products are protected by *finite-length* global patents, the same type of globalization *raises* North-South wage inequality.

2 Moore and Ranjan (2005) focus more specifically on the differential impact of *exogenous* shocks like globalization on *skilled and unskilled workers* for given differential labor market institutions. They build a two-sector, two-factor model of a small, open economy with search unemployment of skilled and unskilled labor *and no growth*, where relative labor endowments determine comparative advantage. Wages are determined by Nash-bargaining between entrepreneurs and workers. Inter alia, Moore and Ranjan analyze the impact of trade liberalization in a skill-abundant economy (i.e., an exogenous increase in the relative price of skilled in terms of unskilled goods), depending on the degree of labor market rigidities as measured by the reservation utility of workers (the level of unemployment benefits). They find that a country with high unemployment benefits ('EU') has higher wages and unemployment rates for both groups of workers than a country with low unemployment benefits ('US') before the trade shock. After trade liberalization, the unskilled (skilled) unemployment rate rises (declines) more in the EU than in the US, while the skilled-unskilled wage differential rises more in the US than in the EU. That is, unskilled workers are hurt from globalization in terms of rising unemployment and a declining wage rate, while skilled workers benefit in terms of declining unemployment and a rising wage rate. Moreover, the higher labor market rigidities are, the more (less) pronounced will be the relative employment (wage) effect of globalization. These findings on *quantitatively* different relative employment and relative wage responses in Europe and the US to a common globalization shock for given different labor market institutions formalize the so-called 'Krugman hypothesis', cf. Krugman (1994a,b).

care of unskilled unemployment). This raises low-skilled employment and hence productivity of complementary skilled labor.

In order to protect domestic firms from imitation of Southern developing countries, politicians often call for stricter IPRP or consider to increase R&D subsidies for domestic firms to spur innovation. We find that stricter IPRP indeed serves to mitigate globalization effects. However, we derive the paradoxical result that if both measures for labor market adjustment costs indicate strong inflexibility, stricter IPRP results in an *increase* in Southern imitation, which demonstrates the importance of general-equilibrium feedback effects from Northern labor market institutions to the Southern globalization force. An increase in Northern R&D subsidies is shown to reduce Southern imitation and to increase North-South wage inequality if there are either asymmetric or no significant labor market adjustment costs, while the opposite happens if both measures for Northern labor market adjustment costs indicate strong inflexibility. We show that a decrease in firing costs has always qualitatively the same effects as an increase in Northern R&D subsidies. Finally, just as stricter IPRP, an increase in the Northern job-finding rate (e.g., by reducing the amount or duration of unemployment benefits) also serves as a mitigation device for the effects of globalization.

With large developing countries like China and India about to enter the open world markets for qualitatively diversified products[3], and with the ongoing public debate in advanced industrialized countries on how to protect domestic labor markets against the new competitors, our results will be relevant for discussing globalization effects for Europe or the US.

The remainder of this paper is organized as follows: section 2 presents the building blocks of the model, which comprises household behavior, product markets, Northern innovation, Southern imitation, and labor market equilibrium conditions. Section 3 derives the steady-state equilibrium. In sections 4 and 5 we provide our main results. We analyze steady-state equilibrium effects of globalization in section 4, while section 5 evaluates stricter IPRP in the South, rising R&D subsidies, decreasing firing costs and an increase in the job-finding rate in the North. Throughout sections 4 and 5, we also discuss steady-state welfare effects for Northern consumers. Finally, section 6 offers some conclusions.

[3] Wacziarg and Welch (2003) use an updated Sachs-Warner index to determine whether developing countries must be classified as "open" or "closed", based on the well-known five Sachs-Warner criteria averaged over the 1990s. Based in this index, both China and India are still closed but approach progressively the threshold of becoming open. China "[r]emains closed based on the undivided power of the Communist Party and its black market exchange rate premium, which averaged 36% between 1990-1999" (ibid, p. 41). India "did not satisfy the tariff openness criteria until 1996 when its average tariff rate fell from 41.0% to 38.6%", and "India's nontariff barriers have been recently reduced below the 40% coverage rate, although these measures seem to have been replaced with a flurry of phytosanitary measures and antidumping duties" (ibid, p. 43).

2 The Model

2.1 Household Behavior

The household side of our model follows the structure of DS (2005a). In both countries, there is a fixed number of households forming a dynastic family whose individual members have an infinite life-time. The number of household members is growing at a common rate $n > 0$, and each household member supplies inelastically one unit of labor. There is full employment in the South, hence the Southern labor force is given by $\overline{L}_{S,t} = L_{S,0} \cdot e^{n \cdot t}$. Due to a labor market imperfection to be discussed later, there is unemployment in the North, and its labor force is given by $L_{N,t} = (1-u_t)\cdot L_{N,0}\cdot e^{n\cdot t} = (1-u_t)\cdot \overline{L}_{N,t}$, where $\overline{L}_{N,t}$ denotes the (exogenous) size of total Northern population at time t, and u_t is the (endogenous) Northern unemployment rate at time t. We will allow $L_{S,0} \neq L_{N,0}$.

Households in North and South share preferences and maximize the discounted lifetime utility

$$Z \equiv \int_0^\infty e^{-(\rho-n)\cdot t} \cdot \ln z_t dt \tag{1}$$

with constant time-preference rate $\rho > n$ and the individual instantaneous CES-utility function[4]

$$z_t = \left\{ \int_0^1 \left[\sum_j \lambda^{\frac{j}{\sigma-1}} \cdot d\left(j,\omega,t\right) \right]^{(\sigma-1)/\sigma} d\omega \right\}^{\sigma/(\sigma-1)} . \tag{2}$$

Equation (2) is a quality-augmented Dixit-Stiglitz consumption index, where $d(j, \omega, t)$ is the quantity of a vertically differentiated good with j improvements of its quality in industry ω consumed at time t, $\lambda > 1$ is the size of each quality improvement in the case of successful innovation, and $\sigma > 1$ is the constant elasticity of substitution between products across industries. As is a standard result in neo-Schumpeterian growth theory, within industries, consumers buy only products with the lowest quality-adjusted price, hence in (2), the sum over qualities j can be deleted. Across industries, consumers solve the static optimization problem

$$\max_{d(.)} \int_0^1 \left[\lambda^{\frac{j(\omega,t)}{\sigma-1}} \cdot d\left(\omega,t\right) \right]^{(\sigma-1)/\sigma} d\omega \qquad \text{subject to} \quad \int_0^1 p\left(\omega,t\right)\cdot d\left(\omega,t\right)\, d\omega \;=\; c_t \;. \tag{3}$$

In (3), t is fixed, $d(\omega, t)$ is the individual's quantity demanded of the product with the lowest quality-adjusted price in industry ω at time t, $j(\omega, t)$ ($p(\omega, t)$) is the quality index (price) of this good, and c_t is the consumption expenditure at time t. The solution of (3) yields the individual's consumption demand function[5]

[4] Apart from DS (2005a), the same type of preferences is also assumed in, e.g., Dinopoulos and Thompson (1998) and Li (2001, 2003).

[5] See Appendix A for a derivation.

$$d(\omega,t) = \frac{q(\omega,t)\cdot p(\omega,t)^{-\sigma}\cdot c_t}{\int_0^1 q(\omega,t)\cdot p(\omega,t)^{1-\sigma}\,d\omega} \quad , \tag{4}$$

where $q(\omega, t) \equiv \lambda^{j(\omega,t)}$ measures the product quality (of the good with the lowest quality-adjusted price) in industry ω at time t. The flow budget constraint of a household is

$$\dot{a}_t = r_t \cdot a_t + w_t \cdot (1-u_t) - n\cdot a - c_t\,, \tag{5}$$

where a is per-capita asset holdings, r is the market interest rate, w is the wage rate (which is the same for all production and R&D workers within a country due to the assumption of perfect mobility across industries and between activities; however, since we assume international labor immobility, Northern and Southern wage rates will differ), and $u_t = 0$ for a Southern household.[6] Inserting (2) and (4) into (1) yields the household's optimization problem

$$\max_{\{c,\,a\}} \int_0^\infty e^{-(\rho-n)\cdot t}\cdot\left\{\ln c_t + \frac{\sigma}{\sigma-1}\cdot\ln\left[\left(\int_0^1 \lambda^{j(\omega,t)}\cdot\frac{q(\omega,t)\cdot p(\omega,t)^{-\sigma}}{\int_0^1 q(\omega,t)\cdot p(\omega,t)^{1-\sigma}\,d\omega}\right)^{(\sigma-1)/\sigma} d\omega\right]\right\} dt \tag{6}$$

subject to (5). Since the individual household takes prices and the evolution of product quality as given, the large second expression in the curly brackets in (6) can be neglected. The current-value Hamiltonian is

$$J(c,\ a,\ \mu,\ t) = \ln c_t + \mu_t\cdot\left[(r_t-n)\cdot a_t + w_t\cdot(1-u_t) - c_t\right] .$$

The first-order conditions lead to the usual intertemporal Euler equation

$$\dot{c}/c = r-\rho \quad , \tag{7}$$

which applies to both Northern and Southern consumption expenditures per capita, c_N and c_S. In a steady-state equilibrium, $r = \rho$ since per-capita consumption will be constant for constant *nominal* wage rates w_N and w_S (*real* wage rates will have a positive steady-state growth rate due to ever-decreasing quality-adjusted goods prices).

2.2 Product Markets, Innovation And Imitation

The industry side of our model is almost identical to DS (2005a), hence our description will be brief. In any industry $\omega \in [0,1]$, irrespective of the quality level of the corresponding goods, output equals

[6] More precisely, we later assume that only Northern production workers can become unemployed because of stochastic Southern imitation, while Northern R&D workers remain always employed. Then, perfect within-country labor mobility with risk-neutral (or perfectly insured) workers ensures that the wage rate for Northern R&D workers is only $1-u_t$ times the wage rate for Northern production workers. Since both Northern wage rates are closely tied by this (stochastic) employment rate, it suffices to derive the wage rate for R&D workers – which will be denoted by w_N – and the unemployment rate u in equilibrium. Then, any increase in u ceteris paribus will induce Northern production workers to apply for R&D jobs until the change in relative labor supply has equalized expected wage earnings per period.

labor input: $Y_N = L_N^Y$ in the North and $Y_S = L_S^Y$ in the South. The R&D process specified below results in a unique quality leader in each industry who is protected by an exclusive patent on his production technology, and who charges an unconstraint monopoly price derived below. This patent expires in the case of two events: either another innovation (that is, an improvement of consumer goods quality of size $\lambda > 1$ in terms of the utility function) occurs in the same industry by a Northern firm, or the leading technology is imitated by a Southern firm producing at lower marginal costs $w_S < w_N$. In both cases, the previous incumbent immediately leaves the market and cannot credibly threaten to reenter (since he would make zero profits in an equilibrium with Bertrand price competition). In the North, the current quality leader maximizes global monopoly profits $\pi_N = (p_N - w_N)\cdot(d_N\cdot L_N + d_S\cdot \bar{L}_S)$ with respect to the price p_N, where Northern and Southern demand functions are given by (4), respectively.[7] It results the unconstraint monopoly price $p_N = [\sigma/(\sigma - 1)]\cdot w_N$ in each industry with a Northern quality leader. Similarly, the successful Southern imitating firm maximizes global monopoly profits $\pi_S = (p_S - w_S)\cdot(d_N\cdot L_N + d_S\cdot \bar{L}_S)$ with respect to the price p_S, which results in the monopoly price $p_S = [\sigma/(\sigma - 1)]\cdot w_S$ in each industry with a Southern quality leader. We follow the notation in DS (2005a) by denoting $Q_t \equiv \int_0^1 q(\omega,t)\,d\omega$ the average quality level across industries (some of which are producing in the North, some in the South) at time t, $E \equiv c_N\cdot L_N + c_S\cdot \bar{L}_S$ the global consumption expenditure, and $\bar{c} = E/(L_N + \bar{L}_S)$ the global per-capita consumption expenditure (of employed workers). Then, from (4), the per-capita global demand for a Northern product with *average* quality level Q is

$$\bar{d}_{N,t} = \frac{Q_t \cdot p_{N,t}^{-\sigma} \cdot \bar{c}_t}{\int_0^1 q(\omega,t)\cdot p(\omega,t)^{1-\sigma}\,d\omega} \quad , \tag{8}$$

and the Southern equivalent $\bar{d}_S$ is found by simply replacing p_N by p_S in the nominator of (8). It follows that global monopoly profits of a Northern quality leader can be written as

$$\pi_N(\omega) = \left[w_N/(\sigma-1)\right]\cdot \bar{d}_N \cdot \left(L_N + \bar{L}_S\right)\cdot q(\omega)/Q \quad , \tag{9}$$

which is the product of profit margin, total market size, and product quality relative to the average.

Now we will consider Northern innovative and Southern imitative R&D activities. The R&D production function of a Northern innovating firm in industry ω is

$$I_i(\omega) = \eta_I \cdot L_{N,i}^I / q(\omega) \quad , \tag{10}$$

where I_i is a Poisson arrival rate, $\eta_I > 0$ is an R&D productivity parameter, and $L_{N,i}^I$ is labor input of firm i, with $\sum_i L_{N,i}^I = L_N^I$ being the total number of Northern R&D workers. The quality level $q(\omega, t)$ =

7 Note that Northern unemployed workers do not generate a positive demand since we abstract from unemployment benefits for simplicity.

$\lambda^{j(\omega,t)}$ in the denominator captures the idea that with rising product quality (i.e., with each innovation success), further improvement becomes increasingly difficult since products become more complex. Hence, an ever increasing amount of R&D labor is needed to maintain a constant innovation rate I_i.[8] R&D returns are assumed to be distributed independently across firms, across industries and over time, hence the industry-wide instantaneous probability of innovation is $I(\omega) = \eta_I \cdot L_N^I / q(\omega)$. Similarly, the Poisson arrival rate of a Southern imitating firm j is defined as

$$C_j(\omega) \;=\; \eta_C \cdot L_{S,j}^C / q(\omega) \tag{11}$$

with R&D productivity parameter $\eta_C > 0$, and $\sum_j L_{S,j}^C = L_S^C$ being the total number of Southern R&D workers. Note that $1/\eta_C$ can also be viewed as a measure of the strictness of IPRP. R&D difficulty of Southern copying is identical to Northern R&D difficulty because the required technical knowledge for how to produce a particular quality of a given product is the same.

With the assumption $w_N > w_S > w_N/\lambda^{1/(\sigma-1)}$, the successful Southern imitating firm replaces the previous Northern incumbent and serves the world market, and in the case of a further innovation, the new Northern quality leader replaces the previous Southern monopolist in turn, which closes the Vernon-type product cycle. Denoting m_N (m_S) the fraction of industries with a Northern (Southern) quality leader, in a steady state with constant I and C, the flow of industries ω with a new Southern quality leader must equal the flow of industries with a new Northern quality leader, thus $m_N \cdot C = m_S \cdot I$. With $m_N + m_S = 1$, it follows $m_N = I/(I + C)$ and $m_S = C/(I + C)$.

Northern firms choose R&D intensity I_i optimally as to maximize expected benefits minus costs from engaging in R&D: $v_I(\omega) \cdot I_i - (1 - s_R) \cdot w_N \cdot L_{N,i}^I$, where $v_I(\omega)$ is the reward for innovating (derived below), and $s_R \geq 0$ is an R&D subsidy. With free entry into R&D races, optimal R&D investment satisfies

$$v_I(\omega) \;=\; (1 - s_R) \cdot w_N \cdot q(\omega) / \eta_I \;. \tag{12}$$

Since product quality $q(\omega)$ stays constant *during* an R&D race, v_I is also a constant, i.e. $\dot{v}_I = 0$.

The usual no-arbitrage condition on the world stock market equates the return from a completely diversified portfolio of the stocks of Northern R&D firms and the save interest rate for a riskless bond, where both assets are held for a time period dt:

$$\frac{\pi_N(\omega,t)}{v_I(\omega,t)} \cdot dt + \frac{\dot{v}_I(\omega,t)}{v_I(\omega,t)} \cdot dt \cdot (1 - I \cdot dt - C \cdot dt) - \frac{v_I(\omega,t) + F(\omega,t)}{v_I(\omega,t)} \cdot (I + C) \cdot dt \;=\; r \cdot dt \;. \tag{13}$$

[8] The underlying idea was first formalized in a neo-Schumpeterian growth model by Segerstrom (1998). The specification in (10) is a special case, also considered in DS (2005a), of the more general formulation in Li (2003, p. 1010).

All terms are standard for neo-Schumpeterian growth models except for the third term on the LHS taken from Grieben (2005). We specify that in addition to suffering from full capital loss in the case of either further Northern innovation or Southern imitation, the previous Northern incumbent firm has to pay firing costs, defined as $F \equiv B \cdot w_N \cdot q(\omega)$ with $B > 0$ being a constant, each time it is replaced from the goods market and thus is forced to dismiss its workers. B will later be used as a policy variable. Firing costs are indexed to $w_N \cdot q(\omega)$ in order not to become negligible in the long run. Dividing (13) by dt, letting $dt \to 0$ and using $\dot{v}_I / v_I = 0$ gives

$$v_I = \left[\pi_N - F \cdot (I + C)\right] / (\rho + I + C) \; . \tag{14}$$

In the remainder we assume that B is sufficiently low such as v_I remains positive in equilibrium. From (9), (12) and (14), we derive the following Northern *steady-state innovative R&D condition*

$$\frac{(1 - s_R) \cdot x_N \cdot L_N}{\eta_I} = \frac{\frac{\bar{d}_N}{\sigma - 1} \cdot \left(L_N + \bar{L}_S\right) - x_N \cdot L_N \cdot B \cdot (I + C)}{\rho + I + C} \; , \tag{15}$$

where $x_N \equiv Q / L_N$ is a measure for the relative R&D difficulty. The LHS is related to the expected discounted cost of innovating, which rises with higher average product quality Q (implying higher R&D difficulty), lower R&D subsidies or lower R&D productivity. The RHS is related to the expected discounted benefit from innovating, which rises with a larger market size (in particular, with lower Northern unemployment), a higher markup price (i.e., a lower elasticity of substitution between products), and a higher average product quality which raises world average demand $\bar{d}_N$. The RHS decreases with larger firing costs, a higher interest rate $r = \rho$, and a higher probability of being removed from the market via further innovation or imitation, which raises both expected firing costs and the effective discount rate (denominator of the RHS).

Similarly, Southern firms optimally choose R&D intensity C_j as to maximize expected benefits minus costs from engaging in R&D: $v_C(\omega) \cdot C_j - w_S \cdot L_{S,j}^C$, where $v_C(\omega)$ is the reward for imitating. With free entry to R&D races, optimal R&D investment satisfies

$$v_C(\omega) = w_S \cdot q(\omega) / \eta_C \; . \tag{16}$$

The Southern no-arbitrage equation equivalent to (13) is[9]

$$\frac{\pi_S(\omega,t)}{v_C(\omega,t)} \cdot dt + \frac{\dot{v}_C(\omega,t)}{v_C(\omega,t)} \cdot dt \cdot (1 - I \cdot dt) - I \cdot dt = r \cdot dt \; , \tag{17}$$

where global monopoly profits of a Southern quality leader are

9 Note that no Southern firm would engage in copying products with a Southern quality leader, because Bertrand price competition would result in zero profits.

$$\pi_S(\omega) = \left[w_S/(\sigma-1)\right]\cdot \bar{d}_S \cdot \left(L_N+\bar{L}_S\right)\cdot q(\omega)/Q \ , \tag{18}$$

similar to (9), with $\bar{d}_S = \bar{d}_N \cdot (p_N/p_S)^{\sigma}$. From (17), the steady-state reward for Southern imitating is

$$v_C = \pi_S/(\rho+I) \ . \tag{19}$$

Then, from equations (16), (18) and (19) together we can determine the Southern *steady-state imitative R&D condition*

$$\frac{x_N \cdot L_N}{\eta_C} = \frac{\frac{\bar{d}_S}{\sigma-1}\cdot\left(L_N+\bar{L}_S\right)}{\rho+I} \ . \tag{20}$$

As in (15), the LHS (RHS) is related to the expected discounted cost (benefit) of imitating with a similar interpretation of the terms. Note finally that we abstract in this model from the possibility that the South becomes itself an innovating country.[10]

2.3 Quality Dynamics And Labor Markets

Before determining the labor market equilibrium for both countries, we need to derive (thereby reproducing results of DS, 2005a) how product quality evolves in North and South, because this is closely related to the demand for production workers. From the definition $Q_t \equiv \int_0^1 q(\omega,t)\,d\omega = \int_0^1 \lambda^{j(\omega,t)}\,d\omega$, it follows

$$\dot{Q} = \int_0^1\left[\lambda^{j(\omega)+1}-\lambda^{j(\omega)}\right]\cdot I\cdot d\omega = (\lambda-1)\cdot I\cdot\int_0^1 \lambda^{j(\omega)}d\omega = (\lambda-1)\cdot I\cdot Q \tag{21}$$

since product quality jumps up from λ^j to λ^{j+1} with each innovation that occurs with constant instantaneous probability I. As is derived in DS (2005a), in a steady state, a constant growth rate of Northern (Southern) average product quality $Q_N/m_N \equiv \int_{m_N} q(\omega)d\omega/m_N$ ($Q_S/m_S \equiv \int_{m_S} q(\omega)d\omega/m_S$) requires equal growth rates $\dot{Q}_N/Q_N = \dot{Q}_S/Q_S$. Moreover, DS (2005a) derive

$$Q_N = \lambda\cdot I\cdot Q/(\lambda\cdot I+C) \quad \text{and} \quad Q_S = C\cdot Q/(\lambda\cdot I+C) \ . \tag{22}$$

From this and the industry fractions m_N and m_S, it follows $Q_N/m_N = (Q_S/m_S)\cdot\lambda$, i.e. average Northern product quality exceeds average Southern product quality by exactly one quality jump of size λ.[11]

We now introduce frictional unemployment into the model of DS (2005a). This is done similar to Arnold (2002; see his motivation on p. 455-56) by assuming that Northern production workers not only lose their jobs because of Southern imitation (which forces the previous Northern incumbent to

[10] See Currie et al. (1999) and Arnold (2003) for endogenous growth models that focus on phases of Southern development (in particular, the switch from imitation to innovation).

[11] This latter result makes clear that the South in our model should not be thought of as a developing country, but rather as a newly industrializing country that closely follows the Northern (quality-)growth path.

shut down), but it also takes time to reenter the labor market. More precisely, the unemployed production worker's instantaneous probability of re-entering the Northern labor market equals an exogenously fixed constant $\beta > 0$, which implies an expected duration $1/\beta$ of unemployment.[12] This means that Northern employment $L_N < \bar{L}_N$ follows the differential equation

$$\dot{L}_N = \bar{L}_N \left(\beta \cdot u + n\right) - C \cdot L_N^Y \ . \tag{23}$$

Note two differences relative to Arnold (2002a) with respect to (23): first, the imitation rate C is endogenous here. Second, since we have positive population growth in this model but want to abstract from demographic unemployment, we make the simplifying assumption that all newly-born Northern individuals immediately become employed and only lose their job if production moves to the South after imitation occurred. A common assumption in Arnold (2002) and this paper is that in the case of Northern innovation in an industry with a Northern quality leader, although production workers of the previous incumbent firm are also laid off, this does not cause additional frictional unemployment since the new incumbent firm instantaneously offers an equal amount of L_N^Y-type jobs.[13]

Goods market clearing implies that global demand for a Northern product with average *Northern* quality must equal Northern supply of goods, hence

$$\bar{d}_N \cdot \frac{Q_N}{Q} \cdot \left(L_N + \bar{L}_S\right) = \bar{d}_N \cdot \frac{\lambda \cdot I}{\lambda \cdot I + C} \cdot \left(L_N + \bar{L}_S\right) = Y_N = L_N^Y \tag{24}$$

with $\bar{d}_N$ given in (8). Equilibrium in the Northern labor market implies $\left(1-u\right) \cdot \bar{L}_N = L_N = L_N^Y + L_N^I$. Using this, $L_N^I = I \cdot Q/\eta_I$ from aggregating (10) over *all* industries ω (since innovative R&D takes place in both industries with a Northern and a Southern quality leader), and (24) gives

$$1 = \bar{d}_N \cdot \frac{\lambda \cdot I}{\lambda \cdot I + C} \cdot \frac{L_N + \bar{L}_S}{L_N} + \frac{I \cdot x_N}{\eta_I} \tag{25}$$

as the *steady-state equilibrium condition for the Northern labor market*. Since the first term on the RHS of (25) is constant in a steady state, x_N must also be a constant. This in turn requires $\dot{Q}/Q = \dot{L}_N / L_N = \dot{\bar{L}}_N / \bar{L}_N = n$, which by use of (21) pins down the steady-state innovation rate:

$$I = n/\left(\lambda - 1\right) \ . \tag{26}$$

Similar to (24), Southern goods market clearing requires

---

[12] A microeconomically founded version of frictional unemployment within a neo-Schumpeterian growth model with matching on the labor market is developed by Şener (2001) and used in Grieben (2005). The simpler version used here is more tractable without changing any of the results qualitatively.

[13] The case of non-instantaneous matching between the job offered by a new quality leader after successful innovation and unemployed workers is covered by Şener (2001) and Grieben (2005).

$$\bar{d}_S \cdot \frac{Q_S}{Q} \cdot \left(L_N + \bar{L}_S\right) \;=\; \bar{d}_S \cdot \frac{C}{\lambda \cdot I + C} \cdot \left(L_N + \bar{L}_S\right) \;=\; Y_S \;=\; L_S^Y \;. \tag{27}$$

Equilibrium in the Southern labor market implies $L_S = \bar{L}_S = L_S^Y + L_S^C$. Using $L_S^C = C \cdot Q_N / \eta_C$ from aggregating (11) over the measure m_N of all industries with a *Northern* quality leader (because copying takes place only there), (22), (27) and the definition $x_N \equiv Q/L_N$ gives

$$1 \;=\; \frac{C}{\left(\lambda \cdot I + C\right) \cdot \bar{L}_S} \cdot \left[\bar{d}_S \cdot \left(L_N + \bar{L}_S\right) + \frac{\lambda \cdot I \cdot x_N \cdot L_N}{\eta_C}\right] \tag{28}$$

as the *steady-state equilibrium condition for the Southern labor market*.

3 Steady-State Equilibrium

In this section, we want to derive the steady-state equilibrium with the constant variables I, C, x_N, c_N, c_S, E, $\bar{c}$, $r = \rho$, w_N, w_S and with the variables L_N, $\bar{d}_N$, $\bar{d}_S$, and Q, all growing at the rate n. The equilibrium of DS (2005a) is obtained as a special case with a perfectly flexible labor market ($\beta \to \infty$), no firing costs ($B = 0$) and no R&D subsidies ($s_R = 0$).

Using the fact that Northern steady-state employment must grow at the rate of population growth ($\dot{L}_N / L_N = n$) and $L_N = \left(1 - u\right) \cdot \bar{L}_N$ in (23), and solving this equation for u yields

$$u \;=\; \frac{C \cdot L_N^Y}{\left(\beta + n\right) \cdot \bar{L}_N} \;. \tag{29}$$

That is, the steady-state unemployment rate will depend positively on the Southern imitation rate and the proportion of production employment in total Northern population, $L_N^Y / \bar{L}_N$, since those jobs are vulnerable to Southern competition (or 'threatened by globalization'). Steady-state unemployment decreases with the labor market flexibility parameter β and the population growth rate n (the latter is just an artifact of our assumption that newly-born individuals immediately find a job). Substituting for L_N^Y in (29) from (24), using (15) to substitute for $\bar{d}_N$, and using $L_N = \left(1 - u\right) \cdot \bar{L}_N$ again, finally yields

$$u \;=\; \frac{A}{D + A} \quad \text{with} \quad D \;\equiv\; \left(\lambda \cdot I + C\right) \cdot \left(\beta + n\right) \quad \text{and}$$
$$A \;\equiv\; \left(\sigma - 1\right) \cdot x_N \cdot C \cdot \lambda \cdot I \cdot \left[\frac{1 - s_R}{\eta_I} \cdot \left(\rho + I + C\right) + B \cdot \left(I + C\right)\right] \tag{30}$$

as reduced form of (29), which defines the Northern steady-state unemployment rate as a function of the endogenous variables C and x_N, given $I = n / \left(\lambda - 1\right)$ from (26). Obviously, u increases in both the relative R&D difficulty x_N (since this implies a larger average product quality, which raises average demand for Northern goods and thus implies a higher Northern production employment, which is vulnerable to Southern imitation) and the Southern imitation rate C.

Next, we derive the equilibrium condition for the Northern economy by solving the Northern steady-state innovative R&D condition (15) for $\bar{d}_N$ and substituting this into the steady-state equilibrium condition for the Northern labor market (25). Using again $L_N = (1-u)\cdot\bar{L}_N$, this gives the *Northern steady-state condition*

$$1 \;=\; x_N \cdot I \cdot \left\{ \frac{(\sigma-1)\cdot\lambda}{\lambda\cdot I + C} \cdot \left[\frac{1-s_R}{\eta_I}\cdot(\rho + I + C) + B\cdot(I+C) \right] + \frac{1}{\eta_I} \right\} \tag{31}$$

as a function of the endogenous variables C and x_N. For $B = s_R = 0$, (31) turns into the special case considered in DS (2005a). Similarly, solving the Southern steady-state imitative R&D condition (20) for $\bar{d}_S$ and substituting this together with $L_N = (1-u)\cdot\bar{L}_N$ into the steady-state equilibrium condition for the Southern labor market (28) gives

$$1 \;=\; \frac{C\cdot x_N\cdot(1-u)\cdot\bar{L}_N}{(\lambda\cdot I + C)\cdot\bar{L}_S\cdot\eta_C}\cdot\left[(\sigma-1)\cdot(\rho+I) + \lambda\cdot I\right].$$

Setting $u = 0$ (i.e., $\beta \to \infty$) gives the special case considered in DS (2005a). Substituting for u from (30) finally yields

$$1 \;=\; \frac{\bar{L}_N\cdot\left[(\sigma-1)\cdot(\rho+I)+\lambda\cdot I\right]}{\bar{L}_S\cdot\eta_C\cdot\left\{ \frac{\lambda\cdot I}{C\cdot x_N} + \frac{1}{x_N} + \frac{(\sigma-1)\cdot\lambda\cdot I}{\beta+n}\cdot\left[\frac{1-s_R}{\eta_I}\cdot(\rho+I+C) + B\cdot(I+C)\right]\right\}} \tag{32}$$

as the *Southern steady-state condition*, which is also a function of C and x_N.

In order to derive the unique steady-state equilibrium of our model graphically, we discuss the slope of the two curves defined by (31) and (32), and we begin with the Southern steady-state condition. A first crucial difference to DS (2005a) arises because contrary to their special case, the slope of the Southern steady-state curve (32) is no longer unambiguously negative. The RHS of (32) is increasing in x_N, while differentiation with respect to C reveals that the RHS of (32) is increasing in C if, and only if,

$$\beta \;>\; C^2\cdot x_N\cdot(\sigma-1)\cdot\left(\frac{1-s_R}{\eta_I} + B\right) - n \;\equiv\; \beta^{crit} \tag{33}$$

is fulfilled, i.e. the Northern labor market must be sufficiently flexible as captured by the parameter β which measures the instantaneous job-finding rate of Northern unemployed workers. The benchmark is given by DS (2005a) as $\beta \to \infty$ (perfectly flexible labor market). Hence with $\beta > \beta^{crit}$ ($\beta < \beta^{crit}$), after a rise in x_N, a decrease (increase) in C is required to restore equilibrium in the South, so the curve for the Southern steady-state condition (32) is downward (upward) sloping in (x_N, C)-space, whereas for $\beta = \beta^{crit}$ it is vertical. With $\beta > \beta^{crit}$, the interpretation of the negative slope is the same as in DS (2005a). An increase in the Southern imitation rate C raises both the proportion of industries m_S with a

Southern quality leader serving the world market (which increases production labor demand L_S^Y) and the Southern R&D labor demand L_S^C. For given labor supply, this requires a decrease in x_N to ensure equilibrium on the Southern labor market. The decrease in x_N not only reduces R&D labor needed to maintain a given imitation rate C, but it also reduces $\bar{d}_S$ (and thus L_S^Y) needed for Southern monopolists to break even, see (20). With $\beta < \beta^{crit}$, an increase in C still raises m_S and – ceteris paribus – the demand for Southern R&D workers. However, the resulting decrease in Northern employment L_N is particularly strong, which means a marked reduction in the effective market size $L_N + \bar{L}_S$ for Southern producers and R&D firms, which in turn reduces labor demand in production and R&D. For given Southern labor supply, the net effect is a required increase in x_N in order to clear the Southern labor market.

The critical value β^{crit} is increasing in all those variables and parameters that ceteris paribus also raise the steady-state unemployment rate given in (30): the larger C, x_N, σ, ρ and B, and the lower s_R, and η_I, the higher is u for any given β.[14] This means that if Northern unemployment is relatively high for a given value of β, the critical level β^{crit} of Northern labor market flexibility at which the Southern steady-state curve becomes vertical is larger, i.e. an increase in C is more 'likely' to require an increase in x_N in order to clear the Southern labor market.

Another crucial difference to DS (2005a) arises because the slope of the Northern steady-state condition (31) is no longer unambiguously positive. To see this, first we observe that the RHS of (31) is increasing in x_N. Then, we differentiate the RHS of (31) with respect to C, use $I = n/(\lambda - 1)$ and find that the RHS of (31) decreases in C – thus, the curve for the Northern steady-state condition is upward sloping in (x_N, C)-space – if, and only if,

$$B \; < \; (1-s_R)\cdot(\rho-n)/(\eta_I \cdot n) \; \equiv \; B^{crit} > 0 \; , \tag{34}$$

whereas for sufficiently large firing costs $B > B^{crit}$ ($B = B^{crit}$) it is downward sloping (vertical).

To interpret the slope of the Northern steady-state curve, we note that in the model of DS (2005a), with $B = 0$, $\beta \to \infty$ and $s_R = 0$, there are two steady-state effects of an increase in C in the North, which are also present in our extended model. **First**, with more Southern copying, the fraction m_N of industries with a Northern quality leader declines, which means that less production workers L_N^Y are needed. For a given supply of workers and no unemployment, these former production workers

[14] Ceteris paribus, the Northern unemployment rate rises with a larger σ since p_N decreases with a higher σ, which raises demand for Northern products and thus increases production employment vulnerable to Southern imitation. An increase in ρ means that Northern consumers want to increase present consumption relative to future consumption, which requires to raise production employment vulnerable to Southern imitation. A higher B or a lower s_R increase Northern R&D costs relative to R&D benefits, which also tends to raise Northern production employment relative to R&D employment. Finally, the more productive Northern R&D labor is as measured by η_I, the less R&D employment is needed to sustain any given innovation rate, which ceteris paribus implies relative more production employment.

must be absorbed as R&D workers, and rising R&D employment implies a temporary increase in the innovation rate, which results in a permanently higher level of relative R&D difficulty x_N. Thus, the first effect contributes to a positive slope of the curve for (31). **Second**, more Southern copying means a higher effective discount rate on benefits from innovating in (15), which requires a larger market size for given x_N such that the innovating firms break even. Given the total number of consumers $L_N + \overline{L}_S$, this requires an increase in global demand for Northern products with average quality $\overline{d}_N$. Hence, output and demand for production workers L_N^Y must increase, which works in the opposite direction (towards a lower level of x_N) to the first effect. Thus, the second effect contributes to a negative slope of the curve for (31). With $B = 0$ and $\beta \to \infty$, the first effect dominates the second, and the Northern steady-state curve is positively sloped.

In our more general case, however, there are two additional steady-state effects of an increase in C in the North. The **third** effect comes from the fact that more Southern copying means more dismissals of production workers in the North, which implies higher expected firing cost payments $B \cdot w_N \cdot q \cdot C$ (obviously, the marginal impact of this effect will be the stronger the higher B is). This reduces the benefit from innovating in (15). Given x_N, this again requires an increase in $\overline{d}_N$ so that the innovating firms break even, hence an increase in L_N^Y is needed. Since for given L_N this means a required decline in R&D employment L_N^I, the third effect works toward a decline in relative R&D difficulty x_N after a rise in Southern copying C (and hence toward a negative slope of the Northern steady-state curve). The interpretation of the expression for B^{crit} in (34) is now straightforward: the smaller the term $(1 - s_R)/\eta_I$ (due to higher R&D subsidies or higher R&D labor productivity), the lower are R&D costs for given average quality of goods $Q = x_N \cdot L_N$ (LHS of (15)), hence the higher will be the *relative* importance of firing costs in determining the change of R&D incentives in the case of an increase in Southern copying C. This means that if firing costs become relatively more important in this sense, the critical level B^{crit} at which the Northern steady-state curve becomes vertical is smaller, i.e. an increase in C is more 'likely' to require a decline in x_N in order to clear the Northern labor market. Similarly, the larger the interest rate $r = \rho$, the more are expected firing costs discounted, which means that they become less relevant, hence the critical level B^{crit} becomes larger. Finally, B^{crit} declines with rising population growth rate n since firing costs are indexed to $Q = x_N \cdot L_N$.

Finally, the **fourth** effect works via a reduction of Northern employment. An increase in Southern copying raises the labor market turnover in the North, which for given expected length of unemployment spells $1/\beta$ implies a decline in total Northern employment L_N. On the one hand, this reduces the market size for Northern monopolists and thus the expected benefit from innovating in (15). On the other hand, however, while R&D difficulty is proportional to L_N in (15), world demand for Northern products of average quality decreases by less than one for one with L_N. Hence, the reduction in L_N reduces R&D costs by more than R&D benefits in (15). To break even, this must be compensated by a decline in $\bar{d}_N$, implying a decrease in L_N^Y and thus an increase in L_N^I and x_N. Therefore, the fourth effect contributes to a positive slope of the Northern steady-state curve.

Figure 1 below illustrates all four cases for the steady-state equilibrium of our model economy (neglecting the special cases with either $\beta = \beta^{crit}$ – where the Southern steady-state curve is vertical – or $B = B^{crit}$, where the Northern steady-state curve is vertical).

insert here: Figure 1

Panel (a) illustrates the only case considered in DS (2005a), i.e. the case of a sufficiently flexible Northern labor market with sufficiently low firing costs, which could be classified as depicting the US economy. The other three cases could be classified as capturing possible cases for European economies, with either high firing costs but also high labor market flexibility, panel (b), or vice versa, panel (c), or with both high firing costs and a low degree of labor market flexibility, panel (d), – where "high" and "low" refer to the comparison with the critical levels β^{crit} and B^{crit}, respectively.[15]

Given the steady-state solution (x_N, C) in point A, all other variables are also determined, given $I = n/(\lambda - 1)$ from (26). $L_N^I / L_N = I \cdot x_N / \eta_I$ follows for given I and x_N, and u is derived from (30) for given I, C and x_N. For given C and u, L_N^Y is determined by (29). Since L_N follows for given $\bar{L}_N$ and u, L_N^I is also determined, as is the equilibrium path for $Q = x_N \cdot L_N$. Given L_N, x_N, I and C, $\bar{d}_N$ is defined by (15) and $\bar{d}_S$ by (20). As shown by DS (2005a), global per-capita consumption expenditure $\bar{c}$ is found by noting first that

$$\int_0^1 q(\omega,t) \cdot p(\omega,t)^{1-\sigma} \, d\omega = p_N^{\,1-\sigma} \cdot Q_N(t) + p_S^{\,1-\sigma} \cdot Q_S(t) \ ,$$

which can be used together with (22) in (8) to derive

$$\bar{d}_N = \frac{p_N^{\,-\sigma} \cdot \bar{c}}{p_N^{\,1-\sigma} \cdot \dfrac{\lambda \cdot I}{\lambda \cdot I + C} + p_S^{\,1-\sigma} \cdot \dfrac{C}{\lambda \cdot I + C}} \quad , \quad \bar{d}_S = \frac{p_S^{\,-\sigma} \cdot \bar{c}}{p_N^{\,1-\sigma} \cdot \dfrac{\lambda \cdot I}{\lambda \cdot I + C} + p_S^{\,1-\sigma} \cdot \dfrac{C}{\lambda \cdot I + C}} \ .$$

With $p_N = [\sigma/(\sigma - 1)] \cdot w_N$ and $p_S = [\sigma/(\sigma - 1)] \cdot w_S$, $\bar{d}_N$ (or $\bar{d}_S$) and the wage rates determine $\bar{c}$, which then determines global consumption expenditure $E = \bar{c} \cdot (L_N + \bar{L}_S)$. As for the wage rates, it suffices to

[15] Obviously, an increase in B rotates the Northern steady-state curve (31) counterclockwise. In panel (b) of Figure 1 as well as in subsequent policy analysis, we consider only the case of a $B > B^{crit}$ such that the absolute slope of this curve exceeds that of the Southern steady-state curve (32). Similarly, a decrease in β rotates the Southern steady-state curve clockwise, and in panel (c) we only consider the case where $\beta < \beta^{crit}$ is such that the slope of the Southern steady-state curve is larger than that of the Northern steady-state curve. According to (33), β^{crit} is increasing in C and x_N. Hence, along the curve for (32) towards lower values for C and x_N, β^{crit} is declining and will eventually fall below any given value for β, which explains the change in slope of (32) for low enough values of C and x_N. Thus, the assumption $\beta < \beta^{crit}$ in panel (c) and (d) of Figure 1 and all later figures refers to the steady-state equilibrium on the negatively sloped segment of the curve for (32) above the (negatively sloped) $\beta = \beta^{crit}$ curve.

derive a constant relative wage w_N/w_S and to normalize e.g. $w_S \equiv 1$. Dividing the Northern steady-state innovative R&D condition (15) by the Southern steady-state imitative R&D condition (20), and solving the resulting equation for $\bar{d}_N / \bar{d}_S$, gives the "*mutual R&D condition*"

$$\frac{\bar{d}_N}{\bar{d}_S} = \frac{\eta_C}{\rho + I} \cdot \left[\frac{1 - s_R}{\eta_I} \cdot \left(\rho + I + C \right) + B \cdot \left(I + C \right) \right] = \left(\frac{w_S}{w_N} \right)^{\sigma} . \qquad (35)$$

Here, the second equality follows because equation (8), its Southern equivalent and the monopolists' markup pricing rule give $\bar{d}_N / \bar{d}_S = (p_S/p_N)^{\sigma} = (w_S/w_N)^{\sigma}$. (35) defines the relative Southern wage rate as an increasing function of the imitation rate C and firing costs B, hence it rises whenever the reward for Southern imitating rises *relative* to the reward for Northern innovating. It is constant in a steady-state equilibrium. Finally, our assumption $w_N > w_S > w_N/\lambda^{1/(\sigma-1)}$ that is necessary for the postulated Vernon-type product cycle requires that

$$1 > \frac{w_S}{w_N} = \left\{ \frac{\eta_C}{\rho + I} \cdot \left[\frac{1 - s_R}{\eta_I} \cdot \left(\rho + I + C \right) + B \cdot \left(I + C \right) \right] \right\}^{\frac{1}{\sigma}} > \lambda^{\frac{1}{1-\sigma}} \qquad (36)$$

is fulfilled. For $I = n/(\lambda-1)$ and $w_S \equiv 1$, the requirement $w_N > w_S$ imposes an upper bound for the firing costs parameter:

$$B < \frac{\rho + \frac{n}{\lambda - 1}}{\eta_C \cdot \left(\frac{n}{\lambda - 1} + C \right)} - \frac{\left(1 - s_R \right) \cdot \left(\rho + \frac{n}{\lambda - 1} + C \right)}{\eta_I \cdot \left(\frac{n}{\lambda - 1} + C \right)} \equiv B^{\max} , \qquad (37)$$

which we assume to be fulfilled throughout our analysis.[16] This restriction becomes the less stringent the lower η_C relative to η_I and the larger s_R is (i.e., the lower R&D costs are in the North relative to the South). Note also that an increase in η_I or s_R not only widens the set of feasible levels of firing costs supporting the product cycle, but it also reduces B^{crit} defined in (34). $B \geq B^{max}$ would mean that the Northern wage rate is below the Southern wage rate, hence production would not shift to the South after imitation occurred. The Northern wage rate must decrease with larger B due to lower Northern R&D benefits, which reduces labor demand in the North.

In Appendix B, we derive the following steady-state utility growth rate that applies to both countries:

$$\frac{\dot{z}}{z} = \frac{\sigma}{\sigma - 1} \cdot \left(\lambda - 1 \right) \cdot I = \frac{\sigma \cdot n}{\sigma - 1} . \qquad (38)$$

With respect to (38), two things are noteworthy. First, $\dot{z}/z$ is declining in σ (the elasticity of substitution between products across industries) because for higher σ, markup prices of all quality leaders are

[16] Differentiating B^{max} with respect to C reveals that for given $I = n/(\lambda - 1)$ in the steady state, B^{max} is uniquely determined if, and only if, $\eta_C \cdot (1 - s_R) \cdot \rho \neq \eta_I \cdot (\rho + I)$.

lower, which reduces monopoly profits and therefore expected discounted benefits from innovation and imitation. With lower R&D intensities in both countries, product quality growth is slower. Second, contrary to the first-generation endogenous growth model of Arnold (2002) that still contains the scale-effect property, a rise in Southern imitation has no long-run growth effects in the North. This is because any change in R&D incentives (other than σ) is finally offset by a corresponding change in R&D difficulty in this TEG ("temporary effects on growth")-version of a non-scale growth model.[17]

4 Globalization

Globalization (a rise in $\bar{L}_S$) requires an increase in x_N for any given level of C in the Southern steady-state condition (32) in order to restore R&D and labor-market equilibrium in the South. This implies a shift of the corresponding curve to the right as shown in Figure 2 below. We first look at panel (a) of Figure 2.

insert here: Figure 2

In the case of a flexible Northern labor market ($\beta > \beta^{crit}$) with relatively low firing costs ($B < B^{crit}$), starting from E_0, globalization leads to a move of the steady-state equilibrium to E_1 and thus to a rise in the steady-state level of R&D difficulty x_N and an increase in the Southern imitation rate C. Southern imitation increases because there is more labor available for doing R&D. The rise in $x_N = Q/L_N$ means that the growth rate of average product quality exceeds temporarily the long-run steady-state level given by (21) and (26) as $\dot{Q}/Q = n$. This in turn means that R&D employment must increase permanently in the North. These additional Northern R&D workers come from the production sector, because rising Southern imitation leads to a decrease in the fraction $m_N = I/(I+C)$ of industries with a Northern quality leader and thus to a decrease in Northern production employment (same effect as in DS, 2005a). Hence, since both C and x_N increase, Southern workers gain in terms of their relative wage rate (remember from (35) that w_S/w_N rises unambiguously with C), and consumers of both countries benefit in terms of a temporary push of the quality-growth rate (since this is positively related to the rates of innovation and imitation, respectively).[18] However, Northern production workers suffer from increased unemployment according to (30).

[17] In the alternative PEG ("permanent effects on growth")-version, R&D difficulty rises with the size of the market. Contrary to the TEG-version, this results in an endogenous steady-state growth rate that can be affected by public policies. See Dinopoulos and Thompson (2000) for further discussion and an empirical test of both versions of rising R&D difficulty. The PEG-version is applied in Dinopoulos and Segerstrom (1999) in order to analyze steady-state-growth and wage-distribution effects of trade liberalization in a North-North model of neo-Schumpeterian growth with flexible labor markets. Further applications of the PEG-version within neo-Schumpeterian growth models with imperfect labor markets can be found in Şener (2001) and Grieben (2004, 2005).

[18] Since population growth in the South leads to a higher steady-state imitation rate, this reintroduces a kind of scale effect into the Southern economy. However, the steady-state growth rate given in (38) does not change.

Interestingly, the same results emerge in the case of an inflexible Northern labor market with relatively low firing costs ($\beta < \beta^{crit}$ and $B < B^{crit}$) as depicted in panel (c) of Figure 2. Again, the increase in Southern copying implies that fewer Northern production workers are needed. In addition, because of the low Northern labor market turnover, the increase in unemployment is particularly strong and induces many Northern workers to switch from production to R&D employment since the latter is not vulnerable to Southern imitation. Moreover, Northern R&D becomes more profitable since w_N decreases with rising C for given $w_S \equiv 1$, see (35). Therefore, x_N also increases in the case depicted in panel (c).

With $\beta > \beta^{crit}$ and $B > B^{crit}$, however, globalization leads to an increase in Southern copying but a decrease in the relative R&D difficulty as shown in panel (b) of Figure 1. While the increase in C comes, as before, from the simple fact that more Southern workers can do more R&D, the decrease in x_N reflects a net reallocation of Northern labor from R&D to production despite the increased unemployment risk for production workers and despite the decrease in w_N. For large enough firing costs, the reduction in R&D benefits from the expected costs of future dismissals more than outweighs the decrease in R&D costs from the lower w_N and the increase in R&D benefits from the larger Southern market size. Hence, Northern consumers and workers suffer from a temporary decline of the quality-growth rate and a decrease in the relative – and absolute – Northern wage rate. The net effect on Northern unemployment is ambiguous which can be seen formally from (30), where a rise in C and a decrease in x_N have opposite effects on u. This is because the absolute level of Northern production employment L_N^Y may actually increase or decrease. On the one hand, there are two effects working toward a reduction in L_N^Y: first, the rise in Southern copying C tends to reduce it due to the decline in the proportion m_N of firms producing in the North. Second, the decline in relative R&D difficulty x_N explained before implies a temporary slowdown of Northern innovative activity and therefore a decline in *relative* average Northern product quality (Q_N/Q decreases if C increases relative to I, see (22)). Given relative goods prices, this reduces the world demand for Northern goods of average (Northern) quality and therefore Northern production employment L_N^Y, see (24). On the other hand, there are also two effects working toward an increase in L_N^Y: first, demand for Northern products rises because with rising C, w_N declines and thus Northern products become cheaper, which raises relative demand $\bar{d}_N/\bar{d}_S$ for given average product quality, see (35). Second, L_N^Y rises ceteris paribus simply because of the decrease in R&D profitability for $B > B^{crit}$ explained before. The net effect on Northern production employment – and hence on u – is ambiguous.

With $\beta < \beta^{crit}$ and $B > B^{crit}$, globalization results in an increase in x_N but a decrease in C as is shown in panel (d) of Figure 1. This is a rather paradoxical case since more Southern labor resources actually produce less imitative R&D in equilibrium. It happens because of the combination of two effects: first, Southern R&D firms have to take into account that increasing their imitation activity would significantly reduce the effective market size of the North (i.e., strongly raise Northern unemployment) because of the low labor market turnover parameter β, which reduces Southern R&D benefits. Of course, this effect applies also to the case with $\beta < \beta^{crit}$ and $B < B^{crit}$ discussed before. Second, Southern R&D firms have to take into account that increasing their imitation activity would significantly raise dismissal costs of Northern R&D firms facing a high firing cost parameter B, which would more than offset rising innovative R&D benefits that result from the larger Southern market size. Hence, innovation activity would decrease in the North, and a larger proportion of Northern workers would then be employed in goods production. Given a low β, this would further increase Northern unemployment, reinforcing the first negative effect on Southern imitation incentives.[19]

Hence, the Southern imitation rate C declines, which implies a significant reduction in Northern expected firing costs due to $B > B^{crit}$ and therefore induces Northern quality follower firms to increase innovative R&D expenditures. This results in a temporary increase in the Northern innovation rate, thus x_N and L_N^I increase permanently. The relative Northern wage rate rises because of the decline in C. Northern unemployment unambiguously declines despite the opposite effects on C and x_N[20]: while C declines (lower unemployment risk for Northern production workers), L_N^Y may rise since the proportion of industries $m_N = I/(I+C)$ producing in the North increases (it may also decline because of the rising R&D-labor demand). Then, however, both L_N^Y and L_N^I increase, and since $(1-u)\cdot \overline{L}_N =$ $L_N^Y + L_N^I$, this requires a decrease in u. Alternatively, if L_N^Y in fact declines despite the increase in m_N, then the joint decrease in L_N^Y and C necessarily implies a decline in u. We can summarize our findings in

Proposition 1: *Starting from a steady-state equilibrium with* (37) *being fulfilled, globalization (i.e., an increase in $\overline{L}_S$) results in*

i.) *a permanent increase in the rate of Southern copying* ($C\uparrow$)*, a permanent increase in relative R&D difficulty* ($x_N\uparrow$)*, a short-run increase in Northern innovation and the quality-growth rate* ($I\uparrow$*,* $\dot{Q}/Q\uparrow$) *above their steady-state levels, no change in the long-run innovation rate* $I = n/(\lambda - 1)$*, a permanent decrease in North-South wage inequality* ($w_N/w_S\downarrow$)*, and an increase in the Northern unemployment rate* ($u\uparrow$)*,* ***if $B < B^{crit}$, independent of the value for β;***

ii.) *a permanent increase in the rate of Southern copying* ($C\uparrow$)*, a permanent decrease in relative R&D difficulty* ($x_N\downarrow$)*, a short-run decrease in Northern innovation and the quality-growth rate* ($I\downarrow$*,* $\dot{Q}/Q\downarrow$) *below their steady-state levels, no change in the*

---

[19] Note that this negative net effect on Southern imitation incentives does not contradict globalization which happened in the first place since globalization is not modeled by a deliberate policy choice of the South (like trade liberalization) but by an increase in an exogenous Southern parameter, $\overline{L}_S$.

[20] Remember from (30) that these two endogenous variables are positively correlated with u.

long-run innovation rate $I = n/(\lambda - 1)$*, and a permanent decrease in North-South wage inequality* ($w_N/w_S \downarrow$)*, while the net effect on Northern unemployment is ambiguous,* ***if*** $\boldsymbol{\beta} > \boldsymbol{\beta^{crit}}$ **and** $\boldsymbol{B} > \boldsymbol{B^{crit}}$;

iii.) *a permanent decrease in the rate of Southern copying* ($C \downarrow$)*, a permanent increase in relative R&D difficulty* ($x_N \uparrow$)*, a short-run increase in Northern innovation and the quality-growth rate* ($I \uparrow$, $\dot{Q}/Q \uparrow$) *above their steady-state levels, no change in the long-run innovation rate* $I = n/(\lambda - 1)$*, a permanent increase in North-South wage inequality* ($w_N/w_S \uparrow$)*, and a decrease in the Northern unemployment rate* ($u \downarrow$)*,* ***if*** $\boldsymbol{\beta} < \boldsymbol{\beta^{crit}}$ **and** $\boldsymbol{B} > \boldsymbol{B^{crit}}$.

To provide a comprehensive assessment of the welfare effects of globalization for Northern consumers would require to take into account the complete adjustment paths of all endogenous variables during the transition from the old to the new steady-state equilibrium. Due to the complexity of the model, this task is beyond the scope of our paper. Nevertheless, the following negative *steady-state* welfare effects of globalization can be established for the representative Northern consumer in our model: with $B < B^{crit}$, globalization hurts consumers in terms of a declining wage rate w_N and a rising unemployment rate u. However, these two negative *static* welfare effects have to be weighed up against three positive welfare effects: first, the innovation rate I spurs up temporarily which raises permanently the average quality level $Q = x_N \cdot L_N$ of consumer goods (dynamic welfare gain). Second, consumers can buy a larger proportion m_S of relatively low-priced Southern consumer goods (with fixed $p_S = \sigma/(\sigma - 1)$) than before the globalization shock (purchasing power effect, representing a static welfare gain). Third, because of the decline in w_N, Northern consumer goods become cheaper. The latter effect does not fully compensate Northern *employed* workers for their nominal wage decline: $w_N/p_N = (\sigma - 1)/\sigma$ stays constant, but the proportion of Northern goods m_N in the consumer goods basket declines.[21] These results hold true independently of the degree of Northern labor market flexibility as measured by the instantaneous job-finding rate β.

In a Northern economy with firing costs exceeding the critical level given in (34), the welfare effects of globalization depend crucially on β. With β exceeding the critical level given in (33), Northern consumers are hurt by globalization in terms of a temporary growth decline and a permanent wage decrease, while they benefit from the facts that they can buy a larger proportion of relatively low-priced Southern consumer goods (positive purchasing power effect), and that Northern consumer goods become cheaper. With β below the critical level, all these effects are reversed, and in addition, Northern

[21] As is noted by DS (2005a), the Northern representative consumer's expenditure c_N is not determined in this model as long as we make no further assumption about the international distribution of firm ownership. Hence, we cannot infer possible welfare effects from changes in consumption quantities.

unemployment declines unambiguously. Table 1 below summarizes the steady-state welfare effects (blue = welfare-increasing, red = welfare-reducing) from globalization for Northern consumers.

Table 1*: *Steady-state welfare effects of globalization for Northern consumers

	$\Delta(w_N/p_N)$	Δu	ΔQ	Δm_S
$B < B^{crit}$, $\beta > \beta^{crit}$	constant	**> 0**	**> 0**	**> 0**
$B > B^{crit}$, $\beta > \beta^{crit}$	constant	ambiguous	**< 0**	**> 0**
$B < B^{crit}$, $\beta < \beta^{crit}$	constant	**> 0**	**> 0**	**> 0**
$B > B^{crit}$, $\beta < \beta^{crit}$	constant	**< 0**	**> 0**	**< 0**

The net welfare effect is ambiguous in all four cases. However, we can conclude that in the long run, consumers in Northern economies with inflexible labor markets do not necessarily suffer more from globalization than consumers in countries with a more flexible labor market. In particular, a – probably unexpected – result is that consumers in Northern countries with large labor market adjustment costs for *both* firms *and* workers ($B > B^{crit}$ and $\beta < \beta^{crit}$) benefit from globalization in terms of employment *and* quality growth (which could be termed a 'double dividend' of globalization), while this is not true for countries with either asymmetric or no significant labor market adjustment costs. The reason for this non-standard result is that the Southern imitation rate *decreases* with globalization in the case of a very inflexible Northern labor market because of the resulting general-equilibrium feedback effects on Southern R&D firms. This cannot happen of course in models like Arnold (2002) where the Southern imitation rate is exogenously fixed.

5 Policy Analysis

5.1 Stricter Intellectual Property Rights Protection (IPRP)

As in DS (2005a), stricter IPRP is modeled as a decrease in the imitation productivity parameter η_I in (11), which reduces the imitation rate C for any given R&D labor input L_S^C and relative R&D difficulty x_N. As can be seen from our two steady-state conditions (31) and (32), this works exactly opposite to globalization (increase in $\bar{L}_S$), hence the shift of the Southern steady-state curve in Figure 1 and all effects summarized in Proposition 1 are simply reversed for a decrease in η_I – stricter IPRP serves as a mitigation device for the effects of the type of globalization we studied in this paper. Note in particular the paradoxical effect on Southern imitation incentives in the case $\beta < \beta^{crit}$ and $B > B^{crit}$: stricter IPRP results in an increase in Southern imitation! The intuition parallels our discussion of the globalization effects above.

In the North-South product-cycle model with non-scale endogenous growth of Şener (2005), successful Northern innovators engage in innovation-deterring and imitation-deterring activities (like lobbying or patent litigation, also termed “rent-protection activities”), aimed at reducing the innovation and imitation probability of Northern and Southern rivals, respectively. He finds that stricter IPRP reduces both the Southern imitation rate and total Northern rent-protection activities. However, this does not lead to more Northern innovation because of important equilibrium effects in the Northern labor market: less Southern imitation implies that a larger proportion of industries produces in the North, which raises labor demand and increases the Northern wage rate, hence innovation costs increase. The net effect is a decrease in the Northern innovation rate (although it decreases proportionally less than the Southern imitation rate), and the North-South wage gap rises. Contrary to DS (2005a) or to our extended model, stricter IPRP does not serve to mitigate globalization effects in Şener (2005) since there, an increase in the relative size of the open South raises the Southern imitation rate (as in our model for all cases except the paradoxical case $\beta < \beta^{crit}$ and $B > B^{crit}$, see Figure 2), but *increases* North-South wage inequality and *reduces* Northern innovation. The reason for these different results is that an increase in the relative size of the South and the Southern imitation rate leads to an increase in Northern imitation-deterring activities, such that the net effect is a decrease in Southern imitation profitability *relative* to Northern innovation profitability. This results in an increase in the relative Northern wage rate and therefore leads to a negative net effect on Northern innovation incentives.[22] Şener emphasizes the importance of general-equilibrium effects associated with labor markets – in particular, the net effects on wage rates – in deriving his results, which is also a major concern of our paper. However, we see that including sufficiently large labor market frictions may overturn some of the general-equilibrium effects obtained for the case of flexible labor markets.

5.2 R&D Subsidies

An increase in s_R affects the steady-state conditions (31) and (32) as is depicted in Figure 3 below: the Northern steady-state curve shifts to the right, and the Southern steady-state curve shifts to the left.

insert here: Figure 3

As can be seen in Figure 3, the movement of C after an increase in s_R is unambiguous in all four cases, but the movement of x_N is ambiguous in panel (a) and (d). To determine the net effect on x_N, we totally differentiate (31) and (32), holding x_N constant. This gives, using $I = n/(\lambda - 1)$,

$$\left.\frac{dC}{ds_R}\right|_{(31)} = \frac{(\rho + I + C)\cdot(\lambda \cdot I + C)}{\eta_I \cdot B \cdot n - (1 - s_R)\cdot(\rho - n)} , \tag{39}$$

[22] However, Şener (2005) qualifies this finding insofar as the net effects on Northern innovation and the relative Northern wage rate *may* be overturned if Northern incumbents hire only Northern labor for *both* innovation-deterring activities in the North *and* imitation-deterring activities in the South. By contrast, in his model, he assumes that Southern labor is hired for imitation-deterring activities in the South.

which is negative if, and only if, $B < B^{crit}$, and

$$\left.\frac{dC}{ds_R}\right|_{(32)} = \frac{\rho + I + C}{1 - s_R + \eta_I \cdot B - \dfrac{(\beta + n)\cdot \eta_I}{(\sigma - 1)\cdot C^2 \cdot x_N}} \ , \tag{40}$$

which is negative if, and only if, $\beta > \beta^{crit}$. In panel (a), the size of the downward shift of (31) is larger than that of the downward shift of (32) for constant x_N if, and only if,

$$(\lambda \cdot I + C)\cdot \frac{\beta - \beta^{crit}}{(\sigma - 1)\cdot C^2 \cdot x_N \cdot n} > B^{crit} - B \ . \tag{41}$$

Therefore, for given other parameters, in panel (a) the net effect of an increase in s_R on x_N is positive (i.e., the downward shift of the curve for (31) is larger than the downward shift of the curve for (32)) if $\beta - \beta^{crit} > 0$ is sufficiently large compared to $B^{crit} - B > 0$, which would mean that the labor market inflexibility problem must not be 'too severe' compared to the firing costs problem. In panel (d) we obtain exactly the opposite condition for $dx_N/ds_R > 0$.

A common feature of the cases (a) – (c) in Figure 3 is that an increase in Northern R&D subsidies reduces the Southern imitation rate, which results in an increase in North-South wage inequality. To understand this finding, we first note that an increase in s_R reduces Northern R&D costs and therefore temporarily spurs innovation and raises R&D employment L_N^I permanently (because x_N rises), which explains the shift of the curve for (31) to the right. By relocating Northern employment from production to R&D, Northern workers become less vulnerable to Southern imitation on average, hence the unemployment rate u declines ceteris paribus. An increase in x_N raises Southern R&D costs (LHS of (20)), and an increase in the Northern effective market size L_N raises Southern R&D costs by more than it raises Southern R&D benefits in (20). Together, this explains the downward shift of the curve for (32) in panel (a) and (b) of Figure 3, where $\beta > \beta^{crit}$. However, with $\beta < \beta^{crit}$ (panel (c) and (d)), Southern R&D firms have to consider the following: an increase in the copying intensity C would actually further improve imitation incentives since the resulting increase in the relative Southern wage rate would be more than compensated by the resulting large decrease in the Northern market size (u increases significantly), which decreases Southern R&D costs by more than it decreases Southern R&D benefits in (20).[23] Therefore, for a sufficiently inflexible Northern labor market, an increase in Northern R&D subsidies can actually improve Southern imitation incentives for given x_N, which explains the upward shift of the curve for (32) in panel (c) and (d) of Figure 3, where $\beta < \beta^{crit}$. However, the general-equilibrium effect on C resulting from this upward shift of the Southern steady-state curve can only be positive if the Northern steady-state curve is negatively sloped (panel (d)). We can summarize our findings in

[23] This effect does not endure ad infinitum because u cannot continue to rise beyond 1.

Proposition 2: *Starting from a steady-state equilibrium with* (37) *being fulfilled, an increase in the Northern R&D subsidy rate s_R results in*

i.) *a permanent decrease in the rate of Southern copying* ($C \downarrow$) *and a permanent increase in North-South wage inequality* ($w_N/w_S \uparrow$), ***if either $\beta > \beta^{crit}$, independent of the value for B, or if $\beta < \beta^{crit}$ and $B < B^{crit}$***;

ii.) *a permanent increase in the rate of Southern copying* ($C \uparrow$) *and a permanent decrease in North-South wage inequality* ($w_N/w_S \downarrow$), ***if $\beta < \beta^{crit}$ and $B > B^{crit}$***;

iii.) *a permanent increase in relative R&D difficulty* ($x_N \uparrow$), *a short-run increase in Northern innovation and the quality-growth rate* ($I\uparrow$, $\dot{Q}/Q \uparrow$) *above their steady-state levels, no change in the long-run innovation rate $I = n/(\lambda-1)$, and an ambiguous effect on the Northern unemployment rate u*, ***if $\beta > \beta^{crit}$*** **and $B > B^{crit}$**;

iv.) *a permanent decrease in relative R&D difficulty* ($x_N \downarrow$), *a short-run decrease in Northern innovation and the quality-growth rate* ($I \downarrow$, $\dot{Q}/Q \downarrow$) *below their steady-state levels, no change in the long-run innovation rate $I = n/(\lambda-1)$, and a negative effect on the Northern unemployment rate* ($u \downarrow$), ***if $\beta < \beta^{crit}$*** **and $B < B^{crit}$**;

v.) *an ambiguous permanent effect on x_N* (*and hence also on u*), ***if either $\beta > \beta^{crit}$ and B < B^{crit} or vice versa ($\beta < \beta^{crit}$ and B > B^{crit})***, *depending on the relative significance of the labor market flexibility problem and the firing cost problem as measured by* (41).

5.3 Reducing Employment Protection: Lower Adjustment Costs For Northern Firms

A decrease in B affects the steady-state conditions (31) and (32) exactly in the same way as an increase in s_R, depicted in Figure 3 above: the Northern steady-state curve shifts to the right, and the Southern steady-state curve shifts to the left. Hence, the movement of C after a decrease in B is again unambiguous in all four cases, and the movement of x_N is again ambiguous in panel (a) and (d). To determine the net effect on x_N, we totally differentiate (31) and (32), holding x_N constant. This gives, using $I = n/(\lambda-1)$,

$$\left.\frac{dC}{dB}\right|_{(31)} = \frac{(I+C)\cdot(\lambda\cdot I+C)\cdot\eta_I}{\eta_I\cdot B\cdot n-(1-s_R)\cdot(\rho-n)}\,, \tag{42}$$

which is again negative if, and only if, $B < B^{crit}$, and

$$\left.\frac{dC}{dB}\right|_{(32)} = \frac{(I+C)\cdot\eta_I}{1-s_R+\eta_I\cdot B-\dfrac{(\beta+n)\cdot\eta_I}{(\sigma-1)\cdot C^2\cdot x_N}}\,, \tag{43}$$

which is again negative if, and only if, $\beta > \beta^{crit}$. The size of the shift of (31) is larger than the shift of (32) for constant x_N if, and only if, (41) is fulfilled. The interpretation of the sizes of the relative shifts of both curves after a decrease in B, as well as the interpretation of the shifts of the curves themselves, exactly equal our discussion of an increase in s_R before. Therefore, Proposition 2 also applies to a decrease in the firing costs parameter B. Table 2 below summarizes the steady-state welfare effects of a decrease in firing costs for Northern consumers, similar to Table 1 before on the welfare effects of globalization.

Table 2*: *Steady-state welfare effects of a decrease in firing costs for Northern consumers

	$\Delta(w_N/p_N)$	Δu	ΔQ	Δm_S
$B < B^{crit}$, $\beta > \beta^{crit}$	constant	ambiguous (< 0 if (41) is violated)	ambiguous (> 0 / < 0 if (41) is fulfilled / violated)	**< 0**
$B > B^{crit}$, $\beta > \beta^{crit}$	constant	ambiguous	**> 0**	**< 0**
$B < B^{crit}$, $\beta < \beta^{crit}$	constant	**< 0**	**< 0**	**< 0**
$B > B^{crit}$, $\beta < \beta^{crit}$	constant	ambiguous	ambiguous (> 0 / < 0 if (41) is fulfilled / violated)	**> 0**

From a political economy point of view, the negative employment effect of globalization for $B < B^{crit}$ (see Table 1) is probably the most relevant. According to Table 2 and given $B < B^{crit}$, this could be compensated by a further decrease in firing costs. However, if either $\beta > \beta^{crit}$ and (41) is violated, or if $\beta < \beta^{crit}$, this would unambiguously thwart the positive quality-growth effect of globalization, and in any case it would thwart the positive purchasing power effect of globalization.

Finally, note that in the closed-economy, neo-Schumpeterian model in Grieben (2005) with non-instantaneous matching on the labor market and endogenous creative destruction, a decrease in firing costs increases the steady-state unemployment rate unambiguously. That result differs from our less clear findings here for three reasons: first, there are no feedback effects from a second country in Grieben (2005). Second, in a matching framework with endogenous creative destruction, a decrease in firing costs raises the innovation rate which immediately increases layoffs. Contrary to the framework in this paper, Grieben (2005) does not assume that in the case of domestic innovation, the new Northern quality leader instantaneously offers an equal amount of jobs. Third, economic growth is endogenous in Grieben (2005) instead of semi-endogenous as it is in this paper, hence the increase in the innovation rate is permanent instead of temporary.

5.4 Increasing Labor Market Flexibility: Lower Adjustment Costs For Northern Workers

In practice, an increase in β could mean to provide incentives for unemployed workers to intensify job search, e.g. by reducing the level or duration of unemployment benefit payments. Alternatively, it could mean an increase in the efficiency of the placement service. Formally, an increase in β does not affect the Northern steady-state curve (31), but it shifts the Southern steady-state curve (32) to the left as is shown in Figure 4 below.

insert here: Figure 4

The steady-state effects are exactly opposite to that of globalization (increase in $\overline{L}_S$) and identical to that of stricter IPRP (decrease in η_I). In the case of a flexible Northern labor market ($\beta > \beta^{crit}$) with relatively low firing costs ($B < B^{crit}$), starting from E_0, an increase in Northern labor market flexibility leads to a move of the steady-state equilibrium to E_1 and thus to a decrease in the steady-state level of R&D difficulty x_N and a decrease in the Southern imitation rate C. To understand these results, first note that the immediate effect of an increase in β is a decrease in Northern unemployment, see (30), hence there is more labor available for both production and R&D (L_N rises). However, dividing both sides of (15) or (20) by L_N demonstrates that in both countries, ceteris paribus discounted R&D benefits decline *relative* to R&D costs: while R&D difficulty is proportional to L_N, world demand for Northern or Southern products of average quality increases by less than one for one with L_N. The explanation for the leftward shift of the Southern steady-state curve is the same as given before when discussing the steady-state effects of an increase in the Northern R&D subsidy rate s_R. Hence, if the Northern labor market is relatively flexible (i.e., $\beta > \beta^{crit}$), a further increase in β reduces Southern imitation incentives, while the opposite holds true if the Northern labor market is relatively inflexible ($\beta < \beta^{crit}$). However, the general equilibrium effect on C can only be positive if the Northern steady-state curve is negatively sloped as in panel (d) of Figure 4.

To sum up, all effects stated in Proposition 1 and Table 1 are simply reversed for an increase in β – just as stricter IPRP, a more flexible Northern labor market also serves as a mitigation device for the effects of the type of globalization we studied here. Ceteris paribus, it improves the welfare of the representative Northern consumer by alleviating the negative employment effects of globalization for $B < B^{crit}$. At the same time, however, it unambiguously thwarts the positive quality-growth effect and the positive purchasing power effect of globalization.

6 Conclusions

This paper emphasizes that the Southern ‘globalization threat’ for the labor markets in advanced industrialized countries is determined in general equilibrium and is thus endogenous. In the case of our model, the degree of Northern labor market frictions (firing costs, job-finding rate) determines both the size of the Southern imitation rate and the sign of the globalization effects on employment, growth and wage rates. Inter alia, our results contradict the popular view that consumers in Northern countries with flexible labor markets will necessarily benefit most from the current wave of globalization, as measured by the entry of large developing countries like China and India into the world free-trade markets. For example, we have shown that *only* consumers in Northern countries with substantial labor market adjustment costs for *both* firms *and* workers enjoy a ‘double dividend’ from globalization:

a permanent reduction in unemployment and a temporary increase in the quality-growth rate of consumer goods.[24] An increase in the job-finding rate (e.g., by decreasing the level or the duration of unemployment benefit payments) mitigates the globalization effects in the same way as stricter IPRP in the South. The negative employment effect of globalization that results for sufficiently low firing costs in the North can be alleviated either by increasing R&D subsidies or by further reducing firing costs. If the job-finding rate is sufficiently low, however, this policy would necessarily come at the cost of a temporary quality-growth slowdown.

Further research could try to endogenize Northern labor market institutions within this type of dynamic North-South non-scale growth models by adding a political-economy dimension. This could be fruitful since it appears to be an empirical regularity that employment protection and openness are positively correlated. For example, using the job protection index of Blanchard and Wolfers (2000) and the measure of openness from Penn World Tables, Mark 5.6, Agell (2002) shows that within a sample of 20 OECD countries between the early 1960s and the late 1970s, "[...] job protection increased the most in those countries that got the most open" (ibid, p. 129).[25] As argued in this paper, the level of job protection (as captured by the firing costs) in open Northern economies is highly relevant for the qualitative effects of globalization shocks coming from the South.

7 Appendices

Appendix A: Derivation Of The Individual's Consumption Demand Function (4)

Defining a new state variable Φ with $\Phi(0) = 0$, $\Phi(1) = c(t)$ and $d\Phi(\omega)/d\omega = p(\omega, t)\cdot d(\omega, t)$, the corresponding Hamiltonian is $H = [\lambda^{[j(\omega, t)/(\sigma - 1)]}\cdot d(\omega, t)]^{(\sigma - 1)/\sigma} + \psi(\omega)\cdot p(\omega, t)\cdot d(\omega, t)$, where $\psi(\omega)$ is the costate variable that belongs to $\Phi(\omega)$. The f.o.c. are

$$\partial H/\partial\Phi = 0 = -d\psi/d\omega \quad \Leftrightarrow \quad \psi(\omega) = \psi \ \forall\omega , \tag{A.1}$$

$$\partial H/\partial d = \left[(\sigma-1)/\sigma\right]\cdot\left[\lambda^{\left[j(\omega,t)/(\sigma-1)\right]}\cdot d(\omega,t)\right]^{-1/\sigma}\cdot\lambda^{\left[j(\omega,t)/(\sigma-1)\right]}+\psi\cdot p(\omega,t) = 0$$

$$\Leftrightarrow d(\omega,t) = \left[-(\sigma-1)/\sigma\cdot\psi\right]^{\sigma}\cdot p(\omega,t)^{-\sigma}\cdot\underbrace{\lambda^{j(\omega,t)}}_{\equiv q(\omega,t)} . \tag{A.2}$$

---

24 We are anxious to point out that our results do not imply the recommendation that Northern labor markets should be made inflexible enough such that Northern consumers are able to enjoy this double dividend from globalization. For example, a decrease in β would unambiguously raise the steady-state unemployment rate in two out of four cases summarized in Table 1, and an increase in firing costs can also have harmful employment or growth effects, as can be inferred from Table 2. The basic message is rather that there is no obvious reason to believe that consumers in Northern countries with particular inflexible labor markets should fear the globalization 'threat' more than others. Instead, globalization can help to mitigate their employment and growth problems.

25 A theoretical reasoning for why the voters' demand for employment protection increases along with exogenous shocks that ceteris paribus tend to raise the steady-state innovation and growth rate is provided in the non-scale endogenous growth model of Grieben (2005). Globalization (as defined in this paper) could be one such shock, although it is not explicitly analyzed in that closed-economy model.

Inserting (A.2) into the budget constraint from (3) yields

$$\left[-(\sigma-1)/\sigma\cdot\psi\right]^{\sigma}\cdot\int_0^1 p(\omega,t)^{1-\sigma}\cdot q(\omega,t)\,d\omega \;=\; c(t)\;. \tag{A.3}$$

Using (A.3) in (A.2) then gives (4).

Appendix B: Derivation Of Equation (38)

Inserting (4) into (2) and using the fact the households only consume goods with the lowest quality-adjusted price gives individual instantaneous utility in the North as

$$z_N(\mathrm{t}) \;=\; c_N(t)\cdot\left\{\int_0^1 \lambda^{\frac{j(\omega)}{\sigma}}\cdot\left[\frac{q(\omega)\cdot p_N{}^{-\sigma}}{\int_0^1 q(\omega)\cdot p(\omega)^{1-\sigma}\,d\omega}\right]^{\frac{\sigma-1}{\sigma}} d\omega\right\}^{\frac{\sigma}{\sigma-1}}$$

$$\Leftrightarrow\quad z_N(\mathrm{t}) \;=\; c_N(t)\cdot Q(t)^{\frac{1}{\sigma-1}}\cdot\frac{Q(t)\cdot\left[\frac{w_N(t)\cdot\sigma}{\sigma-1}\right]^{-\sigma}}{\left[\frac{w_N(t)\cdot\sigma}{\sigma-1}\right]^{1-\sigma}\cdot\frac{\lambda\cdot I\cdot Q(t)}{\lambda\cdot I+C}+\left[\frac{w_S(t)\cdot\sigma}{\sigma-1}\right]^{1-\sigma}\cdot\frac{C\cdot Q(t)}{\lambda\cdot I+C}} \tag{B.1}$$

$$=\;\frac{c_N(t)\cdot Q(t)^{\frac{1}{\sigma-1}}\cdot w_N(t)^{-\sigma}\cdot(\sigma-1)\cdot(\lambda\cdot I+C)}{\sigma\cdot\left[w_N(t)^{1-\sigma}\cdot\lambda\cdot I+w_S(t)^{1-\sigma}\cdot C\right]}\quad,$$

where we have used monopoly markup prices $p_{N,S} = [\sigma/(\sigma-1)]\cdot w_{N,S}$, the definition of average quality level $Q_t \equiv \int_0^1 \lambda^{j(\omega)}d\omega \equiv \int_0^1 q(\omega)d\omega$, $\int_0^1 q(\omega)\cdot p(\omega)^{1-\sigma}\,d\omega = p_N{}^{1-\sigma}\cdot Q_N + p_S{}^{1-\sigma}\cdot Q_S$ and (22). Using the facts that w_S is a constant fraction of w_N (see (36)) and that I and C are constant in a steady-state equilibrium, logarithmic differentiation of the last line of (B.1) gives

$$\frac{\dot z_N}{z_N} \;=\; \frac{\dot c_N}{c_N}+\frac{1}{\sigma-1}\cdot\frac{\dot Q}{Q}-\frac{\dot w_N}{w_N}\quad. \tag{B.2}$$

Inserting $\dot c_N/c_N = \dot c/c = \dot w_N/w_N = 0$, (21) and (26) into (B.2) gives (38).

References

Agell, Jonas (2002): "On the Determinants of Labour Market Institutions: Rent Seeking vs. Social Insurance". *German Economic Review*, Vol. 3(2), 107-135.

Angrist, Joshua D. and Kugler, Adriana D. (2003): "Protective or Counter-Productive? Labour Market Institutions and the Effects of Immigration On EU Natives". *Economic Journal*, Vol. 113 (June), F302-F331.

Arnold, Lutz G. (2002): "On the Growth-Effects of North-South Trade: the Role of Labor Market Flexibility". *Journal of International Economics*, Vol. 58(2), 451-466.

Arnold, Lutz G. (2003): “Growth in Stages”. *Structural Change and Economic Dynamics*, Vol. 14, 55-74.

Blanchard, Olivier and Wolfers, Justin (2000): “The Role of Shocks and Institutions in the Rise in European Unemployment: The Aggregate Evidence”. *Economic Journal*, Vol. 110 (March), C1-C33.

Currie, David, Levine, Paul, Pearlman, Joseph and Chui, Michael (1999): “Phases of Imitation and Innovation in a North-South Endogenous Growth Model”. *Oxford Economic Papers*, Vol. 51(1), 60-88.

Dinopoulos, Elias; Gungoraydinoglu, Ali and Syropoulos, Constantinos (2005): *Patent Protection and Global Schumpeterian Growth*. Manuscript, University of Florida.

Dinopoulos, Elias and Segerstrom, Paul S. (1999): “A Schumpeterian Model of Protection and Relative Wages”. *American Economic Review*, Vol. 89(3), 450-472.

Dinopoulos, Elias and Segerstrom, Paul S. (2005a): *A Theory of North-South Trade and Globalization*. Manuscript, University of Florida and Stockholm School of Economics.

Dinopoulos, Elias and Segerstrom, Paul S. (2005b): *Multinational Firms and Economic Growth*. Manuscript, University of Florida and Stockholm School of Economics.

Dinopoulos, Elias and Thompson, Peter (1998): “Schumpeterian Growth Without Scale Effects”. *Journal of Economic Growth*, Vol. 3(4), 313-335.

Dinopoulos, Elias and Thompson, Peter (2000): “Endogenous Growth in a Cross-Section of Countries”. *Journal of International Economics*, Vol. 51(2), 335-362.

Freeman, Richard B. (1995): “Are Your Wages Set in Beijing?”. *Journal of Economic Perspectives*, Vol. 9(3), 15-32.

Grieben, Wolf-Heimo (2004): “Schumpeterian Growth, North-South Trade and Wage Rigidity”. *Contributions to Macroeconomics*, Vol. 4(1), Article 9.

Grieben, Wolf-Heimo (2005): “Schumpeterian Growth and the Political Economy of Employment Protection”. *Journal of Economics*, Suppl. 10, 77-118.

Grossman, Gene M. and Helpman, Elhanan (1991): “Quality Ladders and Product Cycles”. *Quarterly Journal of Economics*, Vol. 106(2), 557-586.

Helpman, Elhanan (1993): “Innovation, Imitation, and Intellectual Property Rights”. *Econometrica*, Vol. 61(6), 1247-1280.

Krugman, Paul (1994a): “Europe Jobless, America Penniless?”. *Foreign Policy*, Vol. 95, 19-34.

Krugman, Paul (1994b): “Past and Prospective Causes of High Unemployment”. *Federal Reserve Bank of Kansas City Economic Review*, Vol. 79(4), 23-43.

Li, Chol-Won (2001): "On the Policy Implications of Endogenous Technological Progress". *Economic Journal*, Vol. 111 (May), C164-C179.

Li, Chol-Won (2003): "Endogenous Growth Without Scale Effects: Comment". *American Economic Review*, Vol. 93(3), 1009-1017.

Moore, Mark P. and Ranjan, Prija (2005): "Globalisation vs Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality". *Economic Journal*, Vol. 115 (April), 391-422.

Schmidt, Christoph M.; Stilz, Anette and Zimmermann, Klaus F. (1994): "Mass Migration, Unions, and Government Intervention". *Journal of Public Economics*, Vol. 55(2), 185-201.

Segerstrom, Paul S. (1998): "Endogenous Growth Without Scale Effects". *American Economic Review*, Vol. 88(5), 1290-1310.

Şener, Fuat (2001): "Schumpeterian Unemployment, Trade and Wages". *Journal of International Economics*, Vol. 54(1), 119-148.

Şener, Fuat (2004): *Labor Market Rigidities and R&D-Based Growth in the Global Economy*, Manuscript, Union College, Schenectady, forthcoming in *Journal of Economic Dynamics and Control*.

Şener, Fuat (2005): *Intellectual Property Rights and Rent Protection in a North-South Product-Cycle Model*. Manuscript, Union College, Schenectady.

Sinn, Hans-Werner (2004): "The Dilemma of Globalisation: A German Perspective". *Économie Internationale*, Vol. 100, 111-120.

Wacziarg, Romain and Welch, Karen Horn (2003): *Trade Liberalization and Growth: New Evidence*. NBER Working Paper 10152.

Figures

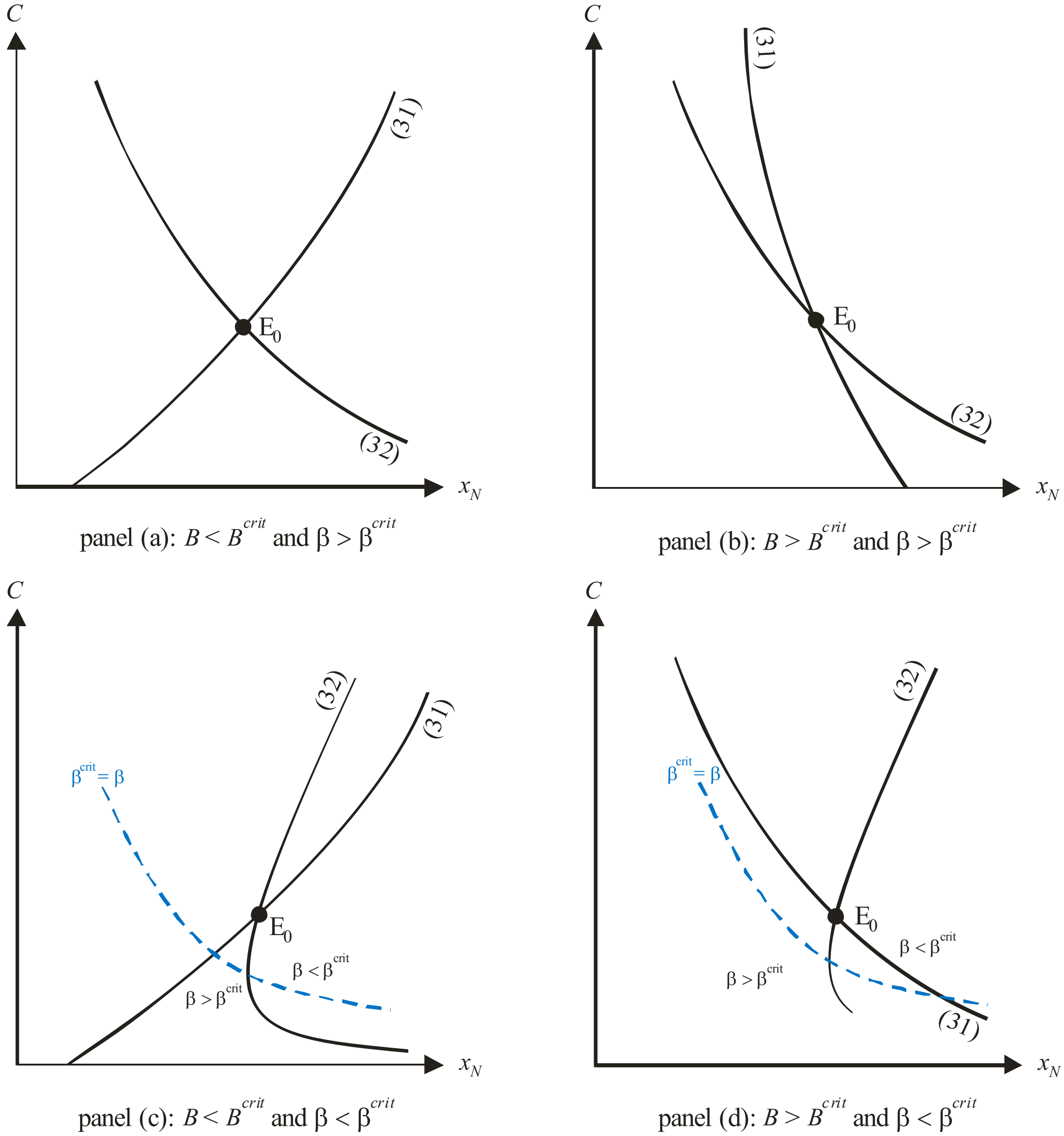

Figure 1: Steady-State Equilibrium

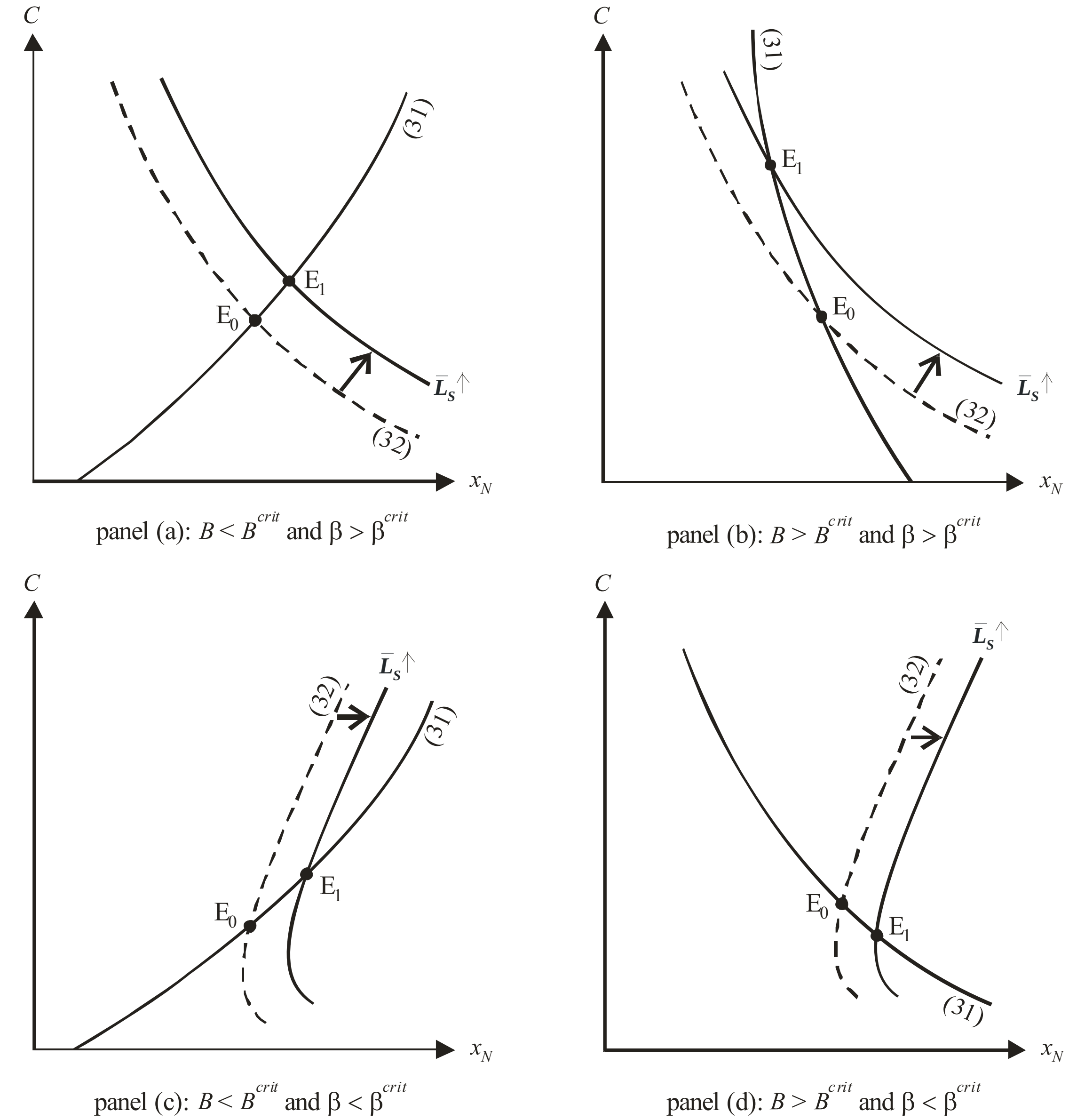

Figure 2*: *Steady-state effects of globalization

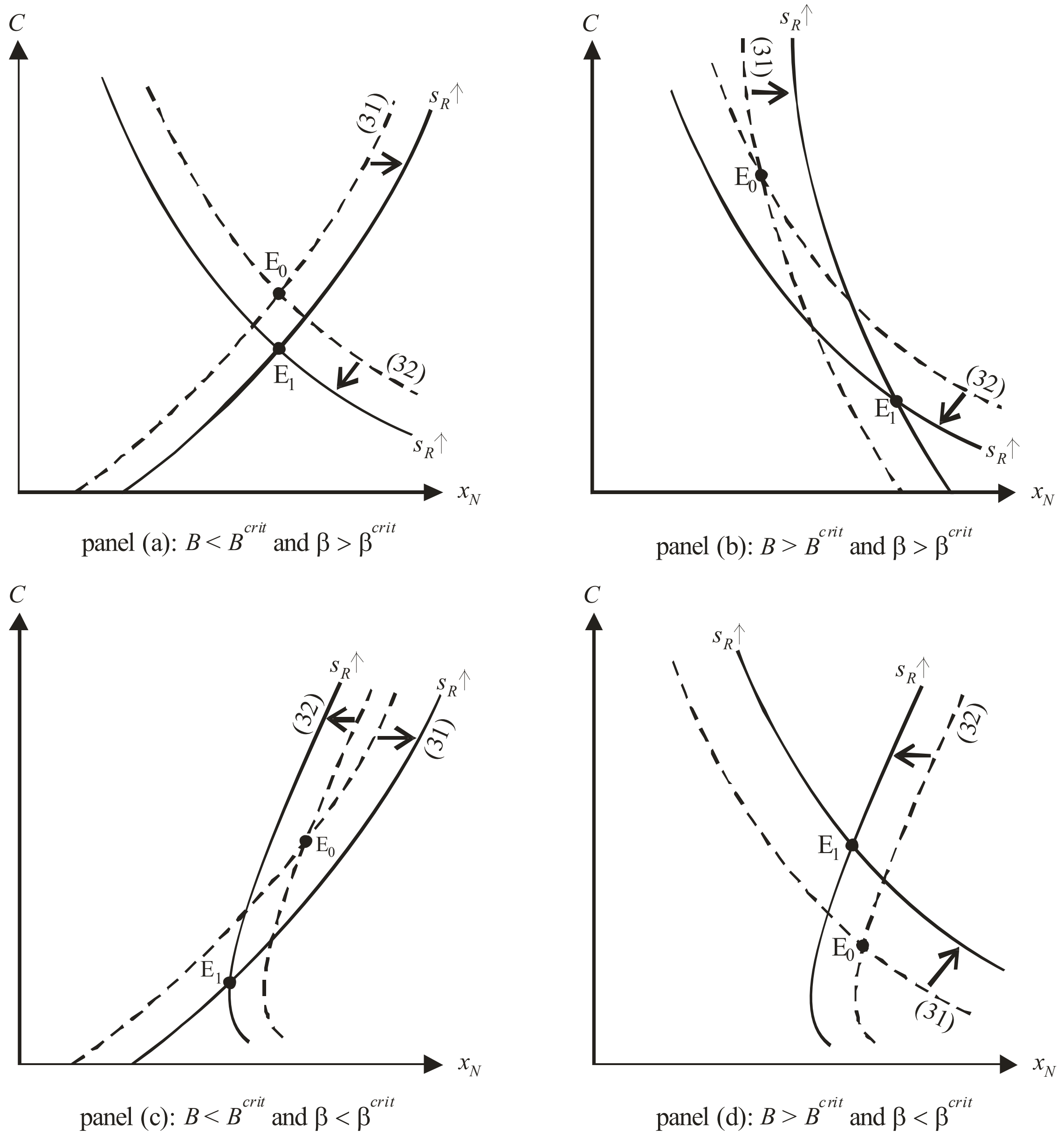

Figure 3: Steady-state effects of rising R&D subsidies in the North

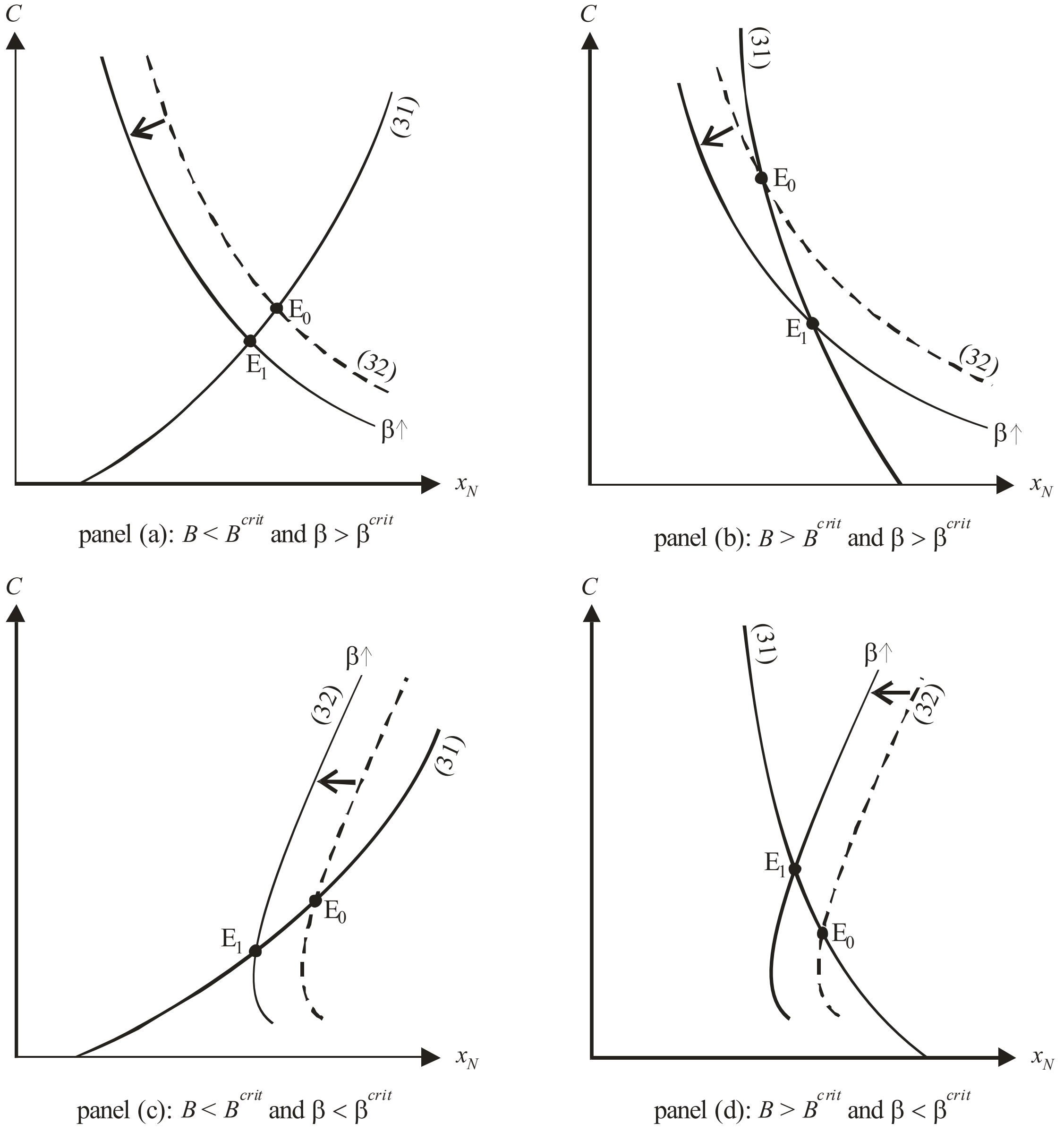

Figure 4: Steady-state effects of increasing Northern labor market flexibility