Integration, Regulation, Lobbying by Firms and Workers, and Technological Change

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Abstract

This paper examines an economic union where oligopolistic firms produce by skilled and unskilled labor and do R&D by skilled labor. The planner of the union accepts new members to the union, deregulates the product market through anti-trust policy and regulates the labor market through a minimum wage for unskilled labor. Firms and workers lobby the planner for prospective policy. It is shown that in the political equilibrium small unions apply product market deregulation, but large unions labor market deregulation. When an economic union grows, it will replace regulation by deregulation in the labor market.

Journal of Economic Literature: $F15$, $J50$, $O40$

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1 Introduction

In the years 1975-2000, the US and UK experienced sharp increases in wage inequality and rapid labor market deregulation. Aghion et al. (2001) argue that these two phenomena are related because of skill-biased technological change. In this paper, I offer an alternative explanation through political economy as follows: Economic integration creates political pressure to allow the cooperation of firms to speed up economic growth. To offset the resulting decrease in income, the labor market will be deregulated.

This paper models economic integration as a political process. I consider an economic union, where firms are subject to oligopolistic competition, but attempt to improve their productivity through in-house R&D. The level of profits depends on how much firms can cooperate in price settlement. I characterize the policy makers in the economic union by a hypothetical *planner* that can deregulate the product market (i.e. to press the profit margins down) through anti-trust policy, and regulate the labor market through imposing an effective minimum wage for (unskilled) labor (either directly, or through supporting labor unions). Lobbies representing workers and firms attempt to influence the planner for prospective policy. In this set up, R&D-based growth plays a crucial rule, for the product and labor markets would be always fully deregulated in an equilibrium with no growth. Finally, in this framework, economic integration is equivalent to the case where the planner accepts new regions (and consequently, new firms) as members to the union.

The growth effects of regulation depend decisively on the structure of economy. Where the same technology is used both in production and in R&D, the economy behaves as if the same final good were used both in consumption and in R&D. In that specific case, labor market regulation (e.g. the minimum wage) decreases profits, incentives to invest in R&D and the growth rate (cf. Peretto 1998). In this study, I assume that there is different technology for production and R&D.[1] With this specification, there can be a positive dependence between the minimum wage and technological change through cost-escaping R&D as follows. With higher wages, firms have more incentives to improve the productivity of labor through R&D (cf. Palokangas 1996, 2000, 2004). This increases investment in R&D and the growth rate.

[1] I take this to the extreme so that R&D employs only labor, for simplicity.

There is also some empirical evidence on a positive relationship between R&D and labor market regulation through high wages and unemployment. Caballero (1993) and Hoon and Phelps (1997) show that changes in unemployment and productivity growth are positively associated.

Except cost-escaping, there has been also other attempts to explain a positive wage-growth relationship. Cahuc and Michel (1996) (using an OLG model), as well as Agell and Lommerud (1997) (using an extensive game framework) show that minimum wages create an incentive for workers to accumulate human capital. Meckl's (2004) assumes efficiency wages for both production and R&D and argues the following. The greater the size of the high-wage sector (e.g. the R&D sector), the higher is unemployment generated by efficiency wages. On the other hand, the greater the relative size of the R&D sector, the higher is the growth rate of the economy. Despite of these alternative explanations, I stick to cost-escaping, because it provides a direct link from rents to incentives to improve technology.

I organize the remainder of this study as follows. In section 2, I present the institutional setting of the study as an extended game. As a part of this game, I construct specific models for households in section 3, firms in 4 and for the economic union in 5. Finally, I analyze the political equilibrium in section 6 and economic integration in section 7.

2 The setting

I consider an economic union that contains a number J of similar regions.[2] A member country of the union is comprised of a smaller number ($< J$) of these regions. Each region $j \in \{1, ..., J\}$ possesses fixed amounts L and N of skilled and unskilled labor, respectively.[3] To examine the political economy of growth and economic integration, the model is then composed as follows:

(i) All firms produce goods from skilled and unskilled labor. The oligopolistic competition of the firms determines prices in the economic union.

[2]The assumption on similar regions is admittedly strong, but with asymmetric regions there can be multiple equilibria in the model.

[3]With some more complication, it is possible to get the same results on the assumption that unskilled workers can transformed into skilled workers at some cost. Cf. Section 4 in Palokangas (2005).

(ii) Firms invest in R&D to escape production costs. Only skilled labor is used in R&D.

(iii) The *planner* of the union accepts new members to the union and regulates (a) the labor market through imposing an effective minimum wage for (unskilled) labor and (b) the product market through allowing the firms to cooperate in price settlement. I call the labor market deregulated, if there is full employment and no effective minimum wage, and the product market deregulated, if the profit margins are pressed to the minimum through anti-trust policy. The planner has its own interests and it is lobbied by interest groups that represent workers and firms.

(iv) Because the new members have access to the same technology and must adopt the same institutions as the old members, economic integration can be characterized by the increase in the size J of the economic union. An expansion of the union intensifies competition in the product market. Any opposition to economic integration manifests itself as an upper limit that the political process sets for the economic union.

I use the common agency model (e.g. Bernheim and Whinston 1986, Grossman and Helpman 1994a, and Dixit, Grossman and Helpman 1997) to establish a political equilibrium with the following sequence of decisions:

1. Worker and employer lobbies make their offers to the planner (section 6). These offers relate the lobbies' prospective political contributions to the planner's policy.

2. The planner regulates firms' market power, sets the minimum wage and accepts new members to the economic union (Section 5).

3. Firms decide how much to invest in R&D (Subsection 4.2).

4. Each firm decides on its output given its expectations on the behavior of the other firms (Subsection 4.1).

5. The households decide on their consumption (Section 3).

This extended game is solved by backward induction.

3 Output, consumption and labor supply

3.1 Production technology

In region $j \in \{1, ..., J\}$ of the economic union, a single firm (hereafter firm j) produces good j from labor with technology

$$y_j = B_j n_j, \tag{1}$$

where y_j output, n_j labor input in production and B_j is the productivity parameter. I assume that all products $j \in \{1, ..., J\}$ are perfect substitutes, for simplicity.[4] The total supply of the composite good in the economic union, C, is the sum of regional outputs y_j:

$$C = \sum_{j=1}^{J} y_j. \tag{2}$$

The average productivity of the economic union is given by

$$B \doteq \frac{1}{J} \sum_{j=1}^{J} B_j. \tag{3}$$

Technology (1), (2) and (3) has the useful property that with symmetry throughout the regions, $n_j = n$ for all j, total consumption is determined by

$$C \Big|_{n_j = n} = JnB. \tag{4}$$

Because consumption per region, C/J, is then independent of the size J of the economic union, there are no scale effects on consumption. In this case, economic integration is motivated only by rents in the goods or labor market.

3.2 Households

All households in the economic union share the same preferences and take income, the prices and the interest rate r as given. Thus, they all behave as if there were a single representative household for the whole economic

[4] With some complication, it is possible to use a CES function here for the same purpose.

union. The household chooses its flow of consumption C to maximize its utility starting at time T,

$$\int_T^{\infty} (\log C) e^{-\rho(\theta - T)} d\theta,$$

where θ is time, C consumption and $\rho > 0$ the constant rate of time preference. Noting (2), this utility maximization leads to the Euler equation[5]

$$\dot{\mathcal{E}}/\mathcal{E} = r - \rho \quad \text{with} \quad \mathcal{E} \doteq pC = p \sum_{j=1}^{J} y_j, \tag{5}$$

where p the consumption price, $\mathcal{E}$ total consumption expenditure, r the interest rate and $\dot{\mathcal{E}} = d\mathcal{E}/dt$. Because in the model there is no money that would pin down the nominal price level at any time, it is convenient to normalize the households' total consumption expenditure in the economic union, $\mathcal{E}$, at the constant number J of regions.[6] This and (5) yield

$$\mathcal{E} = J, \quad p = \mathcal{E} \Big/ \sum_{j=1}^{J} y_j = J \Big/ \sum_{j=1}^{J} y_j, \quad r = \rho = \text{constant} > 0. \tag{6}$$

3.3 The labor market

Skilled labor is used both in production and R&D, but unskilled labor only in production. I assume that technology in production is characterized by the CES unit cost function

$$c(w_j, v_j), \;\; c_w > 0, \;\; c_v > 0, \;\; c_{ww} < 0, \;\; c_{vv} < 0, \;\; c_{wv} > 0. \tag{7}$$

where v_j and w_j are the wages for skilled and unskilled labor, respectively, and the subscripts w and v denote the partial derivatives with respect to w_j and v_j, respectively. Following empirical evidence, I assume that the elasticity of substitution between skilled and unskilled labor is less than one:

$$\frac{cc_{wv}}{c_w c_v} < 1. \tag{8}$$

[5]Cf. Grossman and Helpman (1994b).

[6]With this normalization, the equilibrium price p and the equilibrium wage w are independent of the size of the economic union, J.

The market for skilled labor is competitive, but I characterize labor market regulation by the assumption that the planner sets the minimum wage w_j for unskilled labor. By duality, the equilibrium condition for the market of skilled labor and the full-employment constraint for unskilled labor can be constructed as follows:

$$L = c_v(w_j, v_j)n_j + l_j = c_v(w_j/v_j, 1)n_j + l_j, \tag{9}$$

$$N \geq c_w(w_j, v_j)n_j = c_w(w_j/v_j, 1)n_j, \tag{10}$$

where n_j composite labor input in production, and l_j labor input in R&D.

4 Firms

4.1 Competition in the product market

Following Dixit (1986), I assume that each firm j anticipates the reaction of the other firms $k \neq j$ by

$$dy_k/dy_j = \varphi\, y_k/y_j \text{ for } k \neq j, \tag{11}$$

where $\varphi \in (0,1)$ is a measure of the firms' market power. If $\varphi = 0$, the firms behave in Cournot manner, taking each others' output level as given. The higher φ, the more the firms can coordinate their actions and the higher price they can charge. The planner can decrease (increase) φ by intensifying (weakening) its competition and anti-trust policies. The product market is fully deregulated for $\varphi = 0$.

I assume, for simplicity, uniform initial productivity in the economic union, $B_k^0 = B^0$ for all k. This implies symmetry, $y_k = y$ for all k. Noting (6) and (11), the inverse of the anticipated price elasticity of demand for firm j is then

$$\begin{aligned} \phi(J,\varphi) &\doteq -\left[\frac{y_j}{p}\frac{dp}{dy_j}\right]_{y_k=y} = \left[\frac{y_j}{\sum_{k=1}^J y_k}\frac{d\sum_{k=1}^J y_k}{dy_j}\right]_{y_k=y} = \frac{1}{J}\left[\sum_{k=1}^J \frac{dy_k}{dy_j}\right]_{y_k=y} \\ &= \frac{1}{J}\left[1 + \varphi\sum_{k\neq j}\frac{y_k}{y_j}\right]_{y_k=y} = \frac{1+(J-1)\varphi}{J} = (1-\varphi)\frac{1}{J} + \varphi \geq \frac{1}{J} \\ &\text{with } \partial\phi/\partial J = (\varphi-1)/J^2 < 0 \text{ and } \partial\phi/\partial\varphi = 1 - 1/J > 0. \end{aligned} \tag{12}$$

Firm j maximizes its profit $\pi_j \doteq py_j - c(w_j, v_j)n_j$, where y_j is output, by its labor input n_j holding the production workers' wage w_j and productivity B_j constant, given the production function (1) and the price elasticity of the demand for output, (12). Noting (6), this maximization yields the equilibrium conditions

$$\begin{aligned}
&c(w_j, v_j) = \left[p + y_j \frac{dp}{dy_j}\right] B_j = (1-\phi)pB_j = \frac{(1-\phi)J}{\sum_{j=1}^{J} y_j} B_j, \\
&\pi_j = py_j - c(w_j, v_j)n_j = py_j - (1-\phi)pB_j n_j = \phi p y_j, \\
&c(w_j, v_j)n_j / \pi_j = 1/\phi - 1, \\
&\sum_{j=1}^{J} c(w_j, v_j)n_j = (1-\phi)p \sum_{j=1}^{J} y_j = (1-\phi)J, \quad \sum_{j=1}^{J} \pi_j = \phi p \sum_{j=1}^{J} y_j = \phi J.
\end{aligned} \tag{13}$$

The firms' and workers' income shares are equal to ϕ and $(1-\phi)$, respectively. Given (12), a decrease in firms' market power φ or an increase in the size J of the union intensifies competition and decreases the firm's share ϕ.

Results (13) show that labor input in production, n_j, can be constant, provided that the wage w_j and the profit π_j change in the same proportion. Without this property, there could not be a steady state in the model.

4.2 Research and development (R&D)

Technological change for firm j is characterized by a Poisson process q_j as follows. During a short time interval $d\theta$, there is an innovation $dq_j = 1$ with probability $\Lambda_j d\theta$, and no innovation $dq_j = 0$ with probability $1 - \Lambda_j d\theta$, where Λ_j is the arrival rate of innovations in the research process. The arrival rate Λ_j is in fixed proportion λ to labor devoted to R&D, l_j,

$$\Lambda_j = \lambda l_j, \quad \lambda > 0. \tag{14}$$

I denote the serial number of technology in region j by t_j and variables depending on technology t_j by superscript t_j. The invention of a new technology raises t_j by one and the level of productivity $B_j^{t_j}$ by $a > 1$. Hence,

$$B_j^{t_j} = B_j^0 a^{t_j}. \tag{15}$$

During a short time interval $d\theta$, there is a change in technology from t_j to t_j+1 with probability $\Lambda_j d\theta$, and no change with probability $1-\Lambda_j d\theta$, where Λ_j is given by (14). The average growth rate of the level of productivity (15) in the stationary state is in fixed proportion ($\lambda \log a$) to labor in R&D, l_j (cf. Aghion and Howitt 1998, p. 59). This leads to the following conclusion:

Proposition 1 *Research input l_j can be used as a proxy of the growth rate in region j and the average research input $l = \frac{1}{n}\sum_{j=1}^{n} l_j$ as a proxy of the growth rate for the whole economic union.*

Firm j's dividends are given by

$$\Pi_j = \pi_j - v_j l_j, \tag{16}$$

where π_j is profit, v_j the skilled workers' wage, l_j labor devoted to R&D and $v_j l_j$ expenditures on R&D in region j. Firm j maximizes the present value of its dividends (16) by its input to R&D, l_j, subject to technological change, given the wage v_j. The value of firm j's optimal program at time T is

$$\Omega(t_j, v_j, \pi_j) = \max_{l_j s.t.(14),(16)} E \int_T^{\infty} \Pi_j e^{-r(\theta-T)} d\theta, \tag{17}$$

where θ is time, E the expectation operator and r the interest rate. In the Appendix, I prove the following:

$$\Pi_j/\pi_j = 1 + (1-a)\lambda l_j/r, \quad v_j = (a-1)\lambda \pi_j/r, \tag{18}$$

$$w_j/v_j = \Upsilon(\phi, l_j), \quad \partial\Upsilon/\partial\phi < 0, \quad \partial\Upsilon/\partial l_j > 0,$$

$$n_j = \Delta(\phi, l_j), \quad \partial\Delta/\partial\phi > 0, \quad \partial\Delta/\partial l_j < 0, \tag{19}$$

$$N \geq \Theta(\phi, l_j), \quad \partial\Theta/\partial\phi > 0, \quad \partial\Theta/\partial l_j < 0, \tag{20}$$

where the inequality (20) is the new form of the full-employment constraint for unskilled labor, (10).

5 The economic union

I consider a symmetric equilibrium with $B_j^0 = B^0$, in which case

$$n_j = n,\ l_j = l,\ w_j = w,\ v_j = v \text{ and } \pi_j = \pi.$$

In that equilibrium, the full-employment constraint (20) changes into

$$N \geq \Theta(\phi, l), \quad \partial\Theta/\partial\phi > 0 \text{ if } \partial\Theta/\partial l < 0. \tag{21}$$

From (13) and (20) it follows that

$$\begin{aligned} c(w,v)n &= \frac{1}{J}\sum_{j=1}^{J} c(w_j, v_j)n_j = 1-\phi, \quad \pi = \frac{1}{J}\sum_{j=1}^{J}\pi_j = \phi, \\ c(w,v)n + vl &= c(w,v)n + (a-1)\lambda l\pi/r = 1-\phi+(a-1)\lambda l\phi/r \\ &= 1-[1+(1-a)\lambda l/r]\phi. \end{aligned} \tag{22}$$

By (1), (6), (18) and (20), I define the present value of the expected flow of real income per region, y, as (cf. Aghion and Howitt 1998, p. 61)

$$\begin{aligned} \Psi(l,\phi) &\doteq E\int_T^\infty \frac{1}{p}e^{-r(\theta-T)}d\theta = E\int_T^\infty \left(\frac{1}{J}\sum_{j=1}^{J} y_j\right)e^{-r(\theta-T)}d\theta \\ &= E\int_T^\infty ye^{-r(\theta-T)}d\theta = E\int_T^\infty Bne^{-r(\theta-T)}d\theta = \frac{B(T)n}{r+(1-a)\lambda l} \\ &= \frac{B(T)\Theta(\phi,l)}{r+(1-a)\lambda l}, \quad \frac{\partial\Theta}{\partial l_j} < 0 \;\Leftrightarrow\; \frac{\partial\Theta}{\partial\phi} > 0 \;\Leftrightarrow\; \frac{\partial\Psi}{\partial\phi} > 0. \end{aligned} \tag{23}$$

From (19) and (22) it follows that

$$(1-\phi)/w = c(1, v/w)n = c\big(1, 1/\Upsilon(\phi,l)\big)\Delta(\phi,l).$$

Differentiating the logarithm of this equation totally, and noting (19), one obtains that skilled labor devoted to R&D, l, is an increasing function of the minimum wage for unskilled labor, w:

$$\frac{dl}{dw} = \underbrace{\frac{c_v}{c\Upsilon^2}}_{+}\underbrace{\frac{\partial\Upsilon}{\partial l}}_{+} - \underbrace{\frac{1}{\Delta}}_{+}\underbrace{\frac{\partial\Delta}{\partial l}}_{-} > 0. \tag{24}$$

The workers and the firms lobby the planner which decides on the firms' market power φ, the minimum wage $w_j = w$ for unskilled labor and new members of the economic union (i.e. the size J of the union) in the limits of the inequality $\varphi \geq 0$ and the full-employment constraint (21). Thus, the state variables of the lobbying equilibrium are (φ, w, J). Noting the one-to-one correspondences (12) and (24), the firms' market power φ and the minimum wage w can be replaced by the firms' income share ϕ and labor devoted to R&D, l, as the control variables. The constraints for these state variables are given by $\phi \geq 1/J$ and (21). In this setting, the product market is regulated when the firms are able to cooperate in price settlement, $\phi > 1/J$, and deregulated when they behave in Cournot manner $\phi = 1/J$, and the labor market is regulated with unemployment $N > \Theta(\phi, l)$ and deregulated with full employment $N = \Theta(\phi, l)$.

The wages in the economic union are equal to total labor costs in production, $c(w, v)n$, plus those in R&D, vl. Following Grossman and Helpman (1994a), I assume that the planner has its own interests and collects contributions R_u and R_f from the worker and employer lobbies. A member of the worker lobby earns wages $c(w, v)n + vl$ minus political contributions R_u. A member of the employer lobby earn dividends Π minus political contributions R_f. Because the effects through the the price level p can be internalized at the level of the economic union, the worker lobby maximizes the present value $\mathcal{U}$ of the expected flow of a typical worker's real income $[c(w, v)n+vl-R_u]/p$, and the employer lobby maximizes the present value $\mathcal{F}$ of the expected flow of a typical firm's real dividends $(\Pi - R_f)/p$ at time T. Noting (18), (22) and (23), these targets can be defined as follows:

$$\begin{aligned} \mathcal{U}\Big(l, \phi(J, \varphi), R_u\Big) &\doteq E\int_T^\infty \frac{c(w, v)n + vl - R_u}{p} e^{-r(\theta - T)} d\theta \\ &= \Psi[c(w, v)n + vl - R_u] \\ &= \Psi(l, \phi)\big\{1 - [1 + (1-a)\lambda l/r]\phi - R_u\big\}, \qquad (25) \\ \mathcal{F}\Big(l, \phi(J, \varphi), R_u\Big) &\doteq E\int_T^\infty \frac{\Pi - R_f}{p} e^{-r(\theta - T)} d\theta = \Psi[\Pi - R_f] \\ &= \Psi\big\{[1 + (1-a)\lambda l/r]\pi - R_f\big\}, \qquad (26) \end{aligned}$$

where

$$\mathcal{U}(l, \phi, R_f) + \mathcal{F}(l, \phi, R_f) = (1 - R_u - R_f)\Psi(l, \phi). \qquad (27)$$

Noting (23), the present value the expected flow of the real political contributions at time T is given by

$$E\int_T^\infty \frac{R_u + R_f}{p} e^{-r(\theta - T)} d\theta = \Psi(l, \phi)(R_u + R_f). \qquad (28)$$

Given this and (27), I specify the planner's utility function as follows:

$$\begin{aligned} & G\Big(l, \phi(J, \varphi), R_u, R_f\Big) = G(l, \phi, R_u, R_f) \\ & \doteq E \int_T^{\infty} \frac{R_u + R_f}{p} e^{-r(\theta - T)} d\theta + \zeta_w \mathcal{U}(l, \phi, R_u) + \zeta_f \mathcal{F}(l, \phi, R_f) \\ & = \Psi(l, \phi)(R_u + R_f) + \zeta_w \mathcal{U}(l, \phi, R_u) + \zeta_f \mathcal{F}(l, \phi, R_f) \\ & = \Psi(l, \phi) + (\zeta_w - 1)\mathcal{U}(l, \phi, R_u) + (\zeta_f - 1)\mathcal{F}(l, \phi, R_f), \end{aligned} \tag{29}$$

where constants $\zeta_w \geq 0$ and $\zeta_f \geq 0$ are weights of the worker's and the firm's welfare in the government's preferences, respectively.

Grossman and Helpman's (1994a) objective function (29) is widely used in models of common agency and it has been justified as follows. The politicians are mainly interested in their own income which consists of the contributions from the public, $R_u + R_f$, but because they must defend their position in general elections, they must sometimes take the utilities of the interest groups $\mathcal{U}(l, \phi, R_u)$ and $\mathcal{F}(l, \phi, R_f)$ into account directly. The linearity of (29) in $\Psi[R_u + R_f]$ is assumed, for simplicity.

6 The political equilibrium

The workers' and employers' lobbies try to affect the planner by their contributions R_u and R_f. The contribution schedules are therefore functions of the planner's policy variables:

$$R_u(l, \phi), \quad R_f(l, \phi). \tag{30}$$

The planner maximizes its utility function (29) by (l, ϕ), given the contribution schedules (30) and the constraints (12) and (21). Following proposition 1 of Dixit, Grossman and Helpman (1997), a subgame perfect Nash equilibrium for this game is a set of contribution schedules $R_u(l, \phi)$ and $R_f(l, \phi)$ and policy (l, ϕ) such that the following conditions $(i) - (iv)$ hold:

(i) Contributions R_u and R_f are non-negative but no more than the contributor's income.

(ii) The policy (ϕ, l) maximizes the planner's welfare (29) taking the contribution schedules R_u and R_f as given,

$$(l,\phi) \in \arg \max_{(l,\phi) \text{ s.t. (12) and (21)}} G(l,\phi,R_u\big(l,\phi),R_f(l,\phi)\big);$$

(iii) The worker lobby (employer lobby) cannot have a feasible strategy $R_u\big(l,\phi\big)$ $(R_f\big(l,\phi\big))$ that yields it a higher level of utility than in equilibrium, given the planner's anticipated decision rule,

$$\begin{aligned}(l,\phi) &= \arg \max_{(l,\phi) \text{ s.t. (12) and (21)}} \mathcal{U}\big(l,\phi,R_u(l,\phi)\big),\\ (l,\phi) &= \arg \max_{(l,\phi) \text{ s.t. (12) and (21)}} \mathcal{F}\big(l,\phi,R_f(l,\phi)\big).\end{aligned} \tag{31}$$

(iv) The worker lobby (employer lobby) provides the planner at least with the level of utility than in the case it offers nothing $R_u = 0$ $(R_f = 0)$, and the planner responds optimally given the other lobby's contribution function,

$$\begin{aligned}G\big(l,\phi,R_u(l,\phi),R_f(l,\phi)\big) &\geq \max_{(l,\phi) \text{ s.t. (12) and (21)}} G\big(l,\phi,R_u(l,\phi),0\big),\\ G\big(l,\phi,R_u(l,\phi),R_f(l,\phi)\big) &\geq \max_{(l,\phi) \text{ s.t. (12) and (21)}} G\big(l,\phi,0,R_f(l,\phi)\big).\end{aligned}$$

Noting (30) and (31), the planner's utility function (29) changes into

$$\begin{aligned}\mathcal{G}(l,\phi) &\doteq G(l,\phi,R_u(l,\phi),R_f(l,\phi))\\ &= \Psi(l,\phi) + (\zeta_w - 1) \max_{(l,\phi) \text{ s.t. (12) and (21)}} \mathcal{U}(l,\phi,R_u(l,\phi))\\ &\quad + (\zeta_f - 1) \max_{(l,\phi) \text{ s.t. (12) and (21)}} \mathcal{F}(l,\phi,R_f(l,\phi)),\\ \partial\mathcal{G}/\partial l &= \partial\Psi/\partial l, \quad \partial\mathcal{G}/\partial\phi = \partial\Psi/\partial\phi.\end{aligned} \tag{32}$$

The Lagrangean for the maximization of the planner's utility function (32) by (l,ϕ) subject to the elasticity constraint (12) and the full-employment constraint (21) is given by

$$\mathcal{H} = \mathcal{G}(l,\phi) + \eta[\phi - 1/J] + \varepsilon[N - \Theta(\phi,l)], \tag{33}$$

where the multipliers ε and ϑ are subject to the Kuhn-Tucker conditions

$$\eta[\phi - 1/J] = 0, \quad \eta \geq 0, \quad \varepsilon[N - \Theta(\phi,l)] = 0, \quad \varepsilon \geq 0. \tag{34}$$

Noting (20), (23), (32) and (33), the first-order conditions for the maximization of the planner's utility are the following:

$$\frac{\partial \mathcal{H}}{\partial \phi} = \frac{\partial \mathcal{G}}{\partial \phi} + \eta - \varepsilon \frac{\partial \Theta}{\partial \phi} = \frac{\partial \Psi}{\partial \phi} + \eta - \varepsilon \frac{\partial \Theta}{\partial \phi} = 0, \quad (35)$$

$$\frac{\partial \mathcal{H}}{\partial l} = \frac{\partial \mathcal{G}}{\partial l} - \varepsilon \frac{\partial \Theta}{\partial l} = \frac{\partial \Psi}{\partial l} - \varepsilon \frac{\partial \Theta}{\partial l} = 0. \quad (36)$$

7 Economic integration

If the size of the union, J, is small, then $\phi = 1/J$. In that case, by (33) and (34), $\eta > 0$ and $\partial \mathcal{H}/\partial J = \eta/J^2 > 0$ hold true. If the union is large enough, $J > 1/\phi$, then , and by (23), (34), (35) and (36), it is true that

$$\phi > \frac{1}{J}, \quad \eta = 0, \quad \varepsilon = \frac{\partial \Psi}{\partial \phi} \Big/ \frac{\partial \Theta}{\partial \phi} > 0, \quad N = \Theta,$$

and $\partial \mathcal{H}/\partial J = \eta/J^2 \equiv 0$. These results can be rephrased as follows:

Proposition 2 *The planner has no incentives to prevent economic integration (i.e. the increase of J), $\partial \mathcal{H}/\partial J = \eta/J^2 \geq 0$. In a small union, the product market is deregulated ($\phi = 1/J$). In a large union, the product market is regulated ($\phi > 1/J$) and the labor market deregulated ($\Theta = N$).*

Both current income and the growth rate increase the planner's welfare. Because integration increases competition and improves efficiency, it does not harm the planner. Since competition increases the demand for labor in production, then, in a large union with product market deregulation, a large proportion of labor is devoted to production and only a small proportion to R&D. Because this leaves very little space for R&D and economic growth, the planner must relax product market deregulation and allow firms to cooperate. For the reason that product market regulation boosts economic growth, labor market regulation is no more needed for that purpose. Consequently, in a large union, the labor market is deregulated to increase current income.

In a small economic union with product market deregulation $\phi = 1/J$, noting (20), (23), (34), (35) and (36), there are two possibilities:

(a) The present value of the expected flow of real income, Ψ, does not attain its maximum in the unemployment regime:

$$\frac{\partial \Psi}{\partial l} < 0, \;\; \Theta(1/J, l) = N, \;\; \varepsilon = \underbrace{\frac{\partial \Psi}{\partial l}}_{-} \bigg/ \underbrace{\frac{\partial \Theta}{\partial l}}_{-} > 0.$$

In that case, the labor market is deregulated.

(b) The present value of the expected flow of real income, Ψ, attains its maximum in the unemployment regime: $\Theta < N$, $\varepsilon = 0$,

$$\frac{\partial \Psi}{\partial l} = 0, \quad 0 = \frac{\partial \log \Psi}{\partial l} = \underbrace{\frac{1}{n}}_{+} \underbrace{\frac{\partial \Theta}{\partial l}}_{-} + \underbrace{\frac{\overbrace{(a-1)}^{+}\lambda}{r + (1-a)\lambda l}}_{+}.$$

In that case, the labor market is regulated.

Together with Proposition 2, these results can be rephrased as follows:

Proposition 3 *In a small union with product market deregulation, the labor market is either deregulated or regulated. When the product market is deregulated and the labor market regulated, economic integration will reverse this at some stage so that the product market will be regulated and the labor market deregulated.*

8 Conclusions

This paper examines an economic union with a large number of regions, each producing a different good. The union expands by integrating new regions. Firms improve their productivity through investment in R&D. The less there are firms in the union or the more they can coordinate their actions, the more they earn profits. Both workers and firms lobby the planner which determines the minimum wage for unskilled workers and the firms' market power and decides on new members to the union. The main findings of the paper can be summarized the follows.

High current income and a high growth rate increase the planner's welfare. Labor and product market regulation are growth-enhancing as follows:

(a) A higher minimum wage increases the unit cost of production and decreases output and income. With a higher unit cost of production, the firms have more incentives to increase productivity through R&D. This speeds up R&D and economic growth.

(b) Producer market power decreases production and income. With labor market deregulation (i.e. with full employment), this transfers labor from production to R&D. Consequently, R&D and the growth rate increase.

In a small economic union, there is very little competition and high producer market power even without product market regulation. In that case, the planner has to deregulate the product market in order to raise income. Because integration promotes competition and increases the demand for labor in production, then, in a large union with product market deregulation, a large proportion of labor is devoted to production and only a small proportion to R&D. Consequently, there is very little space for R&D and growth, and the planner must relax product market deregulation. Because product market regulation boosts economic growth, labor market regulation is no more needed for that purpose. Consequently, in a large union, the labor market is deregulated to increase current income.

Appendix

From (13) and (15) it follows that

$$\pi_j^{t_j+1}/\pi_j^{t_j} = B_j^{t_j+1}/B_j^{t_j} = a. \tag{37}$$

The Bellman equation corresponding to (17) is given by[7]

$$\begin{aligned} r\Omega(t_j, v_j, \pi_j) &= \max_{l_j}\Big\{\Pi_j + \Lambda_j\big[\Omega(t_j+1, v_j, \pi_j) - \Omega(t_j, v_j, \pi_j)\big]\Big\} \\ &= \max_{l_j}\Big\{\pi_j - v_j l_j + \lambda l_j\big[\Omega(t_j+1, v_j, \pi_j) - \Omega(t_j, v_j, \pi_j)\big]\Big\}. \end{aligned} \tag{38}$$

The first-order condition corresponding to this is given by

$$\lambda\big[\Omega(t_j+1, v_j, \pi_j) - \Omega(t_j, v_j, \pi_j)\big] = v_j. \tag{39}$$

[7]cf. Dixit and Pindyck (1994), Wälde (1999).

I try the solution

$$\Pi_j = \beta_j \pi_j, \quad \beta_j \in (0,1), \quad \Omega = \Pi_j/\delta_j, \tag{40}$$

in which dividends Π_j is in fixed proportion β_j to profits π_j, and the subjective discount factor $\delta_j > 0$ is independent of income π_j. Given (37) and (40), one obtains

$$\widetilde{\Omega} \doteq \Omega(t_j+1, v_j, \pi_j) = \beta_j \pi_j^{t_j+1}/\delta_j = a\beta_j \pi_j^{t_j}/\delta_j = a\Omega(t_j, v_j, \pi_j). \tag{41}$$

Inserting this and (40) into (38), one obtains

$$r = \Pi_j/\Omega + \lambda l_j \big(\widetilde{\Omega}/\Omega - 1\big) = \delta_j + (a-1)\lambda l_j$$

and

$$\delta_j = r + (1-a)\lambda l_j > 0. \tag{42}$$

From (40) and (16) it follows that

$$v_j l_j = \pi_j - \Pi_j = (1/\beta_j - 1)\Pi_j = (1-\beta_j)\pi_j. \tag{43}$$

Inserting (40), (41), (42) and (43) into (39), one obtains

$$\begin{aligned}(a-1)\lambda = \lambda(\widetilde{\Omega}/\Omega - 1) = v_j/\Omega = v_j\delta_j/\Pi_j = (1/\beta_j - 1)\delta_j/l_j \\ = (1/\beta_j - 1)[r/l_j + (1-a)\lambda].\end{aligned}$$

Noting (14), (40), (42), this equation defines the function

$$\Pi_j/\pi_j = \beta_j = 1 + (1-a)\lambda l_j/r > 0. \tag{44}$$

Inserting this into (43) yields

$$v_j = (1-\beta_j)\pi_j/l_j = (a-1)\lambda \pi_j/r. \tag{45}$$

Noting (7), (13), (43) and (44), one obtains

$$\begin{aligned}n_j &= \Big(\frac{1}{\phi} - 1\Big)\frac{\pi_j}{c(w_j, v_j)} = \Big(\frac{1}{\phi} - 1\Big)\frac{\pi_j}{v_j}\frac{v_j}{c(w_j, v_j)} = \frac{(1/\phi - 1)l_j}{1-\beta_j}\frac{v_j}{c(w_j, v_j)} \\ &= \frac{1/\phi - 1}{(a-1)\lambda}\frac{r}{c(w_j/v_j, 1)}.\end{aligned}$$

This implies

$$\log n_j = \log(1-\phi) - \log\phi - \log c(w_j/v_j, 1) - \log[(a-1)\lambda/r]. \tag{46}$$

Differentiating the full-employment condition for skilled labor, (9), and equation (46) totally, one obtains

$$\begin{pmatrix} n_j c_{wv} & c_v \\ c_w/c & 1/n_j \end{pmatrix} \begin{pmatrix} d(w_j/v_j) \\ dn_j \end{pmatrix} = -\begin{pmatrix} 1 & 0 \\ 0 & 1/[(1-\phi)/\phi] \end{pmatrix} \begin{pmatrix} dl_j \\ d\phi \end{pmatrix},$$

where, by (8), it is true that

$$\mathcal{A} \doteq \begin{vmatrix} n_j c_{wv} & c_v \\ c_w/c & 1/n_j \end{vmatrix} = c_{wv} - \frac{c_w c_v}{c} = \underbrace{\frac{c_w c_v}{c c_{wv}}}_{+} \underbrace{\left[\frac{c c_{wv}}{c_w c_v} - 1\right]}_{-} < 0.$$

This defines the functions

$$\frac{w_j}{v_j} = \Upsilon(\phi, l_j), \quad \frac{\partial \Upsilon}{\partial \phi} = \frac{c_v}{(1-\phi)\phi\mathcal{A}} < 0, \quad \frac{\partial \Upsilon}{\partial l_j} = -\frac{1}{n_j \mathcal{A}} > 0, \tag{47}$$

$$n_j = \Delta(\phi, l_j), \quad \frac{\partial \Delta}{\partial \phi} = -\frac{n_j c_{wv}}{(1-\phi)\phi\mathcal{A}} > 0, \quad \frac{\partial \Delta}{\partial l_j} = \frac{c_w}{c\mathcal{A}} < 0. \tag{48}$$

Given (47), the full-employment constraint (10) changes into

$$N \geq c_w\big(\Upsilon(\phi, l_j), 1\big)\Delta(\phi, l_j) \doteq \Gamma(\phi, l_j) \doteq \Theta(\phi, l_j),$$
$$\frac{\partial \Theta}{\partial \phi} = \underbrace{c_{ww}}_{-} \underbrace{\frac{\partial \Upsilon}{\partial \phi}}_{-} + \underbrace{c_w}_{+} \underbrace{\frac{\partial \Delta}{\partial \phi}}_{+} > 0, \quad \frac{\partial \Theta}{\partial l_j} = \underbrace{c_{ww}}_{-} \underbrace{\frac{\partial \Upsilon}{\partial l_j}}_{+} + \underbrace{c_w}_{+} \underbrace{\frac{\partial \Delta}{\partial l_j}}_{-} < 0. \tag{49}$$

Results (44), (45), (47), (48) and (49) prove (18) and (20).

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