Schumpeterian Growth, Unemployment and Tax/Benefit system in European Countries

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Abstract

This paper analyzes how the frictions in the labor market simultaneously affect the economic growth and the long run unemployment. To this goal, we develop a schumpeterian model of endogenous growth: agents have the choice of being employed in production or being engaged in R&D activities. Unemployment is caused by the wage-setting behavior of unions. We show that: *(i)* Elevate labor costs or powerful trade unions lead to bigger unemployment and to a slowdown of the economic growth. *(ii)* Efficient bargain allows to higher employment, at the price of a lower growth rate. Finally, we suggest a way to reach the optimal rate of growth. *JEL*: E24, F43, J21.
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Introduction

The observed high unemployment in continental Europe and the slowdown in economic growth in the lasts decades naturally raise the question of whether these two phenomena are related. On the empirical side, there is no consensus regarding the sign of the correlation between growth and unemployment, either across countries or across longer periods of time in the same country.[1] The same is true on the theoretical side.[2] Nevertheless, the endogenous growth theory and the equilibrium unemployment theory suggest that the distortions due to fiscal instruments lead to a lower growth or to a higher unemployment rate. This suggests that the link between growth and unemployment can be viewed through the simultaneous link between growth, unemployment and labor market institutions.

Against this background enhancing the explicative role of labor-market variables on the bad performance of European countries, in this paper we construct a theoretical economy to analyze the effects of labor market institutions on growth and equilibrium unemployment. The main hypotheses of our model are the following: *(i)* Innovations are the engine of growth. This implies a "creative destruction" process generating jobs reallocation. *(ii)* Agents have the choice of being employed in production or being engaged in R&D activities; and *(iii)* there is no full employment because the trade union representing the workers' interests sets the wage rate above the competitive level. We show that: *(i)* Powerful trade unions or higher labor costs associated to increases in one or more of the labor-market variables (*e.g.*, the unemployment compensation, the payroll taxes payed by employers, the taxes payed by workers or the cost of employment protection) cause more unemployment and the slowdown of the economic growth. *(ii)* A coordinated bargaining process increases employment, at the price of a lower growth rate. These theoretical predictions are consistent with the empirical results of Adjemian, Langot, and Quintero-Rojas (2006) and Daveri, Tabellini, Bentolila, and Huizinga (2000).

The paper is organized as follows. Section 1 describes the model. Section 2 presents the analysis of the impact of labor market institutions on growth and unemployment. This section also shows the welfare analysis.

[1]See Mortensen (2004) for a wide review of the empirical literature, which shows the diversity of results about the correlation between growth and unemployment.

[2]This is due to the offsetting nature of two main effects: a higher rate of growth in productivity will reduce unemployment trough a positive "capitalization" effect on investment in job creation; whereas the "creative destruction effect", inherent to the growth process, leads to a faster obsolescence of technologies and so to a faster rate of job destruction.

1 The model

1.1 Preferences

We assume that the economy is populated by L agents. Each agent is endowed with one unit flow of labor, so L is also equal to the aggregate flow of labor supply. They may be employed in production (x), engaged in research and development activities (n) or unemployed (u): $L = x + n + u$. When employed, workers pay a tax t on their labor income.

All individuals have the same linear preferences over lifetime consumption C of a single final good:

$$U(C) = E_0 \int_0^{\infty} C_t e^{-\rho t} dt \tag{1}$$

where $\rho > 0$ is the subjective rate of time preference and C_t is the individual's consumption of the final good at time t. Each household is free to borrow and lend at interest rate r_t. However, given linear preferences, the optimal household's behavior implies $\rho = r_t$ $\forall t$. Hence, the level of consumption is undefined. A standard solution to this problem is to assume that households consume all their wage income without saving. Under this assumption we can analyze the impact of the unemployment benefit system.

1.2 Final-good sector

The final good is produced by perfectly competitive firms that use the latest vintage of a unit continuum of intermediate inputs,[3]

$$C = \int_0^1 A_j x_j^{\alpha} dj, \quad 0 < \alpha < 1, \quad j \in [0, 1] \tag{2}$$

A_j represents the productivity of the latest vintage of intermediate good j and is determined by the number of technical improvements realized up to date t, knowing that between two innovations the gain in productivity is equal to $q > 1$ (step size).

Taking the final good as *numéraire* the profits flow is equal to

$$C - \int_0^1 p(x_j) x_j dj$$

[3]We omit the time index since between two innovations all is constant.

1.3 Intermediate-goods sector

Production of one unit of intermediate good j requires one unit of labor as input: $x_j = x_j$.

Since the final-good sector is perfectly competitive, the price of the intermediate good j, $p(x_j)$, is equal to the value of its marginal product:

$$p(x_j) = \frac{\partial C}{\partial x_j} = \alpha A_j x_j^{\alpha-1} \quad \forall j \tag{3}$$

1.4 R&D sector

Technological spillovers lead to good-specific public knowledge allowing to the potential innovators to begin their efforts to improve upon the current "state of the art". But there are no spillovers between sectors. Then, when an amount n_j of labor is used in R&D on good j, innovations arrive randomly at a Poisson rate hn_j, with $h > 0$ a parameter indicating the productivity of the research technology: a potential entrant obtains ideas for new products at frequency h per period. Albeit the innovation frequencies are independent across goods, the expected gains are the same everywhere, hence $\forall j \; n_j = n \quad \Rightarrow \quad A_j = A$.

1.5 Arbitrage condition for innovators

At the "state of the art" v, the aggregate number of potential innovators is given by the arbitrage condition faced by workers:

$$\frac{(1-t)W_{j,v}}{h} = V_{j,v+1} \tag{4}$$

The cost of *R&D* can be viewed as an opportunity cost: the income that the individual loses $(1-t)W_{j,v}$ times the expected duration of the innovation process $1/h$. On the other hand, $V_{j,v+1}$ is the discounted expected payoff of next innovation on sector j,[4] and is determined by the asset equation:

$$rV_{j,v+1} = \Pi_{j,v+1} - hn_{v+1}(V_{j,v+1} + E_{v+1}) \tag{5}$$

$\Pi_{j,v+1}$ are the monopolistic profits earned by the successful innovator, who gets a patent on her innovation, from the sales to the final-good sector until the arrival of next innovation. We assume that the employment protection laws imply a cost E of shutting down a firm, and

[4]Equivalently, the entry condition also reflects the fact that labor can be freely allocated between production and research: $(1-t)W_{j,v}$ is the net value of an hour in production while $hV_{j,v+1}$ is the expected value of an hour in research.

that the monopolist pays a proportional payroll tax τ over employment. Then,

$$\Pi_{j,v+1} = \alpha A_{v+1} x_{j,v+1}^{\alpha} - W_{j,v+1}(1+\tau)x_{j,v+1} \tag{6}$$

so, the expected income generated by a patent on an innovation is equal to the instantaneous profit minus the expected capital loss that will occur when the current innovator is replaced by a new innovator (the flow probability of the profits loss is the arrival rate hn_{v+1} which is the same for all j, as was argued above). Normalizing the lasts expressions by the productivity level associated to the $(v+1)^{th}$ innovation we obtain:

$$\pi_{j,v+1} = \alpha x_{j,v+1}^{\alpha} - w_j(1+\tau)x_{j,v+1} \tag{7}$$

hence the free entry (4) condition becomes:

$$\begin{aligned}(1-t)w_{j,v} &= qhv_{j,v+1} \\ &= \frac{\pi_{j,v+1} - hn_{v+1}e}{r + hn_{\tau+1}}\end{aligned} \tag{8}$$

for $\pi \equiv \frac{\Pi}{A}$, $w \equiv \frac{W}{A}$, $e \equiv \frac{E}{A}$ and $v \equiv \frac{V}{A}$.

1.6 Wage bargaining processes

For each intermediate good sector there is a trade union representing the workers' interests. So the wage rates are the solutions to the bargaining problems between the monopolist and each trade union. We model the bargaining process as a a generalized Nash bargaining game with relative bargaining power β. Given this way of sharing surplus, the union chooses the wage, and the firm chooses the level of employment given this wage (the "right-to-manage" assumption). We assume that all jobs are equally productive and that all workers have the same unemployment benefits so that the wage fixed for each type of job is the same everywhere. But the firm and the trade union in sector j are too small to influence other markets, so the wage rates are settled taking everything else constant.

The union anticipates the labor demand as

$$x_{j,v+1}(w_j) = \arg\max\{\pi_{j,v+1}(x_{j,v+1})\} = \left(\frac{\alpha^2}{(1+\tau)w_j}\right)^{\frac{1}{1-\alpha}}$$

Then, for $0 \leq \beta \leq 1$, the bargained unskilled wage is:

$$\begin{aligned} w_j &= \arg\max\left\{[((1-t)w_j - b)x_{j,v+1}]^{\beta}(\pi_{j,v+1} - hn_{\tau+1}e - \bar{\pi}_{\tau+1})^{1-\beta}\right\} \\ &= \left(1 + \frac{\beta(1-\alpha)}{\alpha}\right)\left(\frac{b}{1-t}\right)\end{aligned}$$

$\bar{\pi}_{\tau+1} \equiv -hn_{\tau+1}e$ denotes the firm's disagreement point and $b \equiv \frac{B}{A}$ the adjusted unemployment compensation.

1.7 Equilibrium

Given $r > 0$, for all intermediate good sector j and for all "state of the art" v a ***steady-state (or balanced growth path) equilibrium*** is defined as follows:

(i) **Wage rule:**

$$w = \frac{\beta_1 b}{1-t}, \quad \beta_1 \equiv 1 + \frac{\beta(1-\alpha)}{\alpha} \tag{9}$$

(ii) **Labor demand for production:**

$$x = \left(\frac{\alpha^2(1-t)}{(1+\tau)\beta_1 b}\right)^{\frac{1}{1-\alpha}} \tag{10}$$

(iii) **Potential Innovators**
From the free entry condition we deduce:

$$n = \left(\frac{1}{h}\right)\left(\frac{qh\pi - r\beta_1 b}{\beta_1 b + qhe}\right) \tag{11}$$

where

$$\pi = \frac{(1-\alpha)(1+\tau)\beta_1 b}{\alpha(1-t)} x \tag{12}$$

(iv) **Unemployment:**
Unemployment u is deduced from the employment identity given the endowment of labor L, the labor demand for production x and the aggregate number of potential innovators n:

$$u = L - x - n \tag{13}$$

(iv) **Economic growth:** The rate of growth in aggregate consumption is given by (see the appendix A):

$$g_t = hn\ln(q) \tag{14}$$

2 The impact of labor market institutions on growth and unemployment

2.1 Passive labor market policies

In this section we analyze the consequences for growth and unemployment of, *(ii)* a more generous unemployment insurance, *(ii)* higher taxes on labor incomes, and *(iii)* employment protection.

Proposition. 1 *An increase in the unemployment compensation (b), or in the payroll taxes (τ), or in the taxes payed by workers (t) or in employment protection (e), leads to (i) an increase in the unemployment and (ii) to a decrease in the rate of growth.*

Proof. a. It is easy to show that:

$$\frac{\partial x}{\partial n}|_{n=b,\tau,t} < 0 \quad \text{and} \quad \frac{\partial \pi}{\partial n}|_{n=b,\tau,t} < 0$$

So,

$$\frac{\partial g}{\partial n}|_{n=b,\tau,t} = \frac{qh\ln(q)}{\beta_1 b + qhe}\frac{\partial \pi}{\partial n}|_{n=b,\tau,t} < 0$$

This result is very intuitive: a higher labor cost implies a higher wage (equation (9)) and so a decline in the labor demand (equation (10)). The total outcome is a contraction of the monopolistic profits with the subsequent reduction in the expected value of an innovation. This, together with the fact that the higher wages make production more attractive with respect to R&D, tends to reduce the number of researchers. Thus, the growth rate falls too.

b. $\frac{\partial x}{\partial e} = 0 \Rightarrow \frac{\partial u}{\partial e} = -\frac{\partial n}{\partial e} > 0$.

Since neither the wage rates or the labor demands change, the only effect is a contraction of the profits. This discourages that workers engage in *R&D* activities, and then the growth rate falls and the unemployment raises.

2.2 The wage bargaining processes

The impact of the unions can be analyzed in two steps. First, for an uncoordinated wage bargaining process, one can derive the implications of a higher bargaining power. Second, we can compare the outcome of an efficient bargaining process with the inefficient outcome computed above.

2.2.1 The bargaining powers

Proposition. 2 *An increase in the unions' bargaining power leads to an increase in the unemployment level and to a decrease in the economic growth.*

Proof. Analogous to the proof of proposition 1: $\frac{\partial x}{\partial \beta} < 0$ and $\frac{\partial \pi}{\partial \beta} < 0$. So, $\frac{\partial g}{\partial \beta} = -\frac{(1-\alpha)\ln(q)}{\beta_1 b + qhe}\left(\frac{\pi}{(1-\alpha)\beta_1} + \frac{(r+hn)b}{\alpha}\right)$.

The economic intuition is the following: a bigger bargaining power implies higher wages. Then the labor demand for production declines, this contracts the monopolistic profits and so the expected value of an innovation. This discourages workers from R&D. The total outcome is more unemployment and lower economic growth.

2.2.2 Inefficient v.s. efficient bargain

If in each sector the monopolistic firm and the trade union bargain over both the labor demand and the wage rate jointly, the outcome is the efficient one (E). That is, the wage and the firm size pairs are the solution to the following problem:

$$(w^E_{j,v+1}, x^E_{j,v+1}) = \arg\max \Big\{ [((1-t)w^E_{j,v+1} - b)x^E_{j,v+1}]^\beta \\ (\pi^E_{j,v+1} - hn^E_{v+1}e - \bar{\pi}^E_{v+1})^{1-\beta} \Big\}$$

The firm's disagreement points and the instantaneous profit flow are respectively:

$$\begin{aligned} \bar{\pi}_{v+1} &\equiv -hn_{v+1}e \\ \pi^E_{j,v+1} &= \alpha(x^E_{v+1})^\alpha - w^E_{j,v+1}(1+\tau)x^E_{j,v+1} \end{aligned}$$

Then at equilibrium, for all j and for all vintage v:

$$w_E = \frac{\beta_1 b}{1-t} \tag{15}$$

$$x_E = \left(\frac{(1-t)\alpha^2}{(1+\tau)b}\right)^{\frac{1}{1-\alpha}} \tag{16}$$

$$n_E = \left(\frac{1}{h}\right)\left(\frac{qh\pi_E - r\beta_1 b}{\beta_1 b + qhe}\right) \tag{17}$$

$$\pi_E = \frac{(1-\alpha\beta_1)(1+\tau)b}{\alpha(1-t)}x_E$$

Proposition. 3 *Under efficient bargaining, employment levels are larger but the rate of economic growth is also lower than under uncoordinated bargaining. However, the comparison is ambiguous for unemployment.*

Proof. It is easy to verify that $x_E = x\beta_1^{\frac{1}{1-\alpha}}$. Since $\beta_1 \geq 1$, then $x \leq x_E$.

On the other hand, $\pi_E < \pi \Rightarrow n_E < n \Rightarrow g_E < g$. Because there are less researchers but more employed in production, we don't know the total effect on u.

The gain in employment for the same labor costs is due to the coordination in the setting of wages and the labor demand for production. Yet, the decreasing returns to research induce a contraction of the monopolistic profits while the opportunity cost of R&D is unchanged. Consequently, there are less researchers under efficient bargaining.

2.3 The impact of growth and unemployment on welfare

Using the employment identities and the relationship $nh = \frac{g}{\ln(q)}$ we rewrite the aggregate welfare (*i.e.* the expected present value of consumption) as (see appendix B for details):

$$E(U) = \frac{A_0(L-u-n)^\alpha}{r - \frac{g(q-1)}{\ln(q)}}$$

Then,

$$\begin{aligned} \frac{\partial E(U)}{\partial g} &= \frac{(q-1)E(U)}{\ln(q)r-(q-1)g} \geq 0 \\ \frac{\partial E(U)}{\partial u} &= -\frac{\alpha E(U)}{x} \leq 0 \end{aligned}$$

This is resumed in the next proposition.

Proposition. 4 *Welfare is increasing in the rate of growth and decreasing in the unemployment rate.*

This result allows us to interpret the links between labor market institutions and growth or unemployment as welfare improving or reducing relationships.

2.4 The optimal economic growth

In order to discuss deeply the impact of labor market institutions on welfare, in this section we derive the average growth rate that would be chosen by a social planner whose objective was to maximize the expected present value of consumption, given by (see appendix B)

$$E(U) = \frac{A_0 x^\alpha}{r - hn(q-1)} \tag{18}$$

Then, the social planner will choose (x, n) to maximize (18) subject to the labor constraint $L = x + n$. This problem is reduced to find the optimal level of research $n*$, such that

$$n^* = \arg\max \left\{ \frac{A_0(L-n)^\alpha}{r - hn(q-1)} \right\} \tag{19}$$

Then,

$$n^* = \frac{1}{1-\alpha}\left(L - \frac{\alpha r}{h(q-1)}\right) \tag{20}$$

2.5 Equilibrium growth rate v.s. optimal growth rate

Given that the average growth rate is proportional to the number of researchers, it is sufficient to compare the optimal level of research with the equilibrium level of our economy, which is given by equations (11) and (12):

$$\hat{n} = \frac{qh(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}\left(\frac{1+\tau}{1-t}\right)^{-\frac{\alpha}{1-\alpha}}(\beta_1 b)^{-\frac{\alpha}{1-\alpha}} - r\beta_1 b}{h(\beta_1 b + qhe)} \tag{21}$$

Clearly, it is very hard to compare n^* to $\hat{n}$ in order to conclude which is the biggest. Nevertheless, the differences between them naturally suggest the question of wether the labor market variables can reduce the gap between the optimal growth rate $g^* = g(n^*)$ and the market growth rate $\hat{g} = g(\hat{n})$. This issue is discussed in next section.

2.6 Labor market institutions and convergence to optimal growth

We are interested on the possibility of reaching the optimal growth rate by controlling key labor-market policy variables. From the analysis in section 2 we deduce that the impact of labor market variables on the level of research $\hat{n}$ is negative, *i.e.* $\frac{\partial \hat{n}}{\partial x}|_{x=\beta,\tau,t,e} < 0$. Thus, if the structural parameters are such that the number of researchers is above the optimal one, a positive adjustment of policy variables may be appealing, and viceversa.

To shed light on how the optimal outcome can be reached, we conduct a simple experience of economic policy in which the union's power is null ($\beta = 0 \Rightarrow \beta_1 = 1$) and there is no cost of shutting down a firm ($e = 0$). So, expression (21) becomes:

$$\hat{n} = q(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}(1+T)^{-\frac{\alpha}{1-\alpha}} b^{-\frac{1}{1-\alpha}} - \frac{r}{h} \tag{22}$$

where $1 + T \equiv \frac{1+\tau}{1-t}$. Then $\hat{n} = n^* \Leftrightarrow$

$$1 + T = \left(\frac{q(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}}{b^{\frac{1}{1-\alpha}} \left(n^* + \frac{r}{h}\right)} \right)^{\frac{1-\alpha}{\alpha}} \tag{23}$$

Is T a tax or a subvention? Clearly, the answer rely on the parameters value. We just can say that T will be a subvention if the following restriction on the parameters is verified:

$$\begin{aligned} q(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} &\geq b^{\frac{1}{1-\alpha}} \left(n^* + \frac{r}{h}\right) \quad \Leftrightarrow \\ q(1-\alpha)^2\alpha^{\frac{1+\alpha}{1-\alpha}} &\geq b^{\frac{1}{1-\alpha}} \left(L - \frac{r}{h}\left(1 - \frac{\alpha q}{q-1}\right)\right) \end{aligned}$$

Concluding remarks

We have constructed a general equilibrium model in which economic growth and unemployment are endogenously determined by the number of innovations made in the economy, which in turn is determined by the workers' incentive to engage in R&D activities. We have shown that: *(i)* High labor cost or powerful trade unions lead to bigger unemployment and to a slowdown of the economic growth. *(ii)* Efficient bargain allows to higher employment, at the price of a lower growth rate. Finally, we have shed light on how to reach the optimal rate of growth.

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A The Rate of Growth

The average growth rate of consumption good (or final output) is deduced as follows: we know that between two consecutive innovations, say τ and $\tau+1$, final output is augmented a fixed amount q, $C_{\tau+1} = qC_\tau$. Hence, between date t and date $t+1$ expected output is given by the following relationship

$$E[C_{t+1}] = q^{\int_0^1 hn_t dt} C_t \tag{24}$$

since from the law of large numbers, the expected value of the number of innovations (the aggregate arrival rate hn) is the same across sectors. Then, by taking logarithms and arranging terms we have that

$$g_t \equiv E[\ln C_{t+1} - \ln C_t] = hn_t \ln(q) \tag{25}$$

B Expected welfare

The expected welfare $E(U)$ is defined as the expected present value of lifetime consumption, but consumption is a random variable that takes the values $\left\{A_0 x^\alpha, A_0 q x^\alpha, A_0 q^2 x^\alpha, \ldots, A_0 q^k x^\alpha, \ldots\right\}_{k \in N}$. Then,

$$\begin{aligned} E(U) &= \int_0^\infty e^{-rt} E(C_t) dt \\ &= \int_0^\infty e^{-rt} \left(\sum_{k=0}^\infty p(k,t) A_t x_t^\alpha \right) dt \end{aligned}$$

where $p(k,t) = \frac{(hnt)^k e^{-hnt}}{k!}$ is the probability to have exactly k innovations up to time t. So,

$$E(U) = \left(\sum_{k=0}^\infty \frac{(hnt)^k q^k}{k!} \right) \int_0^\infty e^{-(r+hn)t} A_0 x^\alpha dt$$

Note that $\sum_{k=0}^\infty \frac{(hnt)^k q^k}{k!} = \sum_{k=0}^\infty \frac{(hnt)^k q^k e^{-hntq}}{k!} e^{hntq} = e^{hntq}$. Then,

$$\begin{aligned} E(U) &= A_0 x^\alpha \int_0^\infty e^{-(r-hn(q-1))t} dt \\ &= A_0 x^\alpha \left[-\frac{e^{-(r-hn(q-1))t}}{r-hn(q-1)} \right]_0^\infty \\ &= \frac{A_0 x^\alpha}{r-hn(q-1)} \end{aligned}$$