Unions

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ABSTRACT   This paper develops a two-sector endogenous growth model with a dual labor market caused by the operation of trade unions. Trade unions strive for the extraction of rents from the growth generating imperfectly competitive primary sector. This union behavior results in a non-competitive wage differential between the primary and secondary (perfectly competitive) sector. How the relationship between growth and unemployment depends on the institutional details of the labor market is analyzed. In general, growth and unemployment are intimately related for two reasons. Unemployment affects the scale of operation of the economy and thereby the growth rate. Growth affects inter-temporal decisions of workers about where to allocate on the labor market once they are laid off, and thereby it affects equilibrium unemployment.

Introduction

T rade unions aim to further the interest of workers in a broad sense. It is generally acknowledged that this behavior tends to increase real wage costs and unemployment. Much less is known about the effects of trade unions on other variables like economic growth. With the advent of the endogenous growth theory, these effects have gained interest. Where traditionally growth theory and unemployment theory have developed among separate lines, recent efforts have been made to study the inter-relatedness between growth and labor market institutions, among which trade unions feature prominently. This paper, will try to add to the understanding of how growth and unemployment are related, and how this relationship is shaped by labor market institutions.

The model that will be developed can best be characterized as a two-sector endogenous growth model, characterized by a non-Walrasian labor market. Endogenous growth results from the accumulation of firm-specific knowledge, and the operation of trade unions results in a dual labor market with non-competitive wage differentials. Unemployment arises due to distortions in the

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supply of labor, caused by the non-competitive wage differential. Besides the presence of trade unions, an important role is played in the model by other institutional factors that characterize labor market performance. More specifically the effects of linking unemployment benefits to previous earnings will be studied in a model with a dual labor market. This way of modeling is strongly inspired by recent empirical literature on technology and employment. In the *OECD Jobs Study* (1994), the relationship between high-tech and high-wage sectors is explored. It is argued that production of manufacturing goods increasingly takes place in conditions of imperfect competition. Imperfect competition results in rents that are often shared with workers, and in wages that differ considerably between sectors, even after controlling for age, education, occupation, and gender. These wage premiums are stable over time and their structure is roughly similar across countries (e.g. Krueger and Summers 1988). An important reason for firms to engage in rent sharing may be the presence of trade unions. The potential consequences of all this are indicated by the OECD (1994, part II, section IV) when it states that "The duality of the labor market under these considerations also introduces frictions in the workings of the market mechanism: the unemployed may prolong their job search in the hope of getting into the 'high-wage' firms and sectors, and displaced workers from the 'high-wage' firms and sectors may have very high replacement rates and hence reservation wages when compensations are based on previous earning." The goal of this paper is to study how the previously described behavior of trade unions affects growth and equilibrium unemployment, and to explain for what (theoretical) reasons growth and unemployment are intimately linked to each other. In particular, the importance of scale effects and inter-temporal trade-offs made by workers in yielding a two-sided causal relationship between growth and unemployment will be emphasized.

Previous papers have already studied the relationship between growth, unemployment and trade unions.[1] Bean and Crafts (1995) show how the operation of trade unions may result in lower investments and growth. Firms invest in order to increase their profits. An essential characteristic of many types of investments is that they have a sunk-cost character. This puts trade unions, once investments have been made, in a relatively strong bargaining position. Due to the sunk-cost character of the investment, the trade union can extract part of the rent that is associated with the investment. Aware of this, firms will invest less (under the assumption that firms and unions cannot sign a complete contract in which the division of rents resulting from investments to be made in the future is agreed upon). The problem described here is known as the 'hold-up problem' and was formally modeled by Grout (1984). Bean and Crafts integrate this insight into a model of endogenous growth in which R&D is aimed at developing new products. The reward for investments resulting in the development of new products is a monopoly profit to be earned by the inventor

of the new product. In the presence of trade unions, some of the profits are extracted by the trade unions, which reduces the incentive to develop new products and thereby reduces growth. The central idea in Daveri and Tabellini (1997) is that the presence of unions results in high real wage costs. They have developed an overlapping generations model in which both labor and capital are used as inputs in the production process. Endogenous growth results from an external effect related to the accumulation of physical capital. Wages are set by monopolistic trade unions. High wage costs push firms to a more capital-intensive production process, and will result in lower employment and a reduction in the marginal product of capital. This last effect induces a fall in savings and growth. Growth and unemployment are thus negatively correlated in both cross-sections and time series, where the correlation stems from differences in wage costs between countries or time-periods.[2]

This model deviates from the before mentioned models in that it models growth and unemployment in the context of a dual labor market and focus on distortions in the supply of labor causing equilibrium unemployment (instead of demand distortions resulting from excessive wage costs). The process is as follows. The consumer and producer behavior in this model is first briefly presented. Subsequently, the labor-market block of the model is discussed, with an emphasis on union behavior. Next, the general equilibrium of the model is presented. The results will be derived on the relationship between growth and unemployment and the effects of several labor market institutions on growth and unemployment will be studied. In turn, the model is extended in order to stress other aspects of labor market institutions that might affect growth, unemployment and their inter-relatedness. The focus will be on the effects of linking unemployment benefits to previous earnings. Besides being interesting from a policy point of view, this extension allows a study of to what extent the relationship between growth and unemployment is sensitive to the particular way of modeling the labor market. Finally, the empirical evidence on the relationship between growth, unemployment and trade unions is discussed.

Consumer and Producer Behavior

A two-sector economy with endogenous growth and a non-Walrasian labor market is modeled. Producer and consumer behavior is briefly discussed in this section. In the model that is developed, there is only one homogeneous factor of production, namely labor. The secondary sector of the economy operates under perfect competition and produces a homogeneous good (labeled Y). Firms in the primary sector, produce unique brands of a high-tech product (labeled x_i). There are N firms in this sector, indexed $i=1,\ldots, N$ that operate under monopolistic competition (N is assumed to be sufficiently large), and consequently earn a non-competitive rent. Trade unions struggle on behalf of the workers with the firm on the division of this rent among the firm and the workers. This

negotiation yields the unions part of the non-competitive rent, which they distribute among the workers in the primary sector. These workers thus receive a non-competitive rent, which makes working in the primary sector more attractive than working in the competitive secondary sector. Under some assumptions that will be explored in this paper, this generates 'wait unemployment', i.e., workers queuing for high-tech high-paid jobs.[3] Growth results from high-tech firms performing research and development (R&D), which results in improved production technologies with which high-tech goods are being produced. Consumers maximize inter-temporal utility, where utility is derived from consumption of the goods produced in the economy.

Consumer behavior is summarized in Table 1. Where it leads to no confusion, time indices have been omitted. Consumers maximize their inter-temporal utility (C.1), where C is the macroeconomic consumption index with the corresponding price index P_c, θ is the subjective discount rate, and I is total income. Utility is derived from consumption of traditional and high-tech goods (C.2), where X is a composite of high-tech goods with corresponding price index P_X, and Y is the traditional good with corresponding price P_Y. Finally, consumers have a love for variety of high-tech goods, indicated by (C.3). Varieties of high-tech goods are imperfect substitutes, the elasticity of substitution being measured by ε. In optimizing their behavior, consumers decide where to allocate on the labor market in the first step in order to maximize the present discounted value of all future consumption streams. The next section will return to this step of optimization where the labor market of the model will be discussed. From the second step of the optimization procedure a spending rule results, showing that a fraction $(1-\sigma)$ of consumption expenditures is spent on traditional goods (equation 1), while a fraction σ is spent on high-tech goods. In the third step, consumers decide how much to buy of each variety of the high-tech goods resulting in the demand function for a high-tech good of variety i (equation 3). Finally, a macroeconomic price index (equation 2), and a price index of high-tech goods (equation 4) are derived.

Producer behavior is summarized in Table 2. Producers in the secondary sector operate under perfect competition and produce a homogeneous good with unitary labor productivity (equations 5 and 6), using labor L_Y at a cost w_Y. Firms in the primary sector maximize profits (P.1), subject to the production function of high-tech goods (equation 7), the allocation rule for research labor (equation 8), and the demand function for the brand of the variety it produces (equation 3). Labor productivity is represented by h, labor input for productive purposes by L_x, and R&D labor by L_r. It is assumed that R&D input is determined on the basis of some rule of thumb according to which firms employ a fixed fraction β of their direct production input for R&D purposes (see de Groot 1998 for extensions). Optimization yields mark-up pricing (equation 10). The mark-up over unit wage costs $([1+\beta]w_Y/h)$ increases as the elasticity of substitution between any pair of high-tech goods decreases.

TABLE 1. CONSUMER BEHAVIOR

$$\max U_0 = \int_0^\infty C_t \, e^{-\theta t} \, dt \quad \text{s.t.} \quad I_{wt} = C_t P_{Ct} \tag{C.1}$$

$$\max_{X,Y} C = X^\sigma Y^{1-\sigma} \quad \text{s.t.} \quad XP_X + YP_Y = CP_C \tag{C.2}$$

$$\max_{x_i} X = \left[\sum_{i=1}^N x_i^{(\varepsilon-1)/\varepsilon} \right]^{\varepsilon/(\varepsilon-1)} \quad \text{s.t.} \quad \sum_{i=1}^N x_i p_{xi} = XP_X \tag{C.3}$$

The first step of optimization will be discussed in the next section. The solutions to problem (C.2) and (C.3) are

$$\frac{YP_Y}{1-\sigma} = CP_C = \frac{XP_X}{\sigma} \quad, \text{ where} \tag{1}$$

$$P_C = \left(\frac{P_X}{\sigma} \right)^\sigma \left(\frac{P_Y}{1-\sigma} \right)^{1-\sigma} \quad, \tag{2}$$

$$x_i = X \left(\frac{p_{xi}}{P_X} \right)^{-\varepsilon} \quad, \text{ where} \tag{3}$$

$$P_X = \left[\sum_{i=1}^N p_{xi}^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} . \tag{4}$$

TABLE 2. PRODUCER BEHAVIOR

Traditional Sector

$$Y = L_Y \, , \tag{5}$$

$$P_Y = w_Y \, . \tag{6}$$

High-tech sector

$$\max_{L_{xi}} \pi_i = x_i p_{xi} - (L_{xi} + L_{ri}) w_{Ti}, \tag{P.1}$$

subject to

$$x_i = h_i L_{xi}, \tag{7}$$

$$L_{ri} = \beta L_{xi} \, , \tag{8}$$

$$x_i = X \left(\frac{p_{xi}}{P_X} \right)^{-\varepsilon} .$$

Labor productivity develops according to

$$\dot{h}_i = \xi h_i L_{ri}. \tag{9}$$

This yields (assuming symmetry)

$$p_x = \frac{\varepsilon}{\varepsilon-1} \frac{w_T (1+\beta)}{h} \, , \tag{10}$$

Note: a dot over a variable represents a derivative with respect to time.

The Labor Market of the Model

In this section, the modeling of the labor-market block of the model will be presented and discussed. First union behavior is discussed as well as under what conditions union behavior will result in a non-competitive wage-differential. Next, is the determination of equilibrium unemployment in a dual labor market.

Union behavior and non-competitive wage differentials. It is assumed that a trade union is operating in each monopolistically competitive high-tech firm. The union and the firm play a game on the division of rents generated by the production of the differentiated high-tech good. The objective of the union is to extract as much of the rents generated in the high-tech firm as possible.[4]

In pursuing rent maximization, the union has to outweigh the positive effect of wage increases with the negative labor-demand effect, induced by the lower product demand following a price (wage) increase. The firm on the other hand wants as low a wage as possible (in order to keep as much of the rents as possible). The ultimate outcome of this 'struggle for rents' is determined on the basis of negotiations between the union and the firm. The bargain between the firm and the union is modeled as

$$\max_{w_T} \Omega_i = (w_{Ti} - O)[L_{xi}(1+\beta)]^\lambda, \text{ where } \pi_i = p_{xi}x_i - w_{Ti}L_{xi}(1+\beta).$$

This is the so-called Nash bargain, or 'right to manage' approach to bargaining between trade unions and firms. The parameter γ(≥0) reflects the *relative* bargaining power of the firm, O reflects the alternative or outside wage for high-tech workers (the firm's profits in case no agreement is reached are assumed to be zero), and λ measures the extent to which employment effects of the wage bargain are taken into account by the unions. Highly individualistic bargaining can be associated with a low λ, and collective bargaining with a high λ. In the special case where λ=1, unions are after maximization of the wage bill (over the alternative). An important point to mention is that the union and the firm do *not* bargain over employment levels, as is assumed in efficient bargaining models (e.g. McDonald and Solow 1985). The reasons for not using an efficient bargaining approach are twofold. First, the efficient bargaining approach is unrealistic from an empirical point of view, as it does not correspond to the observation that employment is usually set unilaterally (e.g. Oswald 1987; Clark and Oswald 1989). Secondly, an efficient bargaining model is incentive incompatible as a firm always has an incentive to renege on the bargained outcome once the bargain has been settled by choosing labor demand on the demand curve (Oswald 1985).

The maximand in the Nash bargain depends crucially on three factors. The first is the relative bargaining power of the parties engaged in the bargain (λ). This relative power depends on the eagerness with which the firm wants to reach an agreement (relative to the union's eagerness). The second factor is the union's objective in the bargain which equals $(w_{Ti}-O)[(1+\beta)L_{xi}]^\lambda$. The third term represents the profits of the firm.

Taking the derivative of the Nash-maximand w.r.t. the wage rate yields the first-order condition for a maximum

$$\frac{\partial \Omega_i}{\partial w_{Ti}} = E_i^\lambda \pi_i^\gamma + (w_{Ti} - O) \lambda E_i^{\lambda-1} \frac{\partial E_i}{\partial w_{Ti}} \pi_i^\gamma + (w_{Ti} - O) E_i^\lambda \gamma \pi_i^{\gamma-1} \frac{\partial \pi_i}{\partial w_{Ti}} = 0,$$

where E_i represents total employment per firm ($[1+\beta]L_{xi}$). Using the envelope theorem ($\partial \pi_i / \partial w_{Ti} = -[1+\beta]L_{xi}$), and

$$\frac{\partial E_i}{\partial w_{Ti}} = (1 + \beta) \frac{\partial L_{xi}}{\partial w_{Ti}} = \frac{-(1 + \beta)\varepsilon L_{xi}}{w_{Ti}} ,$$

which can be derived using the demand function for a good of variety i, leaves us, upon combination with the first-order condition, with

$$\frac{w_{Ti} - O}{w_{Ti}} = \frac{1}{\lambda \varepsilon + \gamma(\varepsilon - 1)} .$$

Using this mark-up of the wage rate over the alternative wage, the non-competitive wage differential can now be characterized. In the remainder of this paper the alternative wage will be assumed to be equal to the wage in the secondary sector.[5] Then, assuming symmetry so that the firm indices can be skipped, the relative wage (ω) is derived as

$$\omega \equiv \frac{w_T}{w_Y} = \frac{\varepsilon(\lambda + \gamma) - \gamma}{\varepsilon(\lambda + \gamma) - (1 + \gamma)} > 1 . \tag{11}$$

Thus it can be seen that a non-competitive wage differential arises due to the operation of trade unions. This wage differential is smaller, the higher the relative bargaining power of the firm. This is intuitively clear, as the firm has no interest in paying high wages. An increase in the elasticity of demand of the high-tech product will decrease the wage differential. The reason for this is that as competition between high-tech firms becomes tougher, the union is hurt more in terms of a loss in employment when it increases its wages. This leads to more modest wage claims by the union. When there is perfect substitution between high-tech goods ($\varepsilon \to \infty$), the non-competitive wage differential disappears. This illustrates the argument that product market competition is a way to eliminate the adverse effects of unions (e.g. Nickell and Layard 1997). Finally, the degree of coordination plays a role in determining the wage differential. The larger the degree of coordination (λ large), the smaller the non-competitive wage differential. With completely collective bargaining ($\lambda \to \infty$), there will be no non-competitive wage differential left ($\omega = 1$).[6]

Equilibrium unemployment in a dual labor market.   An essential characteristic of the model described so far is its dual labor market. The trade union operating in the primary sector leads to a non-competitive rent ($\omega > 1$). There are various reasons why, resulting from this non-competitive element in the labor market, equilibrium unemployment can result. Two of them will be discussed.

The first is, building on the classical literature on dual labor markets, that it may be advantageous for people who are not employed in the primary sector to become unemployed instead of accepting a job in the secondary sector (e.g.

Layered et al. 1991, Ch. 1). This may hold even though benefit payments[7], bw_y, are lower than wages in the secondary sector as unemployed can have a higher probability of (re-)entering the primary sector. Reasons can be that they have more time to search for jobs, or that firms in the primary sector prefer unemployed people over workers from the secondary sector because, for example, secondary-sector workers get 'negative general training' (*cf.* Doeringer and Piore 1971). Also, being in a secondary-sector job may be a bad signal (e.g. McCormick 1990). Persons having accepted a secondary-sector job may be considered as having a high turnover risk. Anyhow, the assumption that unemployed people are more easily matched with high-wage jobs than are workers in the secondary sector is often used as a simple and useful working hypothesis in the literature on unemployment in dual labor markets (e.g. Bulow and Summers 1986; Burda 1988; Calvo 1978; Harris and Todaro 1970; McCormick 1990; Taubman and Wachter 1986).

Secondly, benefits may be so high that they (at least for some time) exceed wages in the secondary sector.[8] This may be caused by an institutional design according to which benefit payments are linked to previous earnings. Even though it may be the case that unemployed people are relatively badly matched with high-wage jobs, it will be attractive for some people to become unemployed and receive the high unemployment benefit. This issue will be addressed later in the paper.

The remainder of this section will discuss how equilibrium unemployment results, making the assumption that unemployed people are relatively efficiently matched with high-paid jobs (compared to workers employed in the secondary sector). The following assumptions are made. At each instant of time there are lay-offs in the primary sector. At an exogenous rate δ jobs in the primary sector fall free. For simplicity, and without loss of generality, it is assumed that there are no lay-offs in the secondary sector. In principle, every worker would like to be employed in the primary sector since this yields him the largest utility (see equation C.1). The number of jobs in this sector is, however, restricted due to the operation of goods-market equilibrium (see equation 1). Taking this into account, a laid-off worker from the primary sector faces two options. He can either allocate himself to a job in the secondary sector, or he can allocate himself to the pool of unemployed. In determining his optimal strategy, the worker has to take the following two considerations into account: (i) the earnings rate when being unemployed is lower than the wage in the secondary sector ($b<1$), and (ii) the matching efficiency of unemployed people is larger than the one of those employed in the secondary sector ($\alpha < 1$, where α is the relative efficiency with which secondary-sector workers are matched with high-paid jobs, compared to unemployed people). The process of outweighing the two opportunities that laid-off high-tech workers are facing finally results in an endogenously determined probability η of going to one of the two states (i.e., the state of

unemployment or secondary-sector employment). The outcome for this probability is such that ex-ante laid-off workers (which are distributed randomly) are indifferent between the two options that they are facing. Refer to Figure 1 for a graphical representation of stocks and flows on the labor market.
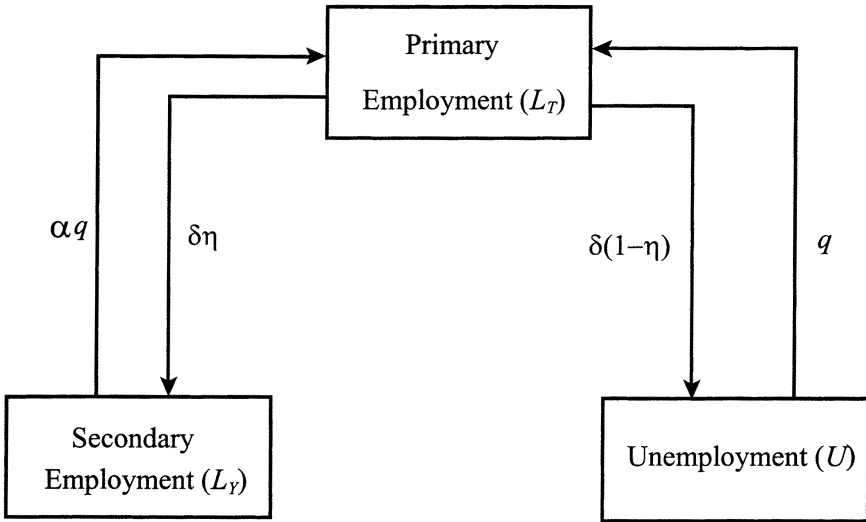

FIGURE 1. STOCKS AND FLOWS ON THE LABOR MARKET.

To formalize the determination of labor-market equilibrium, three value functions (Bellman equations) are introduced. Let V_Y, V_U, and V_T denote the present discounted utility of all future expected consumption streams of, respectively, a worker currently in the secondary sector, a currently unemployed person, and a worker currently in the primary sector. In the steady state in which the allocation of labor is constant over time, the consumption index C grows at the rate σg, where σg is the growth rate of labor productivity h. Thus $C_t = C_0 e^{\sigma g t} = (w_j/P_{C0})e^{\sigma g t}$ is derived. In the remainder, initial labor productivity h_0 is chosen such that P_{C0} is equal to one. So in equilibrium, the value of being in one of the three respective states grows at the rate σg, the rate at which consumer prices decrease and hence at which real wages increase. This implies that the discount rate D at which future job matches have to be discounted equals $\theta - \sigma g$.[9] The larger the growth rate, the less future (nominal) payments are discounted.

A worker in the secondary sector enjoys a wage rate of w_Y from working and he expects in unit time to get a job in the high-tech sector with probability q, which yields him a surplus of $V_T - V_Y$ over his current position. V_Y thus satisfied

$$DV_Y = w_Y + \alpha q(V_T - V_Y) , \tag{12}$$

where DV_Y is the valuation put on having a job in the traditional sector (compare Pissarides 1990). This valuation equals the return on the traditional sector job. Similarly derived is

$$DV_U = bw_Y + q(V_T - V_U) , \tag{13}$$

and

$$DV_T = w_T + \delta\eta (V_Y - V_T) + \delta(1-\eta)(V_U - V_T) . \tag{14}$$

For equilibrium to hold, it is required throughout that the value of a job in the traditional sector equals the value of being unemployed

$$V_Y = V_U . \tag{15}$$

In addition, two flow-equilibrium conditions are imposed, guaranteeing a constant allocation of labor over the three states[10]

$$\delta\eta L_T = \alpha q L_Y , \tag{16}$$

and

$$\delta(1-\eta)L_T = qU . \tag{17}$$

Employment in the high-tech sector equals

$$L_T = N (L_x + L_r) = N (1+\beta) L_x. \tag{18}$$

Finally, a stock-equilibrium condition must be imposed:

$$L = L_T + L_Y + U , \tag{19}$$

so total (exogenous) labor supply L is either employed in one of the two sectors or unemployed. This labor-market block of the model yields a relationship between the unemployment rate and the number of high-tech workers as a function of the relative wage differential (ω), the unemployment benefit (b), the relative matching efficiency of secondary-sector workers (α), and the discount rate (D).

The resulting unemployment in this model has to be thought of as wait unemployment. That is, part of the labor force is deliberately queuing for the high-paid jobs. In the dual structure in this model it is impossible to call this type of unemployment either voluntary or involuntary. It is voluntary in the sense that the unemployed could, in principle, choose to be employed in the secondary sector. They decide not to do so as this is not in their economic interest. It is involuntary, however, as all the unemployed are willing to accept a job in the primary sector, but are not offered such a job because of the rationing that is going on in that sector.

Endogenous Growth and Equilibrium Unemployment

This section will discuss the equilibrium characteristics of the model just described, then, some comparative statics of the model. More specifically, the effects of changes in unemployment benefits (more generally, the generosity of

the social security system), union's bargaining power, relative efficiency of matching unemployed with high-wage jobs, and changes in the discount rate will be examined. The central questions will be whether there is a relationship between growth and unemployment, which factors influence this relationship, and whether the relationship is positive or negative.

   Solution of the model To solve for the model, start from the equations 12-15, which form the partial labor market block of this model. Take the wage rate in the traditional sector as numeraire ($w_Y=1$ so $w_T= \omega$). From these equations we can solve for q. This yields

$$q = \frac{(D+\delta)(1-b)}{\omega(1-\alpha) - (1-\alpha b)} \quad . \tag{20}$$

The wage differential has to be sufficiently large to guarantee positive flows on the labor market ($\omega > (1-\alpha b)/(1-\alpha)$). A smaller wage ratio would result in corner solutions (no labor would be unemployed, and η would be equal to one; there would only be flows between the primary and secondary sector). Using this solution and the flow-conditions (Eq. 16 and 17) the following relationship between unemployment and employment in the two sectors can be derived:

$$U = \frac{\delta L_T}{q} - \alpha L_Y = \frac{\delta L_T [\omega(1-\alpha)-(1-\alpha b)]}{(D+\delta)(1-b)} - \alpha L_Y \quad . \tag{21}$$

Now substituting this equation along with the expression for goods-market equilibrium (equation 1) and the expression for the size of the firm (equation 18) into labor market equilibrium (equation 19), the solution for the size of the production department (as an implicit function)[11] is found:

$$L = N(1+\beta)L_x \left(1 + \frac{\delta[\omega(1-\alpha)-(1-\alpha b)]}{(\theta+\delta-\sigma g)(1-b)} + (1-\alpha)\frac{1-\sigma}{\sigma}\frac{\varepsilon}{\varepsilon-1}\omega \right) . \tag{22}$$

This equation yields the solution for the size of the production department (using that $g = \xi\beta L_x$).

   The solution of the model is graphically depicted in Figure 2. In this figure, three loci are depicted. The GG-locus represents equation 9, which has a slope equal to $1/(\beta\xi)$. The TT-locus represents equation 22. This equation gives us the maximal amount of production labor that can be employed, taking into account goods-market equilibrium and the fact that the effective supply of labor ($L-U$) is endogenous. It is downward sloping since a higher growth rate implies a lower discount rate, increasing the importance of future earnings and thus increasing unemployment and reducing the effective labor supply. The equilibrium growth rate is found at the intersection of the GG- and the TT-locus. Having determined the equilibrium number of high-tech production workers, unemployment follows from using the UU-locus which is derived from goods- and labor-market equilibrium as $U=L-N(1+\beta)L_x[1+\varepsilon\omega(1-\sigma)/\{(\varepsilon-1)\sigma\}]$.[12]
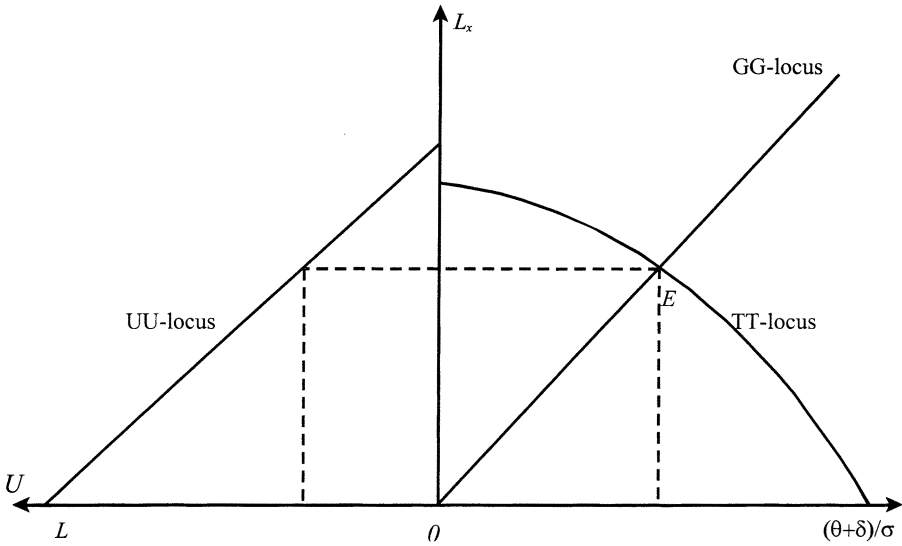
FIGURE 2. EQUILIBRIUM SOLUTION OF THE MODEL.

Now turn to the comparative statics characteristics of the model. First is an explanation of how growth and equilibrium unemployment are related. It is important to recognize the two crucial factors that give rise to such a relationship. First, there is a *scale effect* operating in the model, which is due to its Schumpeterian character. The larger the high-tech firms are, the higher the growth rate of the economy will be. This is in its very essence the scale-effect known from many models of endogenous growth. As unemployment will negatively affect employment and hence the size of high-tech firms, there will be a (partial) negative relationship between unemployment and growth. Secondly, the growth rate affects the *inter-temporal decisions* made by workers. The larger the growth rate, the less workers will discount future wages (or, alternatively, the faster real wages will grow) and the more eager they will be to get a high-paid job in the future. As being unemployed yields the highest probability of being matched with a high-paid job in the future, relatively more people will opt for unemployment as growth becomes higher. Consequently, there will be a (partial) positive relationship running from growth to unemploy-ment. In general, an unambiguous answer cannot be given to the question how growth and unemployment are related. This answer depends on the importance and strength of the scale effect relative to inter-temporal considerations of workers. In the remainder of this section, the comparative-static characteristics of the model will be considered, using Figure 2.

An increase in the generosity of the social security system (b) makes becoming unemployed more attractive since the cost of waiting decreases. This turns the TT-locus downwards. Hence, equilibrium unemployment will increase and both the traditional and the high-tech sector will shrink. High technology (high-tech) firms will become smaller in size and the growth rate will decrease. This will make unemployment a less attractive option for laid-off workers, but still unemployment will unambiguously increase.[13]   An increase in the wage ratio resulting from an increase in the bargaining power of unions results in a decrease of the size of high-tech firms (this follows from Figure 2 in which the TT- and UU-loci turn downwards around their fixed points on the horizontal axis). Growth accordingly will decrease, and the discount rate (D) will increase. To determine the effects of a change in the union's bargaining power or the degree of centralization of the wage bargain on unemployment three effects must be considered. First, an increase in the wage ratio makes becoming unemployed and waiting for an (extra) highly paid job more attractive, increasing unemployment. Secondly, it changes the composition of production in favor of traditional goods (since they become relatively cheap). This results in a smaller high-tech sector and fewer lay-offs, making unemployment a less attractive option. Finally, the discount rate increases as the growth rate declines. This decreases the attractiveness of becoming unemployed. Still, unemployment is likely to increase when unions become more powerful (as has been derived from extensive numerical simulations with the model). An increase in the relative efficiency with which secondary-sector workers are matched with high-tech jobs makes becoming unemployed less attractive and accordingly more laid-off high-tech workers will opt for a job in the secondary sector. This reduces unemployment. In addition, growth will increase following an improved matching efficiency. The at first sight surprising conclusion that an improved relative matching of unemployed people (α lower) results in lower growth and increased unemployment is easily explained by noting that unemployment has the character of wait-unemployment. What essentially happens if the relative matching efficiency improves is that the costs of waiting for a high-paid job decrease. Finally, an increase in the discount rate (θ) makes future high payments and the associated large consumption streams less important for workers. Consequently, relatively much laid-off workers will opt for a job in the traditional sector if the discount rate is large. Unemployment will accordingly decrease and both the high-tech and the traditional sector will become larger in size. In addition, the growth rate will increase.

Although in all the comparative-static exercises that were considered so far, growth and unemployment moved in opposite directions, this conclusion does not hold in general. Depending on the underlying differences in economic structure (either between countries or time episodes), we can find positive as well as negative correlations between growth and unemployment. To illustrate

this, consider the case of an increase in the equilibrium number of firms (which may be considered as an increase in competition). In such a case, all high-tech firms become smaller in size and growth decreases, while the high-tech sector becomes larger. The traditional sector also becomes larger. The increase in the discount rate that follows from the decreased growth rate makes becoming unemployed and opting for a high future payment less attractive and unemployment decreases as well.

Extensions and Generalization of the Model

The central idea in this section is that the linkage of unemployment benefits to previous earnings in the presence of a dual labor market can be an important cause of equilibrium unemployment. More specifically, the linkage may be so tight initially that benefits exceed the wages that are paid in the secondary sector. Even if unemployed people will be less successful in being matched with high-paid jobs than workers in the secondary sector, this may yield a rationale for laid-off high-tech workers to become unemployed. A citation of the *OECD Jobs Study* (1994) is instructive here: "The duality of the labor market ... introduces frictions in the working of the market mechanism: the unemployed may prolong their job search in the hope of getting into 'high-wage' firms and sectors, and displaced workers from the 'high-wage' firms and sectors may have very high replacement rates and hence reservation wages when compensations are based on previous earnings."

To model this idea, the modeling of the labor market as compared to the previous section must be changed. This serves two goals. The first goal is to show that the result that growth and unemployment are intimately related does not hinge on the specific way in which the labor market is modeled. In particular, the assumptions made previously that there are no lay-offs from the traditional sector and that traditional sector workers are relatively poorly matched with high-tech jobs are relaxed. The second goal is to show that the way the labor market is designed does affect the relationship between growth and unemployment and that, depending on the institutional detail of the labor market, some policies may affect growth and unemployment in different ways.

Consumer and producer behavior remain as described before (equations 1-10). On the labor market four groups of people are now distinguished. There are people employed in the primary and the secondary sector; there are high-status unemployed people that have just been laid off from the high-tech sector receiving a high benefit (which they can receive for one instant of time); and there are low-status unemployed receiving a low social security benefit. People in this last group became unemployed either because they were laid off from the secondary sector or because they were not able to find a job when they belonged to the pool of high-status unemployed. Stocks and flows are represented in Figure 3.
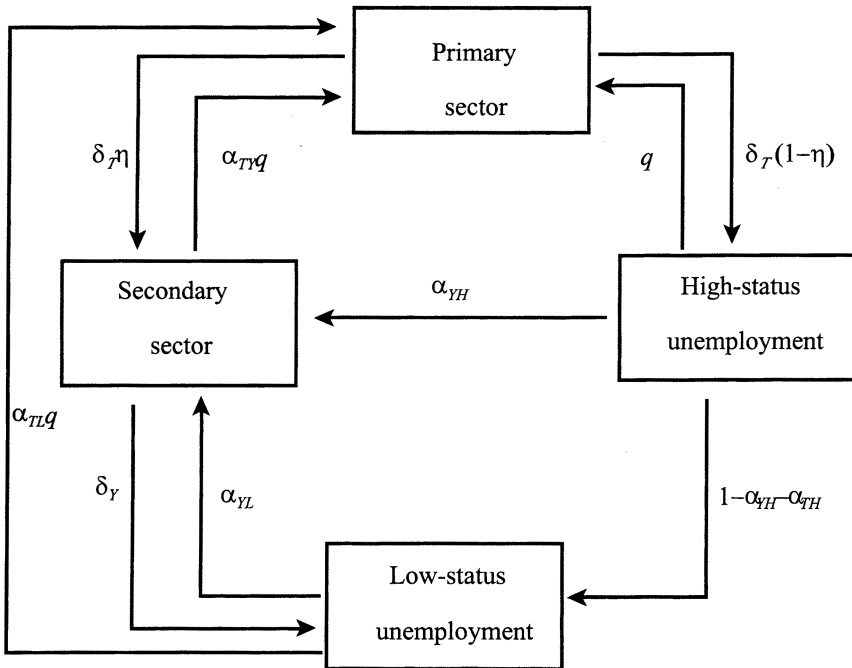
FIGURE 3. STOCKS AND FLOWS ON THE LABOR MARKET-EXTENDED MODEL.

In the remainder of this section, the following assumptions will be made. At each instant of time, a fraction δ_Y $(0\leq\delta_Y\leq1)$ of workers in the secondary sector will be laid off. In the primary sector, the exogenous lay-off rate is δ_T. Upon being laid off, people have to decide whether to become (transitionally) unemployed and receive a benefit equal to bw_T, or to start working in the secondary sector. In making this decision, people have to take into account that the probability of being matched with jobs depends on their status in the labor market. This captures in a simple and stylized way the empirically observed phenomenon of duration-dependent outflow rates out of unemployment (see, for example, van den Berg and van Ours 1994 for some empirical evidence on duration-dependent outflow rates). More specifically, it will be assumed that workers in the secondary sector are more easily matched with high-tech jobs than high-status unemployed, while the matching efficiency of low-status unemployed is worst. These matching probabilities are labeled $\alpha_{TY}q$, q and $\alpha_{TL}q$, respectively, where it is assumed that the relative matching efficiencies satisfy $0\leq\alpha_{TL}<1<\alpha_{TY}$. Both the low- and high-status unemployed can also be matched with jobs in the traditional sector, where these probabilities are assumed to be exogenous and equal to α_{YH} and α_{YL}, respectively, where to $\alpha_{YL}<\alpha_{YH}<1$ (so low-

status unemployed are less easily matched with a job in the secondary sector than high-status unemployed). These assumptions are not subject to the objections one can have against the assumption that unemployed people are more effectively matched with a well-paid job than workers in the secondary sector. Furthermore, benefits for high-status unemployed (i.e., those laid off from the high-tech sector that opt for unemployment) are assumed to be larger than wages in the secondary sector and to only last for one period. This is due to the tightness of the link between benefits (bw_T) and high-tech wages (w_T). When a high-status unemployed person does not find a job in either the primary or the secondary sector, (s)he will become low-status unemployed and receive an (exogenously given) benefit f that is smaller than wages in the secondary sector. People that are laid off from the secondary sector immediately receive the benefit f.

To formalize the labor market equilibrium, four Bellman-equations are formulated describing the valuation put on the four states that people can arrive at (T and Y indicate the primary and secondary sector, respectively, while UL and UH indicate the status of low- and high-status unemployment, respectively). These value-functions look like

$$DV_T = w_T + \delta_T \eta (V_Y - V_T) + \delta_T (1 - \eta)(V_{UH} - V_T) , \tag{25}$$

$$DV_Y = w_Y + \alpha_{TY} q (V_T - V_Y) + \delta_Y (V_{UL} - V_Y) , \tag{26}$$

$$DV_{UL} = f + \alpha_{YL}(V_Y - V_{UL}) + \alpha_{TL} q (V_T - V_{UL}) . \tag{27}$$

and

$$DV_{UL} = f + \alpha_{YL}(V_Y - V_{UL}) + \alpha_{TL} q (V_T - V_{UL}) . \tag{28}$$

For equilibrium to hold, it is required that the value of becoming transitionally unemployed equal the value of acquiring a job in the traditional sector

$$V_{UH} = V_Y . \tag{29}$$

Flow equilibrium requires

$$(\alpha_{TY} q + \delta_Y) L_Y = \alpha_{YL} U_L + \delta_T \eta L_T + \alpha_{YH} U_H , \tag{30}$$

$$\delta L_T = \alpha_{TY} q L_Y + q U_H + \alpha_{TL} q U_L \tag{31}$$

and

$$(1 - \alpha_{YH} - q) U_H + \delta_Y L_Y = (\alpha_{YL} + \alpha_{TL} q) U_L , \tag{32}$$

where U_L and U_H represent long-term and transitional unemployment, respectively. Defining total unemployment as $U = U_H + U_L$, the model is completed by adding equations 11, 18 and 19. The model can now be solved. Given the complexity of the model, numerical simulations must be relied upon. However, the relation of growth and unemployment in this specific model can be unambiguously derived. As before, growth and unemployment are basically

related for two reasons. The scale effect causes unemployment and growth to be negatively related since an increase in unemployment results in smaller firms and lower growth. An increase in the growth rate, however, now affects unemployment negatively. The reason is that when growth increases, high current payments become less critical in the decision where to allocate. As the highest current payments are obtained when becoming unemployed ($bw_T > w_Y$), while the largest probability of regaining a job in the high-tech sector is achieved when allocating towards the traditional sector, more people will opt for a job in the traditional sector and unemployment will decrease. Growth and unemployment are thus unambiguously negatively related.

Table 3 describes some comparative statics of the model, resulting from changes in the unemployment benefit level (f), changes in the bargaining power of trade unions (the qualitative changes are identical to those of a change in the degree of coordination of wage bargaining), changes in the effectiveness with which various groups are matched with high-tech jobs (α), and changes in the discount rate (θ). The results are broadly in line with what was seen in the simple version of this model and will therefore not extensively be discussed again.[14] The point where results differ is with respect to changes in the subjective discount rate. Increases in the discount rate make, contrary to the previous model, waiting as an unemployed more attractive. Current wages

TABLE 3. COMPARATIVE STATICS OF THE EXTENDED MODEL.

	Base	f (+ 0.1 %)		α (+0.1%)		γ (+0.1%)		θ (+ 10%)	
L_X	0.598	0.569	-	0.602	+	0.602	+	0.581	-
L_T	44.827	42.702	-	45.133	+	45.152	+	43.590	-
L_Y	49.310	46.972	-	49.647	+	49.664	+	47.949	-
U_T	0.959	3.865	+	0.535	-	0.512	-	2.656	+
U_L	4.905	6.461	+	4.685	-	4.672	-	5.804	+
η	0.786	0.095	-	0.881	+	0.887	+	0.391	-
q	0.0746	0.0691	-	0.0753	+	0.0754	+	0.0714	-
g (in %)	1.494	1.423	-	1.504	+	1.505	+	1.453	-
D	0.0200	0.0205	+	0.0200	-	0.0200	-	0.0232	+

Note: the base-line is based on the following parameter constellation: θ=0.029, γ=4, λ=1 (implying ω=1.1), δ_T=0.1, b=0.94, f=0.94, α_{TL}=0.89, α_{TY}=1.11, L=100, σ=0.6, β=0.25, ε=3, N=60, ξ=0.1, α_{YL}=0.5, α_{YH}=0.6, δ_Y=0.05. Signs in the table indicate the direction of change when compared to the base-line.

become more important in deciding where to allocate, and, since the highest earnings are gathered (initially) when becoming unemployed, relatively more people will opt for unemployment. This will make both the traditional and the high-tech sector smaller in size and the growth rate will decrease accordingly. This will further increase the discount rate and reinforce the inter-temporal effects.

Some Empirical Evidence on Growth, Trade Unions and Unemployment

Empirical studies that systematically test for the relationship between growth and unemployment, controlling for all kinds of potentially important variables that may shape this relationship like the presence of trade unions is scarce. A recent study which considers the effects of labor market institutions on growth and unemployment is Nickell and Layard (1997). It presents a rich data set on labor market institutions. Furthermore, it presents regressions explaining growth and unemployment from the data capturing labor market institutions, as well as an extensive and critical review of the results obtained in empirical studies explaining either growth or unemployment, and/or their inter-relatedness. The labor market institutions that are considered are taxes on labor, laws and regulations covering employees' rights, trade unions and the structure of wage bargaining, the social security system (in a broad sense), the system of education and training, and barriers to regional labor mobility. Cross-section regressions are presented in which unemployment (both short- and long-term)[15] and productivity growth are regressed on the measures capturing labor market institutions. The data cover 20 OECD countries and two time periods (1983-1988 and 1989-1994). In their regressions (which are mainly intended to give a quick insight into the correlations between the data they have gathered), no other conditioning variables were used other than those capturing labor market institutions. The growth rate, for example, is not regressed on the unemployment rate, the savings rate, population growth, and other variables that are known to influence economic growth.[16] Similarly, the unemployment rate is not regressed on variables such as product market competition, the growth rate, and productivity relative to the U.S. at the beginning of the time period. The results obtained on the basis of these exercises are that high taxes, generous social security systems, and strong unions that coordinate little with employers increase unemployment. The correlations between growth and labor market institutions are weak. Some weak evidence is found that employment protection has a positive effect on growth, while total labor taxes and benefit duration have a negative effect.

The effects of taxes on growth and unemployment were studied by Daveri and Tabellini (1997). They argue that in the presence of trade unions, high taxes are shifted onto higher (gross) labor costs and result in unemployment (see the

Introduction). In addition, these high wage costs result in large capital-labor ratios and thereby reduce the returns to investment and lower economic growth. They empirically test their thesis that countries with high taxes are characterized by low growth and high rates of unemployment. Their tests are based on a panel of 14 OECD countries during the period 1965-1991 (which is divided into five sub-periods of equal length). Their results are in line with the theoretical predictions and reasonably robust both quantitatively and qualitatively with respect to the employed estimation technique as well as the instruments used. Correcting for differences in effective tax rates on capital and labor, they conclude that growth of per capita GDP and unemployment as well as investments and unemployment are negatively correlated. Furthermore, the increase in unemployment and the slowdown in growth can, to a large extent, be traced back to increases in taxes on labor. More specifically, they argue that the rise of 9.4 percentage points in the rate of effective labor taxes experienced on average in the European countries under consideration has resulted in a decline in the growth rate of 0.5 percentage points a year, and in increase in unemployment of about 4 percentage points.

Most of the literature on the effects of trade unions on investments takes the theoretical literature on the hold-up problem as a starting point (see the Introduction) and tests whether investments are lower in the presence of trade-unions. An extensive survey of the literature investigating union effects on productivity, profits, and growth is Addison and Hirsch (1989). They find support in the literature for rent-seeking behavior of unions that lowers firms' investments in physical capital, as well as in R&D and other risky activities. This results in productivity growth being relatively low in unionized firms and industries. Bean and Crafts (1995) have later confirmed these results on the basis of a panel regression covering 137 industries and eight periods. The independent variables they include are the growth rate of the capital stock, concentration ratios, and the level of import penetration to capture the effects of competition, and variables capturing the impact of industrial relations like union recognition and the presence of multiple unions. The main conclusions they reach are that the presence of unions significantly depresses total factor productivity and that workplaces with multiple unions experience about 1 percentage point lower growth of total factor productivity than single union workplaces. In cross-sectional studies on the effects of trade unions no significant growth effects have been found to our knowledge.

Van Reenen (1996) looks at the relationship between labor market institutions and growth from a totally different angle. Based on a panel of British firms, he finds evidence for the importance of rent-sharing. In particular, he finds robust evidence that innovating firms generally pay higher wages, while rival innovations tend to depress their own wages. This evidence can be seen as an indication that firms engage in rent-sharing in order to enhance productivity

(growth). Theoretical models on efficiency wages can provide arguments for this behavior. This study is instructive in that it reveals one of the serious problems one is faced with in empirical research. High wages may be a resultant of strong unions which depress investments in R&D and lower growth, while high wages may also result from rent-sharing by fast-growing firms that were successful in innovating. From an empirical point of view, discriminating between the alternative theories is a formidable task. It can be concluded that the empirical research performed so far on the relationship between growth and unemployment and the way labor market institutions shape this relationship is scarce. Testing theories is a difficult task given their subtle implications. Future empirical research has to test in a more systematic way how growth and unemployment are related, controlling for all kinds of variables, using improved data sets on more disaggregated levels, and acknowledging the insights (to be) gained by theoretical research in order to avoid testing without a sound theoretical background.

Conclusions

The model that has been developed in this paper is characterized by the endogenous determination of (i) economic growth, (ii) non-competitive wage differentials and (iii) unemployment. A crucial role in this model is played by trade unions that struggle with high-tech firms about the rents generated by those firms. The outcome of this struggle was shown to be an important determinant of equilibrium growth and unemployment. The model enables us to address some elements of the pressing problems of unemployment and economic growth in a single and coherent general-equilibrium framework.

The results described here should be useful for a better understanding of the post World War II performance of European countries. In this author's opinion, the development of the generous welfare state (as represented by an increase in f) is an important element in explaining this performance characterized by increased unemployment and lower growth since the early 1970s. In this sense, this paper can be seen as complementary to the paper by Daveri and Tabellini (1997) who point at the importance of increased taxes on labor. The model also implicitly suggests some reasons for the empirically established fact that European countries have persistently stayed behind the United States in terms of productivity levels (refer to de Groot and van Schaik 1997 for a two-country model in which the focus is on the relative performance of the U.S. and Europe in terms of productivity and unemployment). The relatively generous welfare state that characterizes Europe in this view resulted in relatively high European unemployment rates and an associated small growth-generating high-tech sector. This may have had adverse consequences for the number of people working in the R&D sector of the economy with the associated consequence of lagging behind of Europe in terms of productivity performance.

NOTES

1. For an extensive discussion of other studies on growth and unemployment we refer to de Groot (1998).

2. A slightly modified version of Daveri and Tabellini's model can be found in Nickell and Layard (1997). They conclude that the mechanism focused upon by Daveri and Tabellini, which relies heavily on a strong impact of the interest rate (marginal product of capital) on savings, is one which they do not expect to operate much in practice. Still, they expect labour market institutions to be important and to affect long term growth rates not via equilibrium unemployment but via effects on savings, human capital accumulation, technological and managerial innovation, and the start-up rate of new companies.

3. This way of modelling is inspired by a paper of McDonald and Solow (1985). They show that in a dual labor market where only the primary sector of the labour market is unionised and the secondary sector behaves competitively, a non-competitive wage differential and equilibrium unemployment arises. The main focus of McDonald and Solow (1985) is on the development of wages and employment over the business cycle. Our focus is on the relation between growth and unemployment in the long run, abstracting from issues related to the business cycle.

4. By making this choice, we abstain from several interesting issues related to the operation of trade unions. For example, this choice of the objective function neglects the apparent fact that unions care about the macroeconomic unemployment rate, the income distribution, lay-off criteria, unemployment insurance, working conditions, and their membership. For our aim, the simple way of modelling a union's preferences is, however, sufficient. It captures the idea that we have in mind, namely that trade unions are mainly after the extraction of economic rents, aimed at furthering the interest of workers within the firm and resulting in a non-competitive wage differential.

5. It is important to recognise that unemployment in this model has the character of wait-unemployment. This means that some people are deliberately queuing up in the pool of unemployed in order to get a high-paid job with a relatively high probability. In principle every laid-off high-tech worker could get the wage in the secondary sector, and hence this is the relevant outside option for the trade union. The only reason not to opt for this wage is that it may be in the (economic) interest of some people to become unemployed.

6. In general, we can divide the parameter space in two regions. For $\lambda > 1 - (\varepsilon - 1)\gamma/\varepsilon$ the wage-differential (ω) is smaller than the mark-up ($\varepsilon/[\varepsilon-1]$). When either γ or λ goes to infinity, the wage-differential converges to one. For $\lambda < 1 - (\varepsilon-1)\gamma/\varepsilon$, the wage-differential (ω) is larger than the mark-up, and for $\lambda = 1 - (\varepsilon -1)\gamma/\varepsilon$ they are equal.

7. We assume for simplicity that benefits are paid out of non-distortionary lump-sum taxes. The height of these benefits is exogenously given.

8. In addition, not considered here, there may be non-pecuniary benefits from being unemployed (e.g., the consumption of leisure) yielding total utility from being unemployed that is larger than utility from working in the secondary sector. More specifically, we can assume that bw_Y represents the unemployment benefit *plus* the value of leisure. In this case it may hold that benefits that are paid to unemployed are lower than wages in the secondary sector, while bw_Y is larger than wages in the secondary sector. We then can generate equilibrium unemployment, even if unemployed people are relatively poorly matched with high-wage jobs.

9. Substituting the expression for C_t into the utility function C.1, we get $U_0 = \int w_j e^{-(\theta - \sigma g)t} dt$.

10. Note that we can neglect flows between traditional-sector employment and unemployment, because, in equilibrium, there is no incentive to alternate between equilibrium strategies that have been chosen.
11. From goods-market equilibrium (equation 1), we derive using the production functions and pricing behaviour of firms in both sectors that
$$YP_y/XP_x = L_y w_y (\epsilon - 1)/NL_x \epsilon (1+\beta) w_T = (1-\sigma)/\sigma.$$
12. Drawing L_x as a function of g in Figure 2 results in a two rectangular hyperbolics of which one can be excluded since U, g and L_x have to be non-negative for an economically reasonable equilibrium.
13. From equation, 22 it follows that L_x unambiguously decreases when benefits increase. Using goods-market equilibrium (equation1) and the definition for the size of the high-tech sector (equation 18), we derive that L_T and L_Y thus decrease. Using labour-market equilibrium (equation 19) it directly follows that unemployment will increase. This result straightforwardly follows using Figure 2 in which the TT-locus turns downwards.
14. On the basis of an extensive sensitivity analysis for reasonable parameter values, we express confidence in all the qualitative results presented in Table 3.
15. An extensive study with an exclusive focus on the relation between unemployment and labour market institutions is Nickell (1997).
16. The only variable included in the growth-regression is productivity relative to the USA at the beginning of the time-period. Inclusion of this variable reduces the explanatory power of the variables capturing labour market institutions. We refer to Barro and Sala-i-Martin (1995), Levine and Renelt (1992) and Mankiw, Romer and Weil (1992) for extensive empirical studies regressing growth in a cross-section of countries on potential explanatory variables like population growth, savings rates, school enrolment rates, initial income per capita relative to the leader country (the USA), trade variables like the terms of trade and openness, government consumption and investment, and institutional variables like political instability, black market premia, tariff rates and political rights. We refer to Temple (1999) for an excellent survey of empirical insights on growth performance.

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