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The Struggle for Rents in a Schumpeterian Economy

A General Equilibrium Model

by

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Abstract.
This paper develops a two-sector endogenous growth model with a dual labour market. Trade unions strive for the extraction of as high a rent as possible from the growth generating imperfectly competitive primary sector. This union behaviour results in a non-competitive wage differential between the primary and secondary (perfectly competitive) sector. The consequence of this distortion is the coming about of wait unemployment, *i.e.*, unemployed queuing for high-paid jobs. Employment and growth are negatively dependent on the relative strength of the union. An increase in concentration in the high-tech sector is good for growth and employment.

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1. Introduction.

Unemployment is currently seen as one of the most pressing economic problems that deserves to be put high on the policy agenda of the European Community. At the same time, there is deep concern about the relative position (in terms of, *e.g.*, labour productivity) of Europe in the world-economy. The OECD recently took a standpoint in the intriguing debate on these issues by arguing that 'Establishing a competitive environment could, therefore, improve job prospects by both eliminating wage premia and encouraging output expansion' (*cf.* OECD 1994c, p. 23 and 53). From this policy prescription it seems as if there is a free lunch associated with strengthening competitive forces in an economy as it might *both* foster economic growth and reduce unemployment. To assess the OECD argument, we will develop an endogenous growth model that enables us to address the issues raised by the OECD in a consistent framework. From a theoretical point of view, we contribute to the literature, as not many studies have appeared that allow us to assess the interrelatedness of endogenous growth and unemployment in a general equilibrium framework.

The existence of large, non-competitive inter-industry wage differentials for the US has convincingly been shown in a seminal paper by Krueger and Summers (1988). Other empirical studies (*e.g.*, Brown and Medoff (1989), Dickens and Katz (1987), and Gera and Grenier (1994)) have shown these differentials to be positively correlated with average firm size in the industry, profitability of the industry, union density, and industry concentration. Furthermore, the wage differential turns out to be stable over time and consistent between countries. The issue of unemployment and its potential relation with economic growth is particularly interesting in Europe where the unemployment problem is 'probably the most widely feared phenomenon of our times. It touches all parts of society' (OECD 1994a, p.7). Various explanations for the difference in unemployment performance between countries and over time have been proposed (*e.g.*, Bean (1994a and 1994b), and Layard *et al.* (1991)), among which the potential role of trade unions is often stressed. Research on economic growth has seen a resurgence, both theoretically and empirically, in questions on the role of institutions in determining the long-run wealth of nations.

Somewhat undervalued is the potentially important role of labour market institutions. It is especially in this area of research that we try to add to the existing theoretical literature, by stressing the interrelatedness between labour market institutions, unemployment and growth.

In order to be able to achieve the goals set out above, we need a model that simultaneously explains the existence of (i) non-competitive wage differentials, (ii) endogenous growth, and (iii) unemployment. We therefore develop a two-sector endogenous growth model with a dual labour market. The secondary, traditional sector operates under perfect competition and produces a homogeneous good. The primary, high-tech sector produces various brands of a high-tech product. Firms in this sector operate under monopolistic competition, and consequently earn a non-competitive rent. Trade unions struggle on behalf of the production 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 to the high-tech workers. High-tech workers thus receive a non-competitive rent, which makes working in the high-tech sector more attractive than working in the competitive secondary sector. Under some reasonable assumptions, this is shown to generate 'wait unemployment' in equilibrium, *i.e.*, workers queuing for high-tech high-paid jobs. The model has Schumpeterian characteristics as the rate of growth crucially depends on the opportunity of high-tech firms to make profits. Contrary to the common economic wisdom (as expressed by, *e.g.*, the OECD (1994)), concentration is shown to be good for growth and employment.

This model relates to existing theoretical literature in several ways. The labour-market block of our model is inspired by a paper by McDonald and Solow (1985). They show that in a dual labour market, where only the primary sector of the labour market is unionized and the secondary sector behaves competitively, a non-competitive wage differential and equilibrium unemployment arises.[1] The growth block is based on Smulders and Van de Klundert (1995). They have incorporated the accumulation of firm-specific knowledge in a general equilibrium two-sector endogenous growth model. The main contribution of our paper to the existing literature is that we allow for the existence of equilibrium unemployment and endogenous growth in a general equilibrium two-sector model. Most of the papers addressing the relationship between endogenous growth and unemployment, use search-models of the labour market (*e.g.*, Bean and Pissarides (1993), Aghion and Howitt (1991 and 1994)). An efficiency wage approach to generate a relationship between growth and unemployment is used in Van Schaik and De Groot (1995). Bean and Crafts (1995) address the potential relationship between the operation of trade unions and

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[1] The main focus of McDonald and Solow (1985) is on the development of wages and employment over the business cycle. We only deal with steady-state issues.

economic growth.[2] We deviate from these previous studies by allowing the accumulation of firm specific knowledge (resulting in endogenous growth) and the coming about of non-competitive wage differentials due to the operation of trade unions (resulting in equilibrium unemployment) in a dual labour market. A second theoretical contribution is related to the labour-market block of our model. Dual labour-market models as developed by Harris and Todaro (1970) are often criticized for unemployment being positively related to primary-sector employment (which is inconsistent with empirical evidence; Lindbeck and Snower (1991)). Our general equilibrium model turns out to overcome this unattractive feature.

We think that this model yields some useful insights for understanding the Post-WWII development of Europe. This development is characterized by low unemployment and high growth in the 1950s and 1960s, while the 1970s and 1980s saw high unemployment accompanied with low growth rates. We argue that for understanding these developments, attention has to be paid to (i) distortions in labour supply caused by the welfare states that came about in the 1960s and early 1970s, and (ii) the changing potential to grow due to diminishing catching-up possibilities. Combination of these two factors is argued to be a potentially important explanation for European stagnation since the early 1970s.

This paper proceeds as follows. Section 2 briefly presents the consumer and producer behaviour in our model, which is inspired by an endogenous growth model with firm specific knowledge as developed by Smulders and Van de Klundert (1995). This section mainly serves for setting the stage of the model. The central and most innovative part of the paper is in section 3 where we extensively discuss the labour-market block of our model. This section will be concluded with a numerical example of the partial labour-market block. In section 4, we will start with a brief discussion of the growth block of the model. Then we will simulate the complete model and present some numerical simulations. Section 4.3 contains some discussion on the potential relevance of the model developed in this paper. Section 5 concludes.

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[2] Van der Ploeg (1987) develops a model in which the operation of a trade union is shown to lower investment and the capital stock. The reason is essentially that the union's promise of low future wage demands, which is optimal ex ante as it encourages present investment in capital, is incredible. The union namely has an incentive to renege on its promise once the capital has been installed. This credibility problem generates an inefficiency caused by trade unions in terms of reduced output, capital and employment. Endogenous growth is not considered in the model, however. This paper will not deal with the credibility problems that potentially arise. We will model the unions as being myopic in the sense that they disregard the effects of their wage claims on investment behaviour of the firms. However, we do allow for the existence of endogenous growth.

2. Consumer and Producer Behaviour.

We model a two-sector economy with endogenous growth. The producer and consumer behaviour in such models is more or less standard in the literature on endogenous growth and discussed extensively in, *e.g.*, Smulders and Van de Klundert (1995), and Van Schaik and De Groot (1995). We therefore restrict ourselves to a very brief description. This section only serves as a background.

Our economy consists out of two sectors, one high-tech and one traditional sector. In the traditional sector, a homogeneous good is produced under perfect competition. In the high-tech sector, n firms are operating, indexed $i = 1,...,n$. This number of firms is chosen to be exogenous. We deliberately abstain in this paper from the complex issue of entry and exit behaviour and all related strategic considerations. They are interesting in their own right (see for example Van Schaik and De Groot (1995)), but not essential for the issues that we want to focus on in this paper.[3] Each of these firms produces a unique brand of the high-tech good. Monopolistic competition prevails in this sector. We assume that a high-tech firm holds only a negligibly small market share (n is supposed to be sufficiently large), so that competition is monopolistically à la Chamberlin. There is only one homogeneous factor of production, *viz.* labour. Labour can be in one of three potential states, *viz.* being employed in one of the two sectors or being unemployed. It gets a 'state specific' payment (we will turn to this issue at length in the next section). Consumers maximize intertemporal utility, where utility is derived from consumption of the goods produced in the economy.

Consumer behaviour is summarized in Table 1. Consumers maximize their intertemporal utility (C.1). They derive utility from consumption of traditional and high-tech goods (C.2). Finally, consumers have a love for variety, indicated by (C.3). Performing optimization in three steps yields the familiar Ramsey-rule (eq. 1), a spending rule showing that a fraction (1-σ) of consumption expenditures is spent on traditional goods, and the demand function for a high-tech good of variety i (eq. 4). Finally, we get a macroeconomic price index (eq. 3), and a price index of high-tech goods (eq. 5).

Producer behaviour is summarized in Table 2. Producers in the traditional sector operate under perfect competition and produce a homogeneous good with unitary labour productivity (eqs. 6 and 7). Firms in the high-tech sector maximize the present discounted value of all future profits

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[3] Another reason for this choice is that an exogenously given number of firms with persistent profit opportunities matches real world phenomena quite well (see Mueller (1986)). Nevertheless, a world in which profits are driven to zero by the process of entry and exit of firms may serve, in our opinion, as a useful theoretical benchmark.

(P.1), subject to the production function (eq. 8), the accumulation of firm specific knowledge (eq. 9), and the demand function for the brand of the variety it produces (eq. 4). Optimization yields mark-up pricing (eq. 10), a static condition for optimal investment in R&D (eq. 11), and a dynamic equation governing the allocation of high-tech labour over time (eq. 12).

Table 1. Consumer behaviour

$$\max\ U_0 = \int_0^\infty \frac{c_t^{1-\rho}}{1-\rho} e^{-\theta t} dt \quad \text{s.t.} \quad \dot{A}_t = r_t A_t + I_t - c_t P_{ct} \tag{C.1}$$

$$\max\ c = X^\sigma Y^{1-\sigma} \quad \text{s.t.} \quad X P_X + Y P_Y = c P_c \tag{C.2}$$

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

This three-step maximization problem yields

$$\frac{\dot{c}}{c} = \frac{1}{\rho}\left[r - \frac{\dot{P}_c}{P_c} - \theta\right]. \tag{1}$$

$$\frac{Y P_Y}{1-\sigma} = c P_c = \frac{X P_X}{\sigma} \quad \text{where} \tag{2}$$

$$P_c = \left(\frac{P_X}{\sigma}\right)^\sigma \left(\frac{P_Y}{1-\sigma}\right)^{1-\sigma} \tag{3}$$

$$x_i = X\left(\frac{p_{xi}}{P_X}\right)^{-\varepsilon} \quad \text{where} \tag{4}$$

$$P_X = \left[\sum_{i=1}^{n} p_{xi}^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{5}$$

where

A: wealth
c: composite consumption good
I: income other than rental income
n: number of high-tech firms
P_c: macroeconomic price index
p_{xi}: price of high-tech good of variety i
P_X: price index of high-tech goods
P_Y: price of traditional good
r: nominal interest rate
U: utility index
x_i: volume of high-tech good of variety i
X: composite of high-tech goods
Y: volume of traditional goods

θ: subjective discount rate
$1/\rho$: intertemporal elasticity of substitution
ε: elasticity of substitution between high-tech goods ($\varepsilon>1$)
σ: share of high-tech goods in utility ($0<\sigma<1$)

A dot over a variable represents a derivative w.r.t. time

Table 2. Producer behaviour

Traditional sector

$$Y = L_Y \tag{6}$$

$$P_Y = w_Y \tag{7}$$

High-tech sector

$$\max_{L_{ri}, L_{xi}} V_i = \int_0^\infty \left[x_{it} p_{xit} - (L_{xit} + L_{rit} + L_{fi}) w_{xi} \right] e^{-rt} dt \tag{P.1}$$

subject to

$$x_i = h_i L_{xi}, \tag{8}$$

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

$$x_i = X \left(\frac{p_{xi}}{P_X} \right)^{-\varepsilon}. \tag{4}$$

This yields (assuming symmetry)

$$p_x = \frac{\varepsilon}{\varepsilon - 1} \frac{w_x}{h} \tag{10}$$

$$w_x = p_h \xi h \tag{11}$$

$$r = \xi L_r + L_x \frac{p_x}{p_h} \frac{\varepsilon - 1}{\varepsilon} + \frac{\dot{p}_h}{p_h} \tag{12}$$

where

h: high-tech labour productivity
L_f: fixed cost (*e.g.* management)
L_r: research labour
L_x: high-tech production labour
L_Y: traditional labour
p_h: shadow price of investment in R&D
w_x: wage rate in high-tech sector
w_Y: wage rate in traditional sector
ξ: productivity parameter in R&D

3. The Labour Market of the Model.

In this section, we will state the labour-market block of our model. Section 3.1 discusses union behaviour. This union behaviour is shown to result in a non-competitive wage-differential in section 3.2. Equilibrium unemployment is derived in section 3.3. We end with the presentation of an illustrative numerical example of the partial labour-market equilibrium in section 3.4.

3.1 Union behaviour.

We assume that in each monopolistically competitive high-tech firm, a trade union is operating. The union and the firm play a game on the division of rents generated by the production of the differentiated high-tech good. For simplicity, we assume that the union only represents the production workers who are currently employed (an assumption that seems to match reality rather well). The objective of the union is to extract as much of the rents generated in the high-tech firm as possible. 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, *e.g.*, the macroeconomic unemployment rate, the income distribution, lay-off criteria, unemployment insurance, working conditions, and their membership (we refer to *e.g.*, Oswald (1985) and Layard *et al.* (1991) for extensive discussions on the potential objectives of trade unions). 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 in the firm.

In pursuing rent maximization, the union has to outweigh the positive effect of wage increases with the negative labour 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 modelled as follows:

$$\max_{w_{xi}} \; \Omega_i \;=\; (w_{xi} - O)\, L_{xi} \left(\pi_i^{\prime}(w_{xi}) - \bar{\pi}_i\right)^{\gamma}, \quad \text{where} \quad \pi_i^{\prime} \;=\; p_{xi} x_i - w_{xi} L_{xi} . \tag{13}$$

This is the so-called Nash bargain, or 'right to manage' approach to bargaining between trade unions and firms. The parameter γ reflects the *relative* bargaining power of the firm, O reflects the alternative or outside wage for a high-tech production worker, and $\bar{\pi}_i$ is the firm's profit in case no agreement is reached in the bargain. 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, we find the efficient bargaining approach 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), and Clark and Oswald (1989)). Secondly, an efficient bargain 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 labour 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, γ. This relative power depends on the eagerness with which the firm wants to reach an agreement (relative to the unions eagerness). The second factor is the union's objective in the bargain, $(w_{xi}-O)L_{xi}$. The union thus wants to maximize the wage bill over the alternative income of the production workers in the firm. It might alternatively, without affecting the main results, aim at maximizing the income of all workers employed in the firm. The third term represents the operating profits of the firm, net of the outside profit that prevails if no agreement is reached. Without loss of generality, we assume $\bar{\pi}_i=0$ in the remainder of this paper (see footnote 4). We could, alternatively, use the firm's total profits in the bargain. This will not affect the main results, though it complicates the expressions to be derived considerably (the main effect of using total profits is that the bargained wage is lowered as the firm is more resistant to wage increases as these increases also have to be paid to the research and 'fixed' workers).

Log-linearizing the Nash maximand and taking the derivative w.r.t. the wage rate yields the first order condition for a maximum

$$\frac{\partial \Omega_i}{\partial w_{xi}} = \frac{1}{L_{xi}(w_{xi}-O)}\left[\frac{\partial L_{xi}}{\partial w_{xi}}(w_{xi}-O) + L_{xi}\right] + \frac{\gamma}{\pi_i^{\prime}}\frac{\partial \pi_i^{\prime}}{\partial w_{xi}} = 0. \tag{14}$$

Using the envelope theorem ($\partial\pi_i^{\prime} / \partial w_{xi} = -L_{xi}$), and

$$\frac{\partial L_{xi}}{\partial w_{xi}} = -\varepsilon \frac{L_{xi}}{w_{xi}}$$

which can be derived using the demand function for a good of variety *i*, leaves us, upon combination with (eq. 14), with[4]

$$\frac{w_{xi} - O}{w_{xi}} = \frac{1}{\varepsilon + \gamma(\varepsilon - 1)} \quad \text{so} \quad w_{xi} = O\frac{\varepsilon + \gamma(\varepsilon - 1)}{\varepsilon + \gamma(\varepsilon - 1) - 1}$$

3.2 The non-competitive wage differential.

After having determined the wage on the basis of the bargain described above, the firm extends the wage rate to the managers and research labourers (that is, the wage which is agreed upon for the production workers also applies to non-production workers in the firm). Though simplifying, this assumption seems justified. Empirical research has shown that if one occupational group in a certain firm or industry is highly paid, then workers in other occupational groups in that same firm or industry are also highly paid (*e.g.*, Dickens and Katz (1987) and Dell'Aringa and Lucifora (1990)).[5] This evidence points to the existence of rent sharing. Furthermore, the firm unilaterally chooses its employment level (the 'right to manage' approach) with the objective of maximizing the present discounted value of the firm (see Table 2).

Using the mark-up of the wage rate over the alternative wage, we can now characterize the non-competitive wage differential. In the remainder of this paper we will assume the alternative wage to be equal to the unemployment benefit.[6] This benefit is paid out of lump sum taxes and

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4 Not making the assumption of zero 'opportunity profits' leaves us with the following result for the mark-up

$$\frac{w_x - O}{w_x} = \frac{w_x \frac{1}{\varepsilon - 1} L_x - \bar{\pi}}{w_x L_x \left(\frac{\varepsilon}{\varepsilon - 1} + \gamma\right) - \bar{\pi}\varepsilon}$$

This solution is intractable analytically. The comparative statics results are, however, in line with results described earlier. The only important difference is that the mark-up is lower the higher the outside option per production worker for the firm. The reason for this is simply that a high outside option makes the firm more resistant to high wages and increases the threatpoint of the firm.

5 Lindbeck and Snower (1990) develop an insider-outsider model to explain this phenomenon (together with the existence of non-competitive wage differentials). There is an issue of aggregation here. We assume in our model that wages are extended to managers and research labourers at the firm level. The empirical studies referred to look at the correlations of wage premia for different groups at industry level.

6 Alternatively, we could model the alternative wage as a weighted average of the unemployment benefit and the wage rate in the traditional sector, where the weights are determined on the basis of the probability that one ends up in one of the two states (*i.e.*, unemployment or employment in the traditional sector). This would, however, complicate the analysis without altering the qualitative results.

equals a fixed proportion (*b*) of the wage in the traditional sector. We can then derive the relative wage (ω)[7]

$$\frac{w_x}{w_Y} \equiv \omega = b\,\frac{\varepsilon + \gamma(\varepsilon - 1)}{\varepsilon + \gamma(\varepsilon - 1) - 1} > 1 \tag{15}$$

We thus see 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 at all in paying high wages.[8] 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. Finally, an increase in the unemployment benefit increases the wage differential. This is due to the fact that increased benefits improve the union's bargaining position as the 'fall-back earnings' of the production workers (the earnings in case no agreement is reached and the worker becomes unemployed) are better.

From the previous description of union behaviour, it has become clear that the trade union is able to extract part of the firm's rent and distribute this among the workers in the high-tech firm. Such a union is absent in the traditional sector, resulting in a non-competitive wage differential between the high-tech and the traditional sector. Our division of sectors in a high-tech, unionized, imperfectly competitive sector with high-paid jobs, and a competitive, traditional sector with low-paid jobs closely resembles the distinction made by Doeringer and Piore (1971) between the primary and secondary sector (see also Dickens and Lang (1988) for a description of the renaissance of segmented labour-market models). In the real world, one can think of the primary sector as being the high-tech industrial sector, while large parts of the service sector possess the attributes of the secondary sector (Bluestone and Harrison (1988)). Furthermore, the distinction matches the empirical literature on wage differentials quite well. This literature shows non-competitive wage-differentials to be most prominent in imperfectly competitive and profit making industries.

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7 Note that we assume symmetry between high-tech firms so we can skip the firm-indices. From this point on, we assume $(1-b)(\varepsilon+\gamma(\varepsilon-1)) < 1$ (to guarantee $\omega>1$, as is consistent with empirical evidence).

8 This might change when efficiency wage considerations are allowed to play a role in the model (see, *e.g.*, De Groot and Van Schaik (1995) for a two-country endogenous growth model where such considerations turn out to be crucial in determining equilibrium unemployment and the relative labour productivity of countries).

3.3 Equilibrium unemployment in a dual labour market.

An essential characteristic of our model described so far is its dual labour market. The trade union, operating in the high-tech sector, extracts rents from the firms in the process of bargaining with the firm. This leads to primary-sector workers receiving a non-competitive rent ($\omega>1$). As workers are striving for the highest possible pay-off, all workers would in principle like to be employed in the high-tech sector. The number of jobs in this sector is, however, restricted. We assume that at some exogenous rate δ jobs in the high-tech sector fall free. Upon being laid-off, a worker faces two options. He can either decide to allocate himself to a job in the traditional sector (these jobs are freely available), 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 earnings rate when being employed in the traditional sector ($b<1$), and (ii) the probability of entering the high-tech sector from the secondary sector (αq) is lower than from unemployment (q). The process of outweighing the two opportunities that laid-off high-tech workers are facing finally results in a (endogenously determined) probability (η) of going to one of the two states (*i.e.*, the state of unemployment or traditional sector employment; see Hansen (1985)). After having chosen this probability, the workers are distributed randomly. The outcome for this probability is such that ex-ante laid-off workers are indifferent between the two options that they are facing.[9] Over their whole lifetime, all workers earn the same (in expected terms). A perfect insurance market guarantees that all consumers can consume their optimal amount each period.

In Figure 1, we depict the labour market and the flows on this market in a stylized way. Note that in equilibrium, there is no incentive to alternate between equilibrium strategies that have been made. Take, for example, a worker who is in the traditional sector. Being in that sector has some value for him, and this value is composed out of current and future earnings. In equilibrium, this value is the same as the value that unemployed workers derive from being unemployed. Now suppose that a traditional sector worker moves to the pool of unemployed. The effect of that move is that the value of being unemployed goes down as more unemployed people are competing for the high-tech jobs falling free, reducing the probability of entering the high-tech sector (this

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9 An alternative way of looking at this process is the following. Each period, δL_T persons are laid-off in the high-tech sector (where L_T is high-tech employment and equals, by definition, $n(L_x+L_r+L_f)$). They form a coalition and aim at maximizing the total discounted future pay-off for the group as a whole. This maximum is reached for some division of the laid-off workers over the two states. After having determined this optimal division, members of the group are allocated randomly (but according to the optimal division) over unemployment and traditional sector employment.

probability, *q*, is determined endogenously in the model). Moving from traditional-sector employment to the pool of unemployment is therefore no strategy that will be chosen in equilibrium (and vice versa). We can thus neglect flows between traditional-sector employment and unemployment.

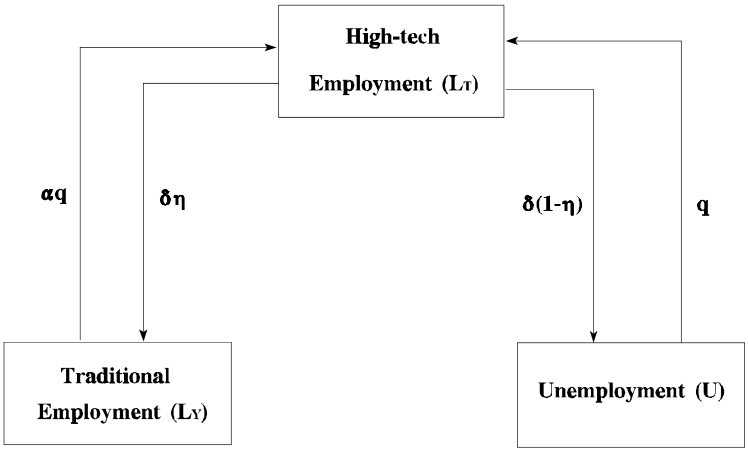

Figure 1. Labour-market flows

The assumption of the unemployed having a higher probability of entering into the high-tech sector than workers in the traditional sector (α<1) is crucial for our model and intensively debated (and used as a working hypothesis) in the literature (*e.g.*, Bulow and Summers (1986), Burda (1988), Calvo (1978), Harris and Todaro (1970), McCormick (1990), Taubman and Wachter (1986)). Reasons that we can advance are (i) that a secondary-sector worker has less time to search for a high-tech job (which is often argued to be questionable from an empirical point of view as unemployed persons appear to spend only little more time on searching for jobs than employed workers, and on-the-job search is a very natural phenomenon), (ii) that a high-tech firm is less inclined to offer a secondary-sector worker a job than an unemployed person as acceptance of secondary-sector work is conceived as being a bad signal (*e.g.*, McCormick 1990), (iii) that secondary-sector employment ‘scars’ workers by reducing their trainability and punctuality (*e.g.*, Doeringer and Piore (1971)). Lindbeck and Snower (1991) give a critical discussion of the Harris and Todaro types of theories and provide alternative explanations for the coexistence of a perfectly competitive secondary sector and equilibrium unemployment. These alternatives use heterogenous preferences (for example some workers disliking secondary-sector jobs more than others), or heterogenous productivities or endowments to explain the coming about of unemployment.[10] Though the assumption made is not without problems, we still feel comfortable with its use as a working hypothesis (see also Burda (1988), Clark and Summers (1979) and Pissarides (1988) for empirical support for our choice).

To formalize the determination of the labour-market equilibrium, we now introduce three value functions (Bellman equations; see, *e.g.*, Pissarides (1990)). Let V_Y, V_U, and V_T denote the present discounted value of expected income streams of, respectively, a worker in the traditional sector, an unemployed, and a worker in the high-tech sector. The worker in the traditional 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 αq, which yields him a surplus of V_T - V_Y over his current position. V_Y thus satisfies

$$rV_Y = w_Y + \alpha q(V_T - V_Y) \tag{16}$$

where rV_Y is, in a perfect capital market, the valuation put on having a job in the traditional sector (this job may be seen as an asset). This valuation equals the return on the traditional sector job. This equation can also be written as

$$V_Y = \frac{1}{1+r}\left[w_Y + (1-\alpha q)V_Y + \alpha q V_T\right]$$

According to this formulation, the present discounted value of being in the traditional sector equals the present discounted value of the wage earned in the current position (which is assumed to be paid at the end of the period) plus the expected value derived from the state the worker is in during the next period. With probability αq the worker gets a job in the high-tech sector (which has a value of V_T), while with the residual probability the worker remains in his current state and gets V_Y.

Similarly, we derive

$$rV_U = bw_Y + q(V_T - V_U) \tag{17}$$

and

$$rV_T = w_x + \delta\eta\,(V_Y - V_T) + \delta(1-\eta)(V_U - V_T) \tag{18}$$

Note that the workers discount their income at the nominal interest rate r, as they can freely save

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10 Another line of reasoning that can also explain the existence of wait unemployment relies on subjective factors. Waiting for a high-tech job in this view is preferred if the utility from unemployment benefits and status effects associated with a primary job exceeds the utility derived from a secondary sector job (this is worked out in a formal model by Van de Klundert (1990)). Using such a framework (instead of the assumption that the probability of getting a high-wage job is lower when being a secondary sector worker) would not alter the main results of the model.

and borrow at the financial market at the nominal interest rate. This enables them to smooth their consumption profile over their lifetime (note that over their whole lifetime, all consumers earn the same amount of money in expected terms). For equilibrium to hold, we require throughout that the value of a job in the traditional sector equals the value of being unemployed

$$V_Y = V_U \tag{19}$$

We impose two flow-equilibrium conditions, guaranteeing a constant allocation of labour over the three states

$$\delta\eta L_T = \alpha q L_Y \tag{20}$$

and

$$\delta(1-\eta)L_T = qU \tag{21}$$

where

$$L_T = n(L_x + L_r + L_f) \tag{22}$$

Finally, we have to impose a stock-equilibrium condition

$$L = L_T + L_Y + U \tag{23}$$

so total labour supply (L) is either employed in one of the two sectors or unemployed. This labour-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 acceptance rate of a worker in the traditional sector (α), and the discount rate ($1/(1+r)$). We recall that the division of laid-off high-tech workers over unemployment and the traditional sector (η) is determined endogenously, as well as the probability of entering the high-tech sector (q).

The resulting unemployment in our model has to be thought of as wait unemployment. That is, part of the labour force is deliberately queuing for the high-paid jobs. In the dual structure that we have in our 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 traditional 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 high-tech sector, but are not offered such a job because of the rationing that is going on in that sector. We, in other words, do not argue that unemployed are lazy and are simply not willing to accept a job. However, unemployment should not only be seen as a demand-side problem. It also results from distorted supply due to the availability of generous benefits (see Ljungqvist and Sargent (1996)). Burda (1988) forcefully argues that wait unemployment, which has to be understood as a sort of investment decision, is useful in understanding the recent development of unemployment in

Europe. Some empirical evidence for this view is given in his paper. Other evidence comes from Clark and Summers (1979) who argue that primary-sector workers who are laid off are unlikely to accept secondary-sector jobs and prefer to wait for a new high-paid job to become available. Still another source of evidence is provided by Pissarides (1988) who shows, on the basis of the Labour Force Survey in Britain of 1984, that there are more unemployed job seekers than employed ones, as is consistent with the idea of wait unemployment. There is, however, no general consensus on the importance of wait unemployment in the literature.

At this point, one can think of various extensions that might enrich the labour-market block of the model. One could think of, *e.g.*, the probability (q) of finding a job in the high-tech sector being negatively dependent on the time that one has spent looking for such a job. This would enable us to capture the issue of long-term, persistent, unemployment due to, for example, obsolescence of skills. We could also allow for a positive value of leisure enjoyed when unemployed, heterogeneous labour where part of the labour force is simply unwilling to accept a job in the secondary sector (*cf.* McCormick 1990), status effects associated with being employed in the primary sector, unemployment benefits being partly indexed on past earnings, the relative bargaining-power of unions being negatively dependent on the macroeconomic unemployment rate, *etc.*. These extensions will modify the results of the model but still, the basic economic forces (*i.e.*, workers having an incentive to allocate themselves towards unemployment when laid-off and wait for a high-tech job as this is in their own economic interest) described in this paper remain at work.

3.4 A numerical example.

To give a good insight into the model developed in this paper, we will present the partial equilibrium model of the labour-market block. This labour-market block is the most innovative part of this paper and a good understanding of this block is required to grasp the working of the general equilibrium model (to be discussed in section 4.2). The partial labour-market model that will be discussed in this section consists of equations (16)-(21) and (23). We add the wage equation $\omega=Wb$, and goods-market equilibrium $L_Y=\zeta L_T$ to complete the model. The wage equation is a short-hand notation of eq. (15), so the parameter W reflects, among others, the relative union power and the demand elasticity of high-tech goods. The goods-market equilibrium can be understood as a simplified representation of consumer behaviour, as represented in Table 1. As consumers have Cobb-Douglas preferences, they spend fixed shares of their income on traditional and high-tech goods. This results in an equilibrium allocation of employed labour over the two sectors. The stronger the consumers prefer traditional goods over high-tech goods, the higher the parameter ζ.[11] So we have a partial equilibrium model with nine equations and eleven unknowns (V_Y, V_T, V_U, L_T, U, L_Y, w_x, w_Y, r, q, and η). We take the wage rate in the traditional sector as a numéraire (w_Y=1). The nominal interest rate is exogenously determined.

In the remainder of this subsection, we will distinguish two scenarios. The first is characterized by high growth and interest rates.[12] We will call this the 'high-growth scenario'. The second is characterized by a low growth rate (the 'low-growth scenario'). In our numerical simulations we will take values for the nominal interest rate of 10% and 5%, respectively. The other parameters of the model are chosen to equal

$$\zeta=1.1,\ \alpha=0.3,\ \delta=0.3,\ W=1.25,\ b=0.9.$$

The results of the numerical simulations for our base run under the two scenarios are summarized in Table 3. Furthermore, the Table contains the comparative statics results for a 1% increase in unemployment benefits (b) and the parameter W (which can be thought of as an increase in the relative bargaining power of trade unions).

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[11] An important remark is that, as we assume $\zeta>0$, an increase in L_T is (given the labour-market constraint (23)) associated with a decrease in unemployment in our partial equilibrium model. This is in sharp contrast with the often criticized characteristic of partial Harris-Todaro models in which unemployment and high-tech employment move in the same direction. We return to this issue when describing the results in our general equilibrium model (in section 4.2). It will turn out that the relation between high-tech employment and unemployment can either be positive or negative.

[12] Note that the growth and interest rate are, in the general equilibrium model, positively linked by the Ramsey rule, which is left implicit in this partial equilibrium model (see Van Schaik and De Groot (1995) for an extensive discussion of the general equilibrium characteristics of the growth-block of our model).

Table 3. The high and low-growth scenarios.

	High-growth scenario			Low-growth scenario		
	base	W +1%	b +1 %	base	W +1%	b + 1%
High-tech Employment (L_T)	45.4	-2.6	-5.6	44.2	-2.9	-6.2
Traditional Employment (L_Y)	50.0	-2.6	-5.6	48.6	-2.9	-6.2
Unemployment (U)	4.6	+54.2	+115.5	7.2	+37.4	+79.3
Wage differential (ω)	1.13	+1.0	+1.0	1.12	+1.0	+1.0
Allocation parameter (η)	0.77	-12.0	-23.1	0.67	-12.0	-23.0
Acceptance probability (q)	0.70	-12.0	-23.1	0.61	-12.0	-23.0
'Unemployment rate' U/L_T	0.10	+58.3	+128.2	0.16	+41.4	+91.1

Note: The base-run values are in absolute values, while the comparative statics values are in percentage changes from the base-run.

We can conclude from Table 3 that under the high-growth scenario, high-tech employment is only slightly higher than under the low-growth scenario, while unemployment is significantly lower. There is, in other words, a negative relationship between growth and unemployment. This result can be understood as follows: with relatively high growth and interest rates, future earnings are relatively heavy discounted. In other words, much weight is put on current earnings. This implies that laid-off high-tech workers have a relatively strong incentive to allocate themselves into the direction of traditional sector employment (as this yields relatively high current earnings). The allocation parameter η is therefore relatively high under the high-growth scenario, resulting in relatively low equilibrium unemployment and an increased effective supply of labour (defined as (L-U), which is evenly distributed over the two sectors, given the operation of the goods-market equilibrium).

The comparative statics results are intuitively clear. An increase in unemployment benefits affects the allocation of labour in two ways. Firstly, it reduces the cost of waiting for a job in the high-tech sector as an unemployed person. Consequently, more laid-off high-tech workers allocate themselves in the direction of the pool of unemployed (η decreases). This reduces the effective supply of labour (L-U) and consequently reduces the employment in both sectors. Secondly, the increase in benefits increases the threatpoint of the trade union and thereby leads to a higher wage differential. This increases, ceteris paribus, the attractiveness of a future job in the high-tech sector which results in more people allocating towards the pool of unemployed as this yields the highest probability of a future high-paid job.

In case the relative bargaining power of the trade union (represented by *W*) increases, only the second effect described previously is operating. The increase in relative power increases the wage differential, increasing the attractiveness of a future job in the high-tech sector and resulting in higher unemployment and reduced effective labour supply.

A final remark to be made is that under the high-growth scenario, results are much more sensitive to shocks. The reason for this is that under the high-growth scenario the interest rate is high, increasing the discounting of future revenues and making people more sensitive to changes in current earnings.

4. Endogenous Growth and Equilibrium Unemployment.

This section is divided in three subsections. Section 4.1 very briefly presents a partial model in which the equilibrium rate of growth is derived for an exogenously given rate of unemployment (as extensively discussed in the previous section). In section 4.2 we come to the discussion of the complete model. We will simulate the model and present some comparative statics results. The overall results are in line with the results presented in section 3.4 and 4.1. Of course, some minor modifications have to be made in the general equilibrium context. This gives rise to some interesting results. Section 4.3 discusses the potential relevance of the model developed in this paper by assessing its usefulness for explaining the Post-WWII development of Europe in terms of growth and unemployment.

4.1 Endogenous growth in a dual economy.

In section 3.4, the interest rate was assumed exogenous. For understanding the determination of the equilibrium growth and interest rate, we will now focus on the growth block of our model. This will be done on the basis of a partial equilibrium model where U/L_T, which results from the labour-market equilibrium, is taken to be exogenous and equal to μ. The partial model further consists of equations (1)-(12), (15), (23), and a steady-state definition. We describe and solve the model in Appendix A. The equilibrium growth rate of the model is shown to equal

$$g = \frac{\xi\left[\frac{L}{n} - (1+\mu)L_f\right] - \theta\left[(1+\mu) + \frac{1-\sigma}{\sigma}\frac{\varepsilon}{\varepsilon-1}\omega\right]}{\sigma(\rho-1)\frac{\varepsilon}{\varepsilon-1}\frac{1-\sigma}{\sigma}\omega + (1+\mu)(\sigma(\rho-1)+1)}$$

This formula reveals the growth rate to depend negatively on the relative wage rate and the rate of unemployment (as a fraction of high-tech labour). In other words, the equilibrium rate of growth is crucially dependent on labour-market institutions. The less costly it is to become unemployed (*e.g.*, through a generous welfare system, strong labour unions, *etc*.) the lower the rate of growth. This can be understood as more unemployment lowers the effective supply of labour. This makes each firm in the high-tech sector smaller in size. Consequently, both the fixed and the quasi-fixed cost of R&D expenditures can be spread over less output. This reduces the incentive for high-tech firms to engage in R&D and in turn lowers the equilibrium rate of growth. Furthermore, the rate of growth negatively depends on the fixed cost of the firm. The reason for this has already been given. In Van Schaik and De Groot (1996) we elaborate on the importance of these fixed cost in a two-sector two-country endogenous growth model.

4.2 The complete model.

In this section, we undertake a numerical simulation. The parameter values that we use in our base run are

n=100, ξ=0.35, σ=0.5, ρ=6, θ=0.02, ε=2, b=0.9, γ=2.6, α=0.3, δ=0.3, L_f=0.1

The results for the base run are in Table 4.[13] In turn, we performed some comparative statics. The results are also in Table 4 (in percentage changes).

[13] We can compute border-line values for, *e.g.*, b, γ, n, ξ, and σ for which the unemployment rate is zero (assuming the other parameters to be equal to their base-line values). This is instructive for it once again shows that unemployment does not solely result from distortions on the labour market, but is also related to the situation on the goods-market. This is of course due to the general equilibrium characteristics of our model. The border-line parameters are computed as b=0.886, γ=3.174, n=45.53 (we ignore the integer problem), ξ=1.143 and σ=0.356.

Table 4. The general equilibrium model.

	base	(1-b) -1%	γ +1%	n -1%	ξ +1%
High-tech employment (L_T)	39.703	-0.636	+0.440	-0.026	+0.070
Traditional Employment (L_Y)	52.553	-0.679	+0.390	+0.209	+0.016
Unemployment (U)	7.744	+7.866	-4.903	-1.282	-0.469
Nominal interest rate (r)	0.080	-0.789	+0.546	+1.221	+1.016
Growth rate (g)	0.024	-1.053	+0.729	+1.628	+1.355
Allocation parameter (η)	0.671	-2.756	+1.767	+0.493	+0.160
Acceptance probability (q)	0.507	-2.714	+1.818	+0.257	+0.214
Research intensity (L_r/L_x)	0.300	-0.265	+0.181	+0.402	+0.335
Wage differential (ω)	1.150	+0.111	-0.156	0.000	0.000
Average firm size (L_T/n)	0.397	-0.636	+0.440	+0.984	+0.070
'Unemployment rate' (U/L_T)	0.195	+8.557	-5.320	-1.256	-0.539

Note: The base-run values are in absolute values, while the comparative statics values are in percentage changes from the base-run.

A first important remark regarding the results is that high-tech employment and unemployment do not always move in the same direction in our general equilibrium model. This is contrary to the Harris-Todaro type of models. Lindbeck and Snower (1991) criticize the Harris-Todaro types of models for this feature as it is inconsistent with empirical evidence. Our general equilibrium framework turns out to overcome this unattractive feature. This result points to the importance of a sound general equilibrium framework in which also demand and supply considerations are taken into account when analyzing the effects of, for example, policy changes (Lindbeck and Snower (1991) point to the importance of these general equilibrium effects but do not model them explicitly). In our model, general equilibrium characteristics may go somewhat at the expense of microeconomic rigour of the model. This is, however, an inevitable trade-off that one is facing in macroeconomic model-building. Especially the fully fledged demand and supply side of our model and the resulting endogenous determination of the nominal interest rate (in combination with the labour-market block) is crucial for understanding the development of the allocation of labour in our model.

A second general remark is that the ‘unemployment rate’ (U/L_T) and the interest rate (r) are consistently negatively related. This result was already implicitly pointed at in section 3.4, where we showed growth and unemployment to be negatively related in the partial labour-market model. This result stands upright in our fully fledged model.

Table 4 reveals some interesting conclusions. First of all, an increase in unemployment benefits is shown to increase unemployment and decrease the growth rate. The main factor in explaining this result is the distortion in the supply of labour caused by the increased benefits. The increased benefits reduce the cost of waiting in unemployment for a job in the high-tech sector. Consequently, more laid-off workers allocate themselves into the direction of unemployment (η decreases). This effect is reinforced by the benefits improving the threatpoint of the trade union and thereby increasing the bargained relative wage. In turn, the increased relative wage increases the attractiveness of a future high-tech job, leading more people to move towards the pool of unemployed. This results in a lower effective supply of labour. Consequently, employment decreases in both sectors. Given the number of firms, average firm size goes down in the high-tech sector. Research cost can therefore only be spread over less output, reducing the incentive to engage in R&D as well as the equilibrium rate of growth. A further effect explaining the huge increase in unemployment is related to the decrease in the interest rate. Due to this decrease, less weight is put on current earnings and more laid-off high-tech workers consequently decide to allocate themselves into the direction of unemployment, reinforcing the two effects described before. A similar kind of reasoning holds for an increase in the relative bargaining power of the trade union (a decrease in γ).

A second interesting result is that an increase in concentration in the high-tech sector (a decrease in the number of firms, n) turns out to be good for growth and employment, while it leaves the wage differential unaffected. This conclusion stands in sharp contrast with the analysis made in the *OECD Jobs Study* (1994) where increasing competition is argued to reduce non-competitive wage differentials and thereby reduce unemployment and increase output expansion. This result can best be understood as follows. As some firms leave the market (n decreases), the market share that is left for each firm individually increases. This in turn increases the average firm size, ceteris paribus. The consequence of this is that the fixed cost (L_f) and the quasi-fixed cost of doing research can be spread over more output, increasing the incentive for a firm to engage in R&D. The growth rate is consequently fostered (along with the interest rate). An important remark is that this conclusion is of course conditional upon the fact that a decrease in competition is assumed not to lead to decreased efficiency in the high-tech firms. We thus do not claim that decreased competition is, without any doubt, good for economic growth. We do want to stress, however, that a Schumpeterian kind of process is also at work when the intensity of competition is altered. This may lead to positive growth and employment effects of decreased competition. A further effect of increased concentration is that the overall size of the high-tech sector decreases; the increase in average firm size is more than offset by the decrease in the number of firms. To understand the change in the unemployment rate, it is essential to notice the increase in the equilibrium rate of interest. This increase decreases the importance attached by workers to future payments. A laid-off worker is therefore less inclined to accept a current low payment (bw_Y instead of w_Y) in exchange for a higher future probability of a well-paid job (q versus αq). More laid-off workers therefore choose to accept a job in the traditional sector instead of becoming unemployed (η increases).

We will finally discuss the effects of an increase in productivity in the research sector (for example due to increased catching-up possibilities; we will come back to this issue in section 4.3). Such an increase is shown to increase the growth rate and decrease equilibrium unemployment. The essential reason for this is that the increase in R&D productivity increases the incentive to engage in R&D (L_r/L_x increases). This increases the equilibrium rate of growth and the total size of the high-tech sector. Accompanied with the increased growth rate, also the equilibrium interest rate increases. This decreases the importance attached by the workers to current earnings and results into more laid-off high-tech workers allocating towards the traditional sector (η increases).

4.3 General discussion.

The model that has been developed in this paper is essentially 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 main theoretical contribution of this paper to the existing literature is, in our view, that this model enables us to address the pressing problems of unemployment and economic growth in a single, coherent framework. This places some results obtained on the basis of partial equilibrium models in a different perspective, and sometimes even gives rise to different conclusions (for example the Harris-Todaro result of unemployment and high-tech employment always being positively related is modified due to the working of the general equilibrium model).

The results described in section 4.2 might be useful for a better understanding of the Post-WWII performance of European countries. In our opinion, two crucial factors have been at play in this period, namely the development of the generous welfare state and the changing potential for Europe to catch-up in terms of productivity with the United States. The welfare state as *the* crucially important factor in the European unemployment problem is often neglected. The standard argument being that the timing of events has been wrong; during the building up of the welfare state, unemployment remained constant at low levels, while in the period that the generosity of the welfare state was stabilizing, unemployment levels increased to unprecedented levels. This argument has recently been challenged by Ljungqvist and Sargent (1996). According to them, the huge availability in the early postwar period of good jobs concealed the *inherent* instability in the European economies caused by the development of the welfare states. Once the economies were hit by adverse shocks (for example the oil crisis and the restructuring of the economy from manufacturing towards the service sector) the 'time bomb' of the generous welfare state came to explode. We subscribe to the importance of supply-side factors determining unemployment in explaining the relative growth and employment performance of countries (see also De Groot and Van Schaik (1995)). The way in which the generosity of the welfare state affects the outcome of the economic process in our model has extensively been described in previous sections.[14] Contrary to the Ljungqvist and Sargent paper, our model also allows us to assess the effects of the welfare system on economic growth.[15] A second crucial factor in our opinion for understanding European economic performance is the 'catching-up factor'. The 1950s and early 1960s were characterized

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[14] Benefits in our model should be thought of in a very broad sense. They in principal include eligibility criteria, duration of the benefit, social acceptance of making use of these benefits, institutional arrangements, *etc.* This complicates addressing the effects of benefits on unemployment (especially empirically). It is very hard to come up with a good measure of generosity of the welfare system, including all these aspects.

[15] Another important aspect in which our model differs from the Ljungqvist and Sargent model relates to the general equilibrium characteristics of our model. Good jobs in our model are situated in the high-tech sector. Ljungqvist and Sargent (1996) argue that the restructuring from the manufacturing to the service sector (and especially the economic turbulence associated with this restructuring) may have contributed to increased unemployment. In our general equilibrium model, however, this need not be the case. The restructuring from manufacturing to services has, in our opinion, largely been driven by demand factors (*e.g.*, Cornwall and Cornwall (1994)). Such a change in demand structure (σ decreases in our model) will lower economic growth and the size of the high-tech sector. The effect on equilibrium unemployment now depends on two countervailing effects. There is the decrease in the interest rate which is fostering unemployment, but on the other hand there is the shrinking high-tech sector which reduces the probability of getting a job in that sector and thereby reduces unemployment.

by a huge potential to imitate the United States and to catch-up in terms of labour productivity. This is the period of historically unprecedented economic growth. The high growth rates were associated with low unemployment. Although the welfare state was built up in that period and increased the inherent instability of the system, unemployment remained low. The inherent instability of the system was, in other words, concealed by the process of catching-up. In our model, this can be represented by a relatively large value of the productivity parameter of the research sector (ξ). As the potential to catch-up petered out in the early 1970s, growth in the European countries decreased (ξ decreased). This in turn may have led to increases in unemployment (see Table 4).[16]

5. Conclusion.

This paper has developed an endogenous growth model in which trade unions are allowed to play an important role. These trade unions aim at extracting rents generated in the growth generating high-tech sector. This behaviour results in a non-competitive wage differential, which is shown to yield an incentive for people to wait as an unemployed person for a job in the high-tech sector.
Numerical simulations lead us to the conclusion that increased concentration of high-tech firms fosters economic growth and decreases the rate of unemployment. This result is in sharp contrast with the general notion on increased competition as expressed by, *e.g.*, the OECD (1994), and is largely due to the Schumpeterian flavour of our model. Another result that has been derived is that strong unions and generous unemployment benefits are indeed bad for economic growth. By increasing the non-competitive wage differential they increase the incentive for laid-off high-tech workers to become unemployed, reducing the effective labour force and consequently reducing the growth potential of an economy.

In the end we can draw the conclusion that labour-market institutions, among which trade unions are one of the most important, can be of crucial importance for understanding (i) unemployment performance, as well as (ii) the growth potential of an economy. This second conclusion is underestimated in economic research so far. Future research, both theoretically and empirically, might benefit from recognizing this conclusion. To our view, a good understanding of the growth performance of countries, both in absolute and in relative terms, requires an understanding and recognition of the importance of labour-market institutions.

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[16] This reasoning is worked out in a formal model in Van Schaik and De Groot (1996).

Appendix A. Endogenous growth in a dual economy.

This appendix solves the partial endogenous growth model discussed in section 4.1. The model consists out of equations (1)-(12), (15), and (23). We reduce the labour-market block of the model to

$$U \equiv \mu L_T \tag{A.1}$$

and

$$\frac{w_x}{w_Y} \equiv \omega \tag{A.2}$$

We only solve for the steady-state in which it holds per definition that

$$g \equiv \frac{\dot{h}}{h} = \frac{\dot{x}}{x} = \frac{\dot{X}}{X} \quad \text{and} \quad \frac{\dot{Y}}{Y} = 0 \tag{A.3}$$

In addition, from the eqs. (2), (3), and (5), it can be derived that the steady-state circular flow equilibrium is characterized by[17]

$$g = \frac{\dot{P}_Y}{P_Y} - \frac{\dot{p}_x}{p_x} = \frac{1}{1-\sigma}\left(\frac{\dot{P}_c}{P_c} - \frac{\dot{p}_x}{p_x}\right) = \frac{1}{\sigma}\frac{\dot{c}}{c} \tag{A.4}$$

From equations (2), (6), (7), (8), (10), and (A.2) we derive goods-market equilibrium

$$L_Y = \frac{1-\sigma}{\sigma} n L_x \frac{\varepsilon}{\varepsilon - 1}\omega \tag{A.5}$$

Combination of eqs. (23) and (A.1) yields

$$L_Y = L - (1+\mu)L_T \tag{A.6}$$

Substituting out p_x/p_h using eqs. (10) and (11) from eq. (12) and using the steady-state definitions (A.3) and (A.4), and eq. (9) we can derive

$$r = \xi L_x \tag{A.7}$$

Combining the steady-state definitions with eq. (1) we get

$$g = \xi L_r = \frac{r-\theta}{\sigma(\rho-1)} \tag{A.8}$$

We can now derive the equilibrium number of high-tech production workers (L_x) by putting (A.5) and (A.6) equal and using (A.7), (A.8) and the definition for L_T ($=L_x+L_r+L_f$) as

[17] Note that we use the symmetry assumption throughout in this appendix. This allows us to write the expenditures on high-tech goods (XP_X) as nxp_x.

$$L_x = \frac{\frac{L}{n} - (1+\mu)\left(L_f - \frac{\theta/\xi}{\sigma(\rho-1)}\right)}{\frac{1-\sigma}{\sigma}\frac{\varepsilon}{\varepsilon-1}\omega + (1+\mu)\frac{\sigma(\rho-1)+1}{\sigma(\rho-1)}} \tag{A.9}$$

Finally, using (A.7), (A.8), and (A.9) we derive the equilibrium growth rate as

$$g = \frac{\xi\left[\frac{L}{n} - (1+\mu)L_f\right] - \theta\left[(1+\mu) + \frac{1-\sigma}{\sigma}\frac{\varepsilon}{\varepsilon-1}\omega\right]}{\sigma(\rho-1)\frac{\varepsilon}{\varepsilon-1}\frac{1-\sigma}{\sigma}\omega + (1+\mu)(\sigma(\rho-1)+1)} \tag{A.10}$$

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