

The Impact of a Unionised Labour Market in a Schumpeterian Growth Model*

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Abstract

This paper extends the seminal creative destruction growth model of Aghion/Howitt (1992) to investigate the relationship between unemployment and growth. We distinguish low-skilled and high-skilled labour and assume that a union bargains over the low-skilled labour wage. This causes unemployment, but the growth effect is ambiguous. On the one hand the higher wage will squeeze expected profits of innovators, which is bad for growth. On the other hand the union affects the marginal product of high-skilled labour and hence the high-skilled wage in the manufacturing sector declines. This causes a "migration" of high-skilled labour from the manufacturing into the research sector. This effect is growth enhancing. We show that the overall effect depends crucially on the elasticity of substitution between high-skilled and low-skilled labour. With an elasticity less than one the "good" growth effect dominates the bad, and vice versa. In the Cobb Douglas case the two effects cancel out.

JEL: O4, J5

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1 Introduction

Traditionally, growth and unemployment have been analysed rather separately. This dichotomy is justified on the grounds that unemployment is caused by business cycles, so it occurred only in the short run, whereas growth is a long run phenomenon. With the emergence of the unemployment problem in continental Europe, the view was challenged by the notion of equilibrium (i.e. long run) unemployment. Hence the time dimension of unemployment changed, and a large part of it was seen as structural. By and large, this structural unemployment has been put down to labour market institutions. This begs the question of whether unemployment causing institutions affect the growth path of an economy.

From an empirical point of view the relationship between growth and labour market institutions is unclear (see Nickell and Layard (1999) and Daveri and Tabellini (2000)). While the relationship between unemployment causing variables and TFP growth is weak or non-existent, Daveri and Tabellini report a significant negative relationship between growth and unemployment.

The usual theoretical framework of jointly analysing growth and unemployment have been models, where unemployment is generated by costly search (see e.g. Bean and Pissarides (1993), Pissarides (2000) or Aghion and Howitt (1998)).¹ Usually these models explain mainly the impact of growth on unemployment. In this paper, however, the reversed causality is analysed, where we model the equilibrium unemployment as caused by union wage bargaining and show the effect of unionisation on growth.

An early paper analysing the impact of a unionised labour market on growth is Kemp and van Long (1987), which incorporates a union into a neoclassical growth model. They show that the union will have either no impact on the economy in the long run or that the capital stock will approach zero (depending on the rate of time preference of the union). In a comment to this paper, Palokangas (1989) showed that there might also be an intermediate case with both growth and unemployment. Palokangas (1996) incorporates union wage bargain into a Romer (1990)-type model and analyses a union bargaining over the wage of low-skilled and high-skilled labour in the intermediate sector. He is able to show that the existence of the union might foster growth. In a recent paper, Boone (2000) demonstrates that the existence of a union dampens the growth rate of the economy because firms will invest too many resources in the reduction of overhead costs so that the growth rate of the quality of a product is too low. Other recent papers analysing potential effects of unions on economic growth are Quang/Vousden (1999), Irmen/Wigger (2000), Faini (1999), De Groot (2001) and Bräuninger (2000).

This paper shows that a unionised labour market affects the growth rate of the economy,

¹In a recent paper Şener (2000) presents a schumpeterian growth model with search unemployment.

but that the effect is ambiguous. The impact of the union depends crucially on the elasticity of substitution between high-skilled and low-skilled labour in the intermediate sector. To make this point, the model of Aghion/Howitt (1992 and 1998 resp.) is extended to include high-skilled and low-skilled labour. It is assumed that a union bargains the low-skilled wage. With this setting we generate two different union effects. Firstly a "good" growth effect by indirectly shifting high-skilled labour into the research sector and a "bad" effect by reducing profits in the intermediate sector, which discourages innovators. It will be shown that the elasticity of substitution is an important parameter in determining the dominant effect, because the wage bargain has an asymmetric effect on the labour demand and the labour supply of high-skilled labour in the research sector and the elasticity of substitution determines this asymmetry.

The paper is organised as follows. The next section briefly presents the standard growth model with high-skilled and low-skilled labour. In the third section we will allow for a union which bargains the low-skilled wage with the employer. We will analyse the consequences for unemployment and the growth rate of the economy. The fourth section considers the consequences of efficient bargaining and the last section concludes.

2 The Basic Model

2.1 The Economy

The economy consists of three sectors. A competitive R&D sector where new ideas are produced, a monopolistic intermediate good sector, where the incumbent monopolist supplies the latest generation of the intermediate good to the final goods sector and finally the final goods sector, in which the consumption goods are produced using the "state-of-the-art" intermediate good. The basic inputs of production in the economy are low-skilled labour, high-skilled labour and the intermediate good. Utility is derived from consuming final goods. The production function of the final goods sector takes the following form:

$$Y_t = A_t \cdot X_t^\alpha. \tag{1}$$

Y_t is the amount of final goods produced with the intermediate good of generation t , X_t . A_t is the efficiency parameter of generation t . The parameter α is restricted to be between 0 and 1. The dynamics of the final goods sector arises from the evolution of the efficiency parameter A_t . Every new generation of the intermediate good causes A to grow by a factor γ : $A_{t+1} = \gamma \cdot A_t$. This growth factor γ is fixed and exogenous to the model.² In the intermediate sector the leading edge

²An important point to notice is that certainly only the growth rate of A between two generations of intermediate goods is constant. Whereas the time between the innovations is random. That is the growth rate per unit

intermediate good generation is produced using low-skilled labour, L , and high-skilled labour, N . The production function is assumed to be CES. So the production function takes the form:

$$X_t = [\delta \cdot L_t^{-\rho} + (1 - \delta) \cdot N_t^{-\rho}]^{-\frac{1}{\rho}}, \quad (2)$$

where X_t is the amount of the intermediate good, L_t and N_t is the amount of low-skilled labour and high-skilled labour, respectively. The parameter δ is usually referred to as the distributional parameter of the production function and ρ is a measure of the substitutability between the two inputs.³ From profit maximisation, the factor demands of the monopolist are⁴:

$$W_t^L = \alpha^2 \cdot A_t \cdot [\delta \cdot L_t^{-\rho} + (1 - \delta) \cdot N_t^{-\rho}]^{-\frac{\alpha+\rho}{\rho}} \cdot \delta \cdot L_t^{-\rho-1} \quad (3)$$

for low-skilled labour and:

$$W_t^N = \alpha^2 \cdot A_t \cdot [\delta \cdot L_t^{-\rho} + (1 - \delta) \cdot N_t^{-\rho}]^{-\frac{\alpha+\rho}{\rho}} \cdot (1 - \delta) \cdot N_t^{-\rho-1}. \quad (4)$$

for high-skilled labour. Equilibrium in both labour markets can be determined employing some additional assumptions. Firstly, it is assumed that low-skilled labour, L , is supplied totally inelastically and that the stock of L is exogenously given and time invariant; hence in the basic model there is no unemployment. Denoting the low-skilled stock by \bar{L} , the equilibrium in the low-skilled labour market is given by:

$$W_t^L = \alpha^2 \cdot A_t \cdot [\delta \cdot \bar{L}^{-\rho} + (1 - \delta) \cdot N_t^{-\rho}]^{-\frac{\alpha+\rho}{\rho}} \cdot \delta \cdot \bar{L}^{-\rho-1}. \quad (5)$$

Allocation of the exogenously given and inelastically supplied high-skilled labour \bar{N} is tied down by the assumption of perfect mobility between the intermediate and the R&D sector. This assumption allows to determine the equilibrium by a no-arbitrage condition, which ensures that the high-skilled wage cannot differ between sectors.

Researchers use high-skilled labour to develop new generations of the intermediate good. If a researcher is successful in inventing a new product generation, he will be the new intermediate monopolist and replaces the incumbent one. Innovations are governed by a Poisson process and arrive randomly at the rate $N_t^{R\&D} \cdot \lambda$, where $N_t^{R\&D}$ is the proportion of the high-skilled labour force employed in the research sector and λ is a fixed parameter of the Poisson process. The value of being the new monopolist (at some point in time τ , when the generation t is state-of-the-art)

of time of A is not constant.

³Note that $\rho = \frac{1-\sigma}{\sigma}$, where σ is the elasticity of substitution between the two inputs.

⁴Note that we normalized the price of the consumption good P_{Y_t} to one and that we used the intermediate good demand of the consumption good sector, which can be derived from profit maximization as $P_{X_t} = \alpha \cdot X_t^{\alpha-1} \cdot A_t$.

is V_{t+1} . This value is given by the asset equation:

$$V_{t+1} \cdot r = \Pi_{t+1} - \lambda \cdot N_{t+1}^{R\&D} \cdot V_{t+1}, \quad (6)$$

where Π_{t+1} is the flow profit of the monopolist and with probability $\lambda \cdot N_{t+1}^{R\&D}$, he is replaced by a new innovator. In this case the incumbent monopolist gets nothing. Using the intermediate good demand of the final product sector and the labour demand functions, we can derive the monopoly profit as:

$$\Pi_{t+1} = (1 - \alpha) \cdot \alpha \cdot X_{t+1}^\alpha \cdot A_{t+1}. \quad (7)$$

Using (7), we can derive the demand for high-skilled labour in the R&D sector:

$$W_t^{R\&D} = \lambda \cdot \frac{1}{r + \lambda \cdot N_{t+1}^{R\&D}} \cdot (1 - \alpha) \cdot \alpha \cdot A_{t+1} \cdot X_{t+1}^\alpha \quad (8)$$

Equations (4) and (8) determine the allocation of high-skilled labour between the intermediate and the research sector. By using the full employment condition $\bar{N} = N + N^{R\&D}$ and $A_{t+1} = \gamma \cdot A_t$, we get a forward looking difference equation in $N^{R\&D}$:

$$\lambda \cdot \frac{1}{r + \lambda \cdot N_{t+1}^{R\&D}} \cdot (1 - \alpha) \cdot \alpha \cdot \gamma \cdot A_t \cdot X_{t+1}^\alpha = \alpha^2 \cdot A_t \cdot X_t^{\rho+\alpha} \cdot (1 - \delta) \cdot (\bar{N} - N_t^{R\&D})^{-\rho-1} \quad (9)$$

Equation (9) determines a steady state equilibrium if we impose $N_t^{R\&D} = N_{t+1}^{R\&D} = N^{R\&D}$. We get a steady state level of high-skilled labour working in the research sector $N_{R\&D}^*$ and this level determines the growth rate of the economy. From Equation (1), and using $A_{t+1} = \gamma \cdot A_t$ the growth rate of the economy is:

$$g_Y = \ln(\gamma) \cdot \lambda \cdot N_{R\&D}^* \quad (10)$$

Equation (9) cannot be solved explicitly for steady state values, but it can be shown that an equilibrium exists.⁵

⁵These results are available from the author upon request.

2.2 The Properties of the Steady State

We now impose steady state conditions on equation (9) and log-linearise. The linearised equation (9) reads (a ' \sim ' denotes the relative change of a variable, hence $\frac{dX}{X} \equiv \tilde{X}$):

$$\tilde{N}_{R\&D}^* = \Gamma \cdot \left[(1-b) \cdot \tilde{\lambda} + \tilde{\gamma} - \rho \cdot s^L \cdot \tilde{L} + \frac{(1 + \rho \cdot s^L)}{a} \cdot \tilde{N} + \left(-\frac{1}{1-\alpha}\right) \cdot \tilde{\alpha} \right], \quad (11)$$

with s^L and s^N denoting respectively the steady state production elasticity of low-skilled and high-skilled labour in the intermediate sector; $0 < b \equiv \left(\frac{\lambda \cdot N_{R\&D}^*}{r + \lambda \cdot N_{R\&D}^*}\right) \leq 1$; $(1-a) \equiv \frac{N_{R\&D}^*}{N}$ (hence $(1-a)$ is the part of the high-skilled labour force employed in the research sector) and $\Gamma \equiv (b + [\rho \cdot s^L + 1] \cdot \frac{(1-a)}{a})^{-1} \geq 0$.⁶

A rise in the parameter of the Poisson distribution, λ , causes the steady state level of high-skilled labour, employed in the research sector to rise, since $(1-b) \geq 0$. The economic intuition is the following: on the one hand a higher λ raises the rate of creative destruction, which discourages potential inventors to hire high-skilled labour, but on the other hand the research success will turn up faster; this encourages researchers. The latter effect dominates because of the positive time preference of the agents, they care more about getting the profits today than loosing them tomorrow. The higher the growth rate of the efficiency parameter, γ , the higher is the level of high-skilled labour employed in the research sector, because a higher γ results in higher profit opportunities when becoming a monopolist. The impact of low-skilled labour is ambiguous and depends on σ . If σ is greater (smaller) than one, the impact is positive (negative). Because the economic intuition is also crucial to understand the union effect, we defer the discussion to the next section. A rise in the stock of high-skilled labour causes the steady state level of high-skilled labour in the research sector to rise, because more high-skilled labour is allocated uniformly to the intermediate and the research sector. A rise in α results in a higher price elasticity of the demand for the intermediate good and this causes monopoly profits to decline. This lowers the marginal productivity of high-skilled labour in the research sector and therefore the amount of high-skilled labour employed in the research sector.

3 The Impact of a Labour Union

3.1 Union Wage Bargaining

We assume that the union and the new monopolist bargain over wages and after the wage agreement the intermediate good monopolist will choose the amount of labour he wants to hire,

⁶Note that we assume the production function as being constant ($\tilde{\rho} = \tilde{\delta} = 0$).

given the bargained wage. The sequence of events in the model is the following: after an innovator has been successful and before starting production of the new generation of the intermediate good, he has to bargain with the labour union over the wage for low-skilled labour. After a wage agreement he hires low-skilled and high-skilled labour according to the factor demand curves and starts producing. When the incumbent monopolist is driven out of the market, the process starts anew and the new monopolist has to bargain again with the union. Note that we assume away insider power, which means that after a wage agreement ends (so after the monopolist is driven out of the market) every union member has again the same probability of becoming employed (which would be the same as to assume that after the wage agreement, the new monopolist chooses randomly (e.g. history independent) from the low-skilled labour force).

After these more general assumptions and institutional settings we have to take a closer look at the utility function the union wants to maximise.⁷ To keep the model as simple as possible, we decide to apply the so called "rent maximisation" utility function (this function can be derived from the expected utility function if we assume some sort of income transfer within the union, see Pencavel (1994) ch.3). Hence the utility function of the union takes the explicit form:

$$U = L \cdot (W^L - \bar{W}^L). \quad (12)$$

The union seeks to maximise the difference between the bargained wage W^L and the competitive wage \bar{W}^L times the number of employed. The competitive wage is a reference scenario for a union member and this reference scenario is exogenous to the union. Following the standard approach in the literature on wage bargaining, we assume the Nash bargaining solution to determine the wage for low-skilled labour. The solution to the wage bargain will maximize the following Nash product:

$$\Omega = (U - \bar{U})^\beta \cdot (\Pi - \bar{\Pi}), \quad (13)$$

where β is the (relative) bargaining power of the union, U is union utility after an agreement is reached, \bar{U} is the disagreement point of the union, Π are the profits of the monopolist after an agreement and $\bar{\Pi}$ is the monopolist's disagreement point.

When applying the Nash solution to a bargaining problem much respect has to be paid how to model the disagreement points (see Binmore, Shaked, Sutton (1989) and Binmore, Rubinstein, Wolinsky (1986)). The disagreement points reflect the impasse utilities, which is the utility flow during the bargain. We assume that there is no employment of low-skilled labour during the bargain. Furthermore high-skilled and low-skilled labour are imperfect substitutes, i.e. σ is

⁷An overview over potential specifications of union utility functions, see e.g. the surveys of Oswald (1985), Booth (1995) or Pencavel (1994).

finite. With these assumptions the impasse utility of both parties is zero, hence $\bar{U} = \bar{\Pi} = 0$. The outside option for the union when the bargain is quit unilaterally is the competitive outcome. For the monopolist the outside option is zero, because in the case he quits the bargain he is not able to produce anything. As shown in Binmore, Shaked, Sutton (1989) these outside options serve as constraints in the determination of the Nash solution.

Maximisation of the Nash product, subject to the labour demand curve (3) yields the bargained wage:

$$W^L = \frac{1}{1 + \left[\frac{1}{\frac{1}{\beta} \cdot \frac{W^L}{\Pi} \cdot \frac{\partial \Pi}{\partial W^L} + \frac{W^L}{L} \cdot \frac{\partial L}{\partial W^L}} \right]} \cdot \bar{W}^L \quad (14)$$

By the envelope theorem, $\frac{\partial \Pi}{\partial W^L} = -L$. Moreover, $-\frac{W^L}{L} \cdot \frac{\partial L}{\partial W^L}$ denotes the wage elasticity of low-skilled labour demand. Due to the assumed bargaining structure the union has to bear in mind that a wage hike has two consequences for low-skilled employment. Firstly, there is a static effect that the higher the wage the less low-skilled labour will be hired (this is a movement along the low-skilled labour demand curve) and secondly less low-skilled labour results in a change in the amount of high-skilled employed in the intermediate sector in the steady state. This has repercussions on the demand for low-skilled labour, since high-skilled labour employed in the intermediate sector is a shift parameter of the low-skilled labour demand curve. So the constraint the union faces in the bargaining process is the "total labour demand curve". Letting ε denote the (absolute) value of the elasticity of total labour demand, we obtain the bargained real wage for low-skilled labour,

$$W^L = \frac{1}{1 - \left[\frac{1}{\frac{1}{\beta} \cdot \frac{W^L \cdot L}{\Pi} + \varepsilon} \right]} \cdot \bar{W}^L. \quad (15)$$

which is a markup on the wage in the competitive case \bar{W}^L . This markup depends on the union power β , on the total labour demand elasticity ε , and the relation of low-skilled labour income to profits. From equations (3) and (7) this relation is:

$$\frac{W^L \cdot L}{\Pi} = \frac{\alpha}{1 - \alpha} \cdot s^L. \quad (16)$$

Equation (3) also yields an expression for the wage elasticity of low-skilled labour demand:

$$\varepsilon = -\frac{1}{(\alpha + \rho) \cdot s^L - \rho - 1 + s^N(\alpha + \rho) \cdot \frac{\partial N}{\partial L} \cdot \frac{L}{N}}, \quad (17)$$

where $\frac{\partial N}{\partial L} \cdot \frac{L}{N}$ can be derived using equation (11). From this equation we know that:

$$\frac{dN^{R\&D}}{N^{R\&D}} = \Gamma \cdot (-\rho) \cdot s^L \cdot \frac{dL}{L}. \quad (18)$$

Moreover, $\frac{dN}{N} \left(\frac{a}{a-1} \right) = \frac{dN^{R\&D}}{N^{R\&D}}$. Therefore:

$$\frac{\partial N}{\partial L} \cdot \frac{L}{N} = \frac{1-a}{a} \cdot \Gamma \cdot \rho \cdot s^L. \quad (19)$$

Hence we obtain the wage elasticity of total labour demand as:

$$\varepsilon = \frac{1}{(1+\rho) - (\alpha+\rho) \cdot s^L - (\alpha+\rho) \cdot \frac{1-a}{a} \cdot \Gamma \cdot \rho \cdot s^L}. \quad (20)$$

ε reflects the two above mentioned effects. On the one hand a wage hike will result in lower labour demand. On the other hand there will be a reallocation effect of high-skilled labour due to the change in employment of low-skilled labour. If the elasticity of substitution is less than one (implying that lower low-skilled employment results in a decline of high-skilled employment in the intermediate sector), the reallocation effect lowers the marginal productivity of low-skilled labour. Thus the low-skilled employment loss due to a wage hike is rather high (the (absolute) value of the elasticity of total labour demand will be high). The opposite is true if σ is greater than one. The markup turns out to be:

$$\phi(\beta, \alpha, s^L) = \frac{1}{1 - \left[\frac{1}{\frac{s^L}{\beta} \cdot \frac{\alpha}{1-\alpha} + \varepsilon} \right]} \quad (21)$$

Log-linearising the markup in β , α and s^L yields ⁸ we get:

$$\tilde{\phi} = \phi \cdot \delta_1 \cdot \tilde{\beta} - \phi \cdot \delta_2 \cdot \tilde{\alpha} - \phi \cdot \delta_3 \cdot \tilde{s}^L \quad (22)$$

with $\delta_1 \equiv \frac{\frac{s^L}{\beta} \cdot \frac{\alpha}{1-\alpha}}{\left(\frac{s^L}{\beta} \cdot \frac{\alpha}{1-\alpha} + \varepsilon \right)^2}$, $\delta_2 \equiv \frac{\frac{s^L}{\beta} \cdot \frac{\alpha}{1-\alpha} \cdot \left(\frac{1}{1-\alpha} \right) + \frac{\partial \varepsilon}{\partial \alpha} \cdot \alpha}{\left(\frac{s^L}{\beta} \cdot \frac{\alpha}{1-\alpha} + \varepsilon \right)^2}$ and $\delta_3 \equiv \frac{\frac{s^L}{\beta} \cdot \frac{\alpha}{1-\alpha} + \frac{\partial \varepsilon}{\partial s^L} \cdot s^L}{\left(\frac{s^L}{\beta} \cdot \frac{\alpha}{1-\alpha} + \varepsilon \right)^2}$.

The coefficient of a change in union power $\tilde{\beta}$, δ_1 , is clearly positive. Hence a rise in union power will raise the markup. δ_2 is unambiguously positive, since one can show that $\frac{\partial \varepsilon}{\partial \alpha}$ is positive, i.e., a higher α lowers the markup, since a higher price elasticity of demand for the intermediate good

⁸Throughout the paper we treat s^L and s^N as exogenous variables (although this is only true for the Cobb Douglas case). We justify this simplifying assumption on the basis that firstly we only analyse small changes around some steady state and that secondly these second round effects are rather small in size. So the underlying error of "quantitative nature" and very small.

implies lower monopoly profits, which the union is able to capture. Thus the markup is lower. δ_3 is unambiguously negative, because it can be shown that $\frac{\partial \varepsilon}{\partial s^L}$ is positive for all $(\alpha + \rho) \neq 0$. The economic intuition is, that due to the assumption of a CRS production function, s^N falls when s^L rises. But a decline in s^N lowers the quasi rents generated by high-skilled labour which lowers the bargained wage. Furthermore the demand curve for low-skilled labour becomes flatter with a higher s^L , so that the bargained wage falls.

3.2 The Employment Effects of the Labour Union

This subsection examines how parameter changes influence the steady state (un)employment of low-skilled labour. The preceding analysis of union behaviour established that the wage in the low-skilled labour market is a markup on the competitive wage:

$$W^L = \phi \cdot \bar{W}^L. \quad (23)$$

Because of the "right-to-manage" assumption, both wages are given by the labour demand equation (3). We restrict our analysis to steady states and assume that steady state employment of high-skilled labour in the intermediate sector is $N^*(\bar{L})$ in the competitive case and $N^*(L^U)$ in the presence of union wage bargaining. Hence employment in the unionised economy will be time invariant and so will be the unemployment rate.⁹ By substituting the wages in equation (23) by the labour demand equations, we get:

$$\begin{aligned} A_t \cdot [\delta \cdot (L_t^U)^{-\rho} + (1 - \delta)(N^*(L^U))^{-\rho}]^{-\frac{\alpha+\rho}{\rho}} \cdot \delta \cdot (L_t^U)^{-\rho-1} = \\ \phi \cdot A_t \cdot [\delta \cdot (\bar{L})^{-\rho} + (1 - \delta)(N^*(\bar{L}))^{-\rho}]^{-\frac{\alpha+\rho}{\rho}} \cdot \delta \cdot (\bar{L})^{-\rho-1}. \end{aligned} \quad (24)$$

Log linearisation of equation (24) around a steady state (which determines steady state unemployment) yields:

$$\tilde{L}^U = -\varepsilon \cdot \tilde{\phi} + \tilde{\bar{L}}. \quad (25)$$

The change in steady state employment of low-skilled labour depends only on the markup and on the amount of low-skilled labour in the economy. More low-skilled labour will raise employment in the unionised economy, but the rate of unemployment will remain constant.¹⁰ A rise in the

⁹Note that steady state unemployment will only occur if the reference wage (which is in our case \bar{W}^L) grows at the same rate as the increased technology shifts out the low-skilled labour demand (see equation (3)). If this is not the case the unionised economy will converge to the competitive economy.

¹⁰The change of the unemployment rate is by definition $\tilde{U} = \frac{L}{L-L}(\tilde{\bar{L}} - \tilde{L}^U)$. If the change in the low-skilled labour pool causes union employment to change proportionally, i.e. $\tilde{\bar{L}} = \tilde{L}^U$, the unemployment rate will not

stock of low-skilled labour lowers the reference wage \bar{W}^L and hence, with a constant markup, lowers the union wage and raises employment. The change in employment will be equal to the change in the stock of low-skilled since the wage elasticity of labour demand is assumed constant. In the more general case the wage elasticity determines whether the unemployment rate will rise, remain constant or decline. However the qualitative result, that an increase in the low-skilled labour pool raises low-skilled employment remains unaffected. Finally a higher markup (e.g. due to higher union power β) raises the bargained wage and lowers employment of low-skilled labour.

3.3 The Growth Effects of the Labour Union

It has been shown that the growth rate of the economy depends positively on R&D sector employment (and hence on the allocation of high-skilled labour). The equilibrium allocation in the case of a unionised low-skilled labour market is given basically by equation (11), with the only difference that in the unionised case employment of low-skilled labour is L^U . So using equation (25), the equation determining the employment of high-skilled labour in the R&D sector modifies to:

$$\tilde{N}_{R\&D}^* = \Gamma \cdot \left[(1 - b) \cdot \tilde{\lambda} + \tilde{\gamma} + \rho \cdot s^L \cdot \varepsilon \cdot \tilde{\phi} - \rho \cdot s^L \cdot \tilde{L} + (\rho \cdot s^L + 1) \cdot \tilde{N} + \left(-\frac{1}{1 - \alpha}\right) \cdot \tilde{\alpha} \right], \quad (26)$$

With this equation at hands the growth effects of union wage bargaining can be analysed. Consider first an economy which consists of competitive labour markets for high-skilled, as well as for low-skilled labour. This case of the competitive labour market is nested in the unionised model, when ϕ equals one. So we can analyse the impact of the union as a change in the markup ϕ (the markup is obviously an endogenous variable, but let us for the moment assume that we concentrate on a steady state, where we take the markup determining parameters as given. Later we will also analyse the effect of changes in these parameters). Equation (26) reveals that changes of the markup change $\tilde{N}_{R\&D}^*$ and that the effect depends on σ . We can distinguish three cases. In the Cobb Douglas case, where the elasticity of substitution is one and ρ is zero a change of the markup has no effect on the amount of high-skilled labour employed in the research sector, i.e. a union does not affect steady state growth. When low-skilled and high-skilled labour are very good substitutes (σ exceeds unity and ρ is negative) unionisation of low-skilled labour will lead to a lower steady state high-skilled employment in the research sector and therefore lower growth. The opposite is the case when substitutability between low-skilled and high-skilled labour is low, i.e. σ smaller than one and ρ exceeding zero. Then, steady state growth is faster and the existence of the union may actually foster growth compared to a situation where the low-skilled change. (See (35))

labour market is competitive. In this case the economy faces a trade off between growth and employment. Unemployment will lower the amount of consumable goods but on the other hand it will raise the rate of growth.

What is the economic intuition behind these results? The union rations low-skilled labour, which affects the marginal productivity of high-skilled labour in both the R&D and the intermediate good sector. If the impact of a change in L affects the marginal productivity of high-skilled labour in both sectors asymmetrically this will cause migration of high-skilled labour and the direction of this migration will determine the growth effect of the union. Marginal productivity is given by:

$$\tilde{W}^N = \tilde{A}_t + (-\rho - 1) \cdot \tilde{N} + (\alpha + \rho) \cdot \tilde{X} + \left(2 - \frac{\alpha \cdot \ln(X^{-\rho})}{\rho}\right) \cdot \tilde{\alpha} \quad (27)$$

$$\tilde{W}^{R\&D} = \tilde{A}_t + (1 - b) \cdot \tilde{\lambda} + \tilde{\gamma} + \alpha \cdot \tilde{X} - b \cdot \tilde{N}_{R\&D} + \left(-\frac{\alpha}{1 - \alpha} + 1 - \frac{\alpha \cdot \ln(X^{-\rho})}{\rho}\right) \cdot \tilde{\alpha}. \quad (28)$$

Using these equations we can see that the change in low-skilled labour employed has an asymmetric effect on the productivity of high-skilled labour in the two sectors if and only if $\rho \neq 0$. If ρ is negative ($\sigma > 1$), a decline in L lowers the wage in the intermediate sector by a smaller amount than in the research sector. So we have a wage differential favouring the intermediate sector causing high-skilled labour to move into the intermediate good sector and thereby lowering growth. The opposite is true when ρ is positive ($\sigma < 1$). In this case the decline of the wage in the intermediate sector will be bigger than the decline in the research sector causing a growth enhancing migration of high-skilled labour into the research sector.

The economic intuition is straightforward. The effect of less low-skilled employment is more severe, when σ is smaller than one, because a factor substitution which could dampen the negative effect of lower low-skilled employment is hardly possible. So the decline of high-skilled productivity in the intermediate sector is rather high. The opposite is true when both factors are substitutes.

Since the markup is an endogenous variable we can, using equation (22) and (26), analyse the impact of various parameters that determine the markup. Increased union power, β , results in a higher markup and hence we can apply the previous arguments. The effect of a change in α , the price elasticity of the intermediate good market, is ambiguous. On the one hand, a higher α is bad for growth, because more competition in the intermediate good market implies lower monopoly profits. This discourages researchers and the growth rate will decline. On the other hand a rise in α will lower the markup. If σ is less than one, a smaller markup will lower the growth rate of the economy. Hence the direct effect is amplified by the existence of a union. However, if σ exceeds unity, a smaller markup will raise the growth rate. That is, there are two

opposite effects on the growth rate and it is ambiguous which effect dominates. The coefficient determining the overall effect is given by (using equation (22) and (26)):

$$\tilde{N}_{R\&D}^* = \Gamma \left[\left(-\rho \cdot s^L \cdot \varepsilon \cdot \phi \cdot \frac{\frac{s^L}{\beta} \frac{\alpha}{1-\alpha} \cdot \left(\frac{1}{1-\alpha}\right) + \frac{\partial \varepsilon}{\partial \alpha} \cdot \alpha}{\left(\frac{s^L}{\beta} \frac{\alpha}{1-\alpha} + \varepsilon\right)^2} - \frac{1}{1-\alpha} \right) \cdot \tilde{\alpha} \right] \quad (29)$$

Equation (29) demonstrates the aforementioned effects. If σ is less than one the coefficient of the impact of a change of α on $N_{R\&D}^*$ is negative. In the case of σ exceeding unity the impact is ambiguous, although simulation results suggest that the coefficient is negative for a wide range of parameter constellations, that is the direct effect of a change in α is likely to dominate the indirect one. Finally a rise in α always lowers unemployment.

4 Efficient Bargaining

In the preceding analysis we restricted attention to points on the labour demand curve. What happens when the bargaining between the union and the monopolist is efficient, that is, they bargain over wages *and* employment?¹¹ Since we assumed risk neutral union members, the contract curve will be a vertical line over \bar{L} in wage employment space. Hence there will be no unemployment of low-skilled labour. Nevertheless the bargained wage will be higher than in the competitive case. The growth effect is straightforward. Since the wage will be higher than in the competitive case, monopoly profits will be lower, which discourages innovators. On the other hand, since low-skilled labour employed is \bar{L} , there is no "migration" of high-skilled labour between the intermediate and the research sector. Hence the union effect unambiguously lowers high-skilled labour employment in the research sector and thereby the growth rate of the economy.

5 Conclusion

In this paper we have shown the potential impact of a union on the growth rate of an economy using a simple schumpeterian growth model based on Aghion/Howitt (1992 and 1998 resp.). We extend the model to allow for high-skilled and low-skilled-labour as input factors in the research and intermediate good sector and we allow for a labour union which covers low-skilled labour. Union wage bargaining causes steady state unemployment in the economy where the level of unemployment depends on the stock of low-skilled labour and on parameters influencing

¹¹The details of the efficient bargaining case can be found in the appendix.

the union markup. Moreover the union changes the allocation of high-skilled labour between the research and the intermediate goods sector. Hence the union affects growth. Two opposite effects can be observed. Firstly there is a negative effect, because the union lowers the profits which can be earned in the intermediate sector. Therefore the incentive to perform R&D declines, which is bad for growth. Secondly the wage of the high-skilled declines in the intermediate sector because low-skilled labour employment in the intermediate sector is smaller than in the competitive case. This triggers a migration of former intermediate high-skilled worker into the research sector thereby increasing the growth rate of the economy. Which one of these two effects dominates depends on the elasticity of substitution in the intermediate good production function. If the elasticity of substitution is less (greater) than one the latter (former) effect will dominate and the union has a positive (negative) growth effect. In the Cobb Douglas case with $\sigma = 1$ unionisation of the labour market has no growth effect. Besides these growth effects, the union wage bargain will cause low-skilled unemployment and a smaller wage differential. If we allow for efficient bargaining, the unionisation of the labour market is unambiguously bad for growth, because the only union effect is the lowering of monopoly profits which discourages innovators.

A Appendix

In this Appendix we derive the results of the efficient bargaining case in more detail. In this case the union and the monopolist bargain over wages and employment. By maximising the Nash product (given by (13)) with respect to wage and employment we get:

$$\frac{\partial \log(\Omega)}{\partial W^L} = \left(\frac{1}{W^L - \bar{W}^L} \right) \cdot \beta - \frac{L}{\Pi} = 0 \quad (\text{A1})$$

$$\frac{\partial \log(\Omega)}{\partial L} = \frac{\beta}{L} + \frac{R'(L) - W^L}{\Pi} = 0 \quad (\text{A2})$$

(A1) and (A2) determine the contract curve which is given by:

$$\bar{W}^L = R'(L), \quad (\text{A3})$$

where $R'(L)$ is the marginal revenue of low-skilled labour. Employment in the efficient bargaining case will be on the contract curve implying that low-skilled employment will be \bar{L} . The wage will be given by (A1) noting that $L = \bar{L}$. Some manipulations yield:

$$W_{efficient}^L = \bar{W}^L + \beta \cdot \frac{\Pi}{\bar{L}} \quad (\text{A4})$$

So in the efficient bargaining case monopoly profits are given by:

$$\Pi_t = \frac{1}{1 + \beta} \cdot ((1 - \alpha) \cdot \alpha \cdot X_t^\alpha \cdot A_t) \quad (\text{A5})$$

Using this, equation (26) modifies to:

$$\tilde{N}_{R\&D}^* = \Gamma \cdot \left[-\frac{\beta}{1 + \beta} \cdot \tilde{\beta} + (1 - b) \cdot \tilde{\lambda} + \tilde{\gamma} - \rho \cdot s^L \cdot \tilde{\bar{L}} + (\rho \cdot s^L + 1) \cdot \tilde{N} + \left(-\frac{1}{1 - \alpha}\right) \cdot \tilde{\alpha} \right] \quad (\text{A6})$$

So a movement from a competitive labour market situation to a unionised one with efficient bargaining (which can be interpreted as a change of β) is unambiguously bad for growth.

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