Essays on Economic Growth and Imperfect Markets

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Publication date
2001

3 TRADE UNIONS, EMPLOYMENT AND ECONOMIC GROWTH

3.1 Introduction

One prominent feature of the labour market in almost any country is (collective) bargaining between firms and trade unions. Countries however differ a great deal with regard to legislation on strikes and collective agreements, union membership, the degree of coordination among employers and among employees, government interference with the process wage-setting, and so on. Institutional differences can potentially explain the wide variety of experiences. Even though economies are becoming more integrated and more similar in many respects, unemployment is high in some countries, and low in other countries. Unemployment rates do not seem to converge. Understanding national institutions and in particular the functioning of trade unions helps to understand the performance of national labour markets, and therefore also the dynamic performance of countries. Whereas the traditional neoclassical theory of economic growth relies on exogenous labour-augmenting technical progress to describe the secular rise in labour productivity, and therefore denies any relationship between economic growth and unemployment, more recent contributions envisage increases in productivity as consequence of economic activity, and at least suggest interaction between technical progress and employment of labour. This chapter examines the relation among trade unions, (different) institutional arrangements, unemployment and economic growth closely.

Economic growth can be affected by unemployment in several ways. First, increasing returns to scale at the level of an economy or at firm level imply that the level of employment has a positive effect on the rate of return on (broadly defined) capital. More employment can then trigger more investment (savings) and more growth. Second, Devereux and Lockwood (1991) and Bean and Pissarides (1992) explore a different mechanism. In a life-cycle model for consumption unemployment has an ambiguous effect on the pool of savings and the supply of investment funds. An increase in wages implies on the one hand a decline of employment, but on the other hand a redistribution of income from the inactive, old generation to the active, young generation. The former effect tends to decrease savings, whereas the latter effect tends to increase it, since the young save and the old dissave. Third, Aghion and Howitt (1994) emphasize that more R&D not only means more growth, but also implies more destruction of jobs, leading to more search unemployment. This chapter offers another view on the relationship between growth and unemployment. It stresses that unemployment fortifies barriers to entry, limits competition and the supply of differentiated products, and may therefore harm prospects of economic growth.

National labour markets differ notably and importantly to the degree of coordination among employers and among employees. In countries like the United States or Canada wages are set at firm level, whereas in countries like Sweden or Austria wages are set at an economy-wide level. Olson (1982) and also, in the context of trade unions, Calmfors and Driffill (1988) stress that a 'small' special-interest group is merely concerned with redistribution of (total) income, while a 'large' special-interest group is also concerned with total income. So, the level at which wage are bargained or set matters. In contrast to a union at the level of a firm, an economy-wide union may have the ability to substantially redistribute income in favour of its members, but rather may willingly abstain from this possibility, as it inevitably has to consider the macroeconomic consequences of its actions: the negative effect of unemployment on production and growth. However, a trade union may be constrained in its choice of an optimal strategy. The absence or presence of binding contracts or, generally, the commitment of a union to an optimal strategy is crucial. Grout (1984) and van der Ploeg (1987) show that asset specificity causes the optimal strategy to be time-inconsistent: a union may be willing to offer a wage or a time path of wages that induce (specific) investment, but once investment has occurred is tempted to renege on the announced wage scheme. Commitment is also central in this chapter. An economy-wide trade union may opt for low wages and high profits so as to induce investment in new varieties. The result is superior in terms of welfare to a decentralised, full-employment equilibrium. Increasing returns to scale and imperfect competition imply that in a decentralised equilibrium the factors of production are not paid their true marginal value. The result is that the number of available varieties is too low. An economy-wide union is able to recognize this and may try to correct this market failure. Unfortunately, this strategy of low wages and high profits is time-inconsistent.

In section 2 a general-equilibrium model will be put forward. In this model economic growth is simply equivalent to accumulation of broadly defined capital, and competition on the goods market is characterized by increasing returns to scale, monopolistic supply and costly entry. Households are assumed to be infinitely-lived, ignoring the effect of unemployment on the intergenerational distribution of income and on savings. Whereas in section 2 the labour market is perfectly competitive, in section 3 trade unions are involved in the determination of wages. The model allows us to discuss in section 3 the consequences of unemployment for growth, especially the interaction of imperfect competition on the goods market and on the labour market, the difference between wage-setting at the most decentralised and the most centralised level, and the relation between wages and investment in specific capital. Section 4 summarizes the main conclusions.

3.2 Imperfect competition on the goods market and growth

The literature on endogenous growth rejects the assumption of decreasing returns to capital and postulates constant (or increasing) returns to a broad measure of capital. Capital is thought to include not only physical goods but also human capital, research and development, and public infrastructure. The assumption of constant returns implies that investment possibilities do not diminish and the return on investment does not fall when capital stock expands. Ongoing economic growth is then possible and sustainable. However, increasing returns to scale at the level of firm are not compatible with perfect competition. Two ways are open to tackle this difficulty One way is to assume imperfect competition, rather than perfect competition. Another way is to assume external economies of scale.

The model in this chapter combines these two approaches. Economic growth is endogenous owing to a learning-by-doing effect of aggregate investment. This effect is external to a firm. Furthermore, the goods market is characterized by monopolistic competition. The model is akin to models, put forward by Romer (1990) and by Grossman and Helpman (1991). However, in those models leaning-by-doing fosters research for and development of new products, whereas in this model learning-by-doing is thought to improve the quality of existing products. This section employs the assumption of a perfectly competitive labour market, but the next section 3.3. abandons this assumption and discusses the consequences of wage-setting by trade unions. In this section attention is confined to the determinants of capital accumulation and economic growth as well as product variety.

Firms

The model distinguishes two sectors: first, a perfectly competitive sector using only intermediate goods and producing final goods; second, a monopolistic competitive sector employing capital and labour and producing intermediate, differentiated goods. The final goods are either consumed or added to the capital stock. Capital accumulation is the engine of ongoing growth.

Production of final goods Y requires differentiated inputs $x(j)$ according to

$$Y=\left[\int_0^N x(j)^{\eta}dj\right]^{\frac{1}{\eta}},\ j\in[0,N],\ 0<\eta<1. \tag{3.1}$$

The production function applies to an infinite set of intermediate goods, indexed by j. However only a subset of these goods is supplied, and this subset is represented by the interval [0,N]. The 'number' of available varieties or ,equivalently, the 'number' of the firms that supply these varieties is represented

by N. The production function has the property that a larger number of varieties implies higher factor productivity. Ethier (1982) refers to this property as the (increasing) degree of specialization in production.

Profit maximization under the assumption of perfect competition yields the inverse demand function for variety $i \in [0,N]$,

$$p(i) = x(i)^{\eta-1} \frac{p_y Y}{\int_0^N x(j)^{\eta} dj} \quad . \tag{3.2}$$

where $p(i)$ is the price of variety i. The price of the final good p_y equals the minimum production cost,

$$p_y = \left[\int_0^N p(j)^{-\frac{\eta}{1-\eta}} dj \right]^{-\frac{1-\eta}{\eta}} \quad . \tag{3.3}$$

The price of final good p_Y is the numeraire and is normalised to one in the remainder of this chapter. In a symmetric equilibrium in which $p(i) = p \ \forall i$, the price of each variety is unity as well.

A firm in the monopolistic competitive sector supplying variety $i \in [0,N]$ uses physical capital $k(i)$ and labour $l(i)$ in the production of differentiated goods. The production function exhibits increasing returns to scale with respect to the employment of both factors. However, the productivity of both factors not only depends on the level of production but also on the total capital stock K. This represents a learning-by-doing effect, which - similar to the work of Arrow (1962) and Romer (1986) - depends on past investments and is external to the firm. The production function is of the Cobb-Douglas variety to keep the model and its results simple,

$$x(i) = A k(i)^{\alpha} \bar{K}^{1-\alpha} l(i)^{\beta}, \quad \alpha, \beta < 1, \quad \alpha + \beta \geq 1 \ . \tag{3.4}$$

where

$$\bar{K} = \int_0^N k(i) di \ .$$

Households own the inputs and rent these to firms competitively. Capital and labour are fully mobile between sectors. Therefore, the dynamic problem of the firm collapses into a static one; the firm simply equates the marginal revenue of the inputs to their rental prices in every period, given the price of the final good, expenditure on final goods and production by other firms.

Each firm faces a downward-sloping demand function. Since the set of potential and available varieties is a continuum, the price elasticity of demand is constant and equals $(1-\eta)^{-1}$. The consequence of the monopolistic position is that payments to labour and to capital do not fully exhaust the total revenue of the firm and profits are positive: $\eta(\alpha+\beta)<1$.

Setting up a firm is an investment. The investment cost may include the time and the effort spend on orientation and organization, or goods and labour devoted to product development. The total costs, denoted F, probably depend on the wage rate, however we choose to scale the cost with the total capital stock, $F = fK$. Firms will instantaneously enter the monopolistic competitive sector if the present value of future profits π exceeds the set up cost. In other words, no entrance will occur if

$$\int_{t}^{\infty} \pi(v) e^{-\int_{t}^{v} r(u)\,du}\, dv \le F(t) \ . \tag{3.5}$$

The introduction of a new product is more rewarding than imitation of already existing product, and entrants do not wish to compete with incumbents. Consequently each firm is indeed a monopolistic supplier of a variety.

Firms can issue shares to finance the set up cost. The reward for setting-up a firm is the sum of dividends - the profits of a firm - and expected capital gains or losses. Under the assumption of perfect foresight, return on the stock market should equal the return on capital goods or on consumer loans. The no-arbitrage condition is thus

$$r = \frac{\dot{v}(i)}{v(i)} + \frac{\pi(i)}{v(i)} \ , \tag{3.6}$$

in which v represents the stock market value of firm i, a dot denotes a time derivative, and π is the profit of this firm.

Before presenting other elements of the analysis, let us exploit the symmetry in equilibrium. All firms face the same conditions and are identical: they choose the same level of production and the same, corresponding price. Using as well that at an aggregate level the identity $\bar{K} = K$ must hold the production of final goods can be rewritten,

$$Y = N^{\theta} L^{\beta} K = \kappa^{-1} K, \quad \theta = \frac{1-\eta\alpha-\eta\beta}{\eta} < 1, \tag{3.7}$$

where L is total employment and κ is capital coefficient. Clearly, the production of final goods is linear in the capital stock. Economic growth is thus endogenous; production is unitarily elastic with respect to one of the reproducible factors: capital. The other factors of production, L and N, are in equilibrium constant. By assumption the population does not grow, and a result of the model the number of available products that does not change over time as well. This result will be discussed in more detail shortly.

Savings determine the rate of capital accumulation and economic growth and depend on the real rate of interest. Ignoring depreciation of capital, the real interest rate r equals the marginal revenue of capital,

$$r = \frac{s_K}{\kappa}, \quad s_K = \eta\alpha, \tag{3.8}$$

where s_K is the share of capital in total revenue. The real interest rate depends on employment. This results from economies of scale. Knowledge $\bar{K}$ is assumed to be a non-rival productive factor.[13] Besides, production is subject to economies of scale at the level of a firm. The interest rate also increases with the number of varieties. This is a result of two opposing effects. First, an increased number of intermediate inputs entails a productivity gain in the final goods sector. Second, an increased number of firms in the intermediate goods sector implies less capital and less labour for each firm and therefore a loss in productivity. The gain however outweighs the loss. The gain of more varieties is strictly larger than the loss of a smaller scale of production.

Profit per firm are an important determinant of product variety. Profit is a constant fraction of firms' revenue,

$$\pi = \frac{s_N}{\kappa}\frac{K}{N}, \quad s_N = (1-\eta\alpha-\eta\beta). \tag{3.9}$$

Households

Households are supposed to be infinitely-lived and have identical preferences,

$$U(t) = \int_t^{\infty} \ln[c(v)]\, e^{-\rho(v-t)} dv, \tag{3.10}$$

[13] Another example in which the non-rivalrous character of knowledge yields a similar relationship between the interest rate and the population size can be found in Grossman and Helpman (1991).

where c is consumption, ρ the rate of time preference and intertemporal elasticity of substitution equals one. A household maximizes (9) subject to a budget constraint: The non-human wealth of a household consists of capital goods and shares. This yields the familiar Ramsey rule. Since the population is constant over time, total consumption, $C = Lc$, grows at the rate,

$$\frac{\dot{C}}{C} = r - \rho \ . \tag{3.11}$$

Decentralised equilibrium

The rate of capital accumulation can be deduced from the macroeconomic budget constraint. The setup cost do not require scarce resources and are merely a redistribution between households. These cost do not affect the resource constraint and parallel an income transfer,

$$\dot{K} = Y - C. \tag{3.12}$$

The equations (3.6), (3.11) and (3.12) form a system of three linear differential equations with two forward-looking variables (consumption and the stock market value of firms) and one backward looking variable (the capital stock). Two of the three roots do not satisfy the transversality condition; for a given number of available varieties a unique rational-expectations equilibrium exists and is immediately reached as consumption and the stock market value jump to the values at which the three variables grow at a common rate g,

$$g = \eta\alpha N^{\theta} L^{\beta} - \rho \ . \tag{3.13}$$

The value of the firm at time t exactly matches in equilibrium the present discounted value of expected profits from t onwards and is supposed to decline with the number of firms. The spending on intermediate inputs is spread evenly over each variety. If the number of varieties increases the outlays on each variety decrease. This negative effect on profit per firm dominates the effect on productivity in the final goods sector. The parameter θ is less than unity, so that the returns on the introduction of a new product decrease when the range of already existing products expands. This restriction on θ assures that a unique value for the number of varieties (N^{*}) exists at which the value of the (representative) firm equals the set-up cost,[14]

[14] Note that this condition says that the profits per period should in equilibrium match the consumption out of non-human wealth that investors have foregone to finance the set-up cost.

$$\frac{s_N N^{*\theta-1} L^{\beta}}{\rho} = f, \quad s_N = \eta\theta \ . \tag{3.14}$$

If $N(t) < N^*$, the value of the firm exceeds the set-up cost, and firms will enter business until the equality is restored; if $N(t) \geq N^*$, no firm will enter or exit the sector. Attention is confined to a configuration in which the equality (3.14) exactly holds.

An increase in the supply of labour implies an increase in the market size. Therefore, an increase in the labour force boosts both the number of firms and the growth rate. A fall in the subjective rate of time preference increases the growth rate through two channels. First, the households are more willing to save and invest, and, second, product variety increases. Larger set-up costs require a higher profitability of each firm and imply therefore less competition (for expenditure), and less growth.

The external effect of investment ($\alpha<1$) causes the interest rate in the market equilibrium to be below the socially optimal value. This downward bias in the interest rate is aggravated by the monopolistic competition - directly and indirectly. On the one hand an expansion of the capital stock is perceived not only to increase the output of a product but also to decrease the price of this good, so that the return on investment in capital is too low ($\eta<1$). On the other hand the return on research for and development of a new product is also insufficient to give the right incentive to offer different varieties (see appendix A for a characterization of the socially optimal number of varieties and economic growth). The overall bias in the interest rate distorts the intertemporal choice between consumption and investment, so that the growth rate of the consumption, production and the capital stock is too low.

Any change that causes the value of the firm to exceed the set-up cost will invoke entry into the intermediate goods sector. However, the opposite is not true. Firms will always remain in business. The fixed costs only affect the decision to start a firm, but do not interfere with the decision to continue or to stop - once these costs have been incurred. And as the profits are positive, firms will decide to continue their production under any circumstances. Actual or foreseeable adverse changes in the level or in the growth of the profits will only show up in the stock market value as this jumps to ensure the no-arbitrage condition. Different configurations may of course yield different outcomes. For example the additional assumption of fixed costs per period establishes a lower bound to the present discounted value of (gross) profits. Production will cease if the value of the firm is negative. Note however that the entry and exit condition do not coincide due the one-time cost. Exactly this difference makes demands by a union to increase wages and consequently to depress the value of the firm possible and credible.

3.3 Unions and economic growth

In this section the assumption of a perfectly competitive labour market is abandoned. Instead, a union has the ability to set a wage unilaterally. As before the firm cannot influence the wage and has the right to manage; given the wage a typical firm determines employment. The case of a monopoly union is not thought to be a realistic one but should be bring to the fore the macroeconomic consequences of labour market institutions, especially the level at which employers and employees bargain or cooperate. In the following three symmetric cases will be considered. First, at the most decentralised level of wage setting each firm faces a union. Second, at an intermediate level a subset of all firms is confronted by a union. This case is similar to wage setting at an industry level. However, the boundaries of an industry are not defined by the characteristics of product markets but by organisation of the labour market. Third, at the most centralised level a single, economy-wide union determines the wage.

A union maximises a Benthamite welfare function by setting the wage rate every period or by choosing a path of wages in the case of centralised wage-determination. Union members derive only income from labour or from social security payments, that are financed by a proportional tax on labour and benefit income. This assumption is made for convenience and implies that society consists of two groups, capitalists and workers. Profits and interest accrue to the class of capitalist. This configuration does not alter the results qualitatively in the case of wage-setting at decentralised or intermediate level, but will be discussed in the case of an economy-wide union.

The welfare function of a typical union is

$$
\begin{aligned}
U_u(t) &= \int_t^{\infty} U\left[L(v), W(v), B(v)\right] e^{-\rho(v-t)}\, dv, \\
U\left[L(v), W(v), B(v)\right] &= L(P,v)\ln\left[W(v)\right] + \left[M - L(P,v)\right]\ln\left[B(v)\right], \qquad (3.15) \\
L(P,v) &= \int_0^{P} L(i,v)\, di,
\end{aligned}
$$

where P is the relevant non-zero measure for a subset of all existing firms, that may range from an infinitesimally small value to the total number of firms N, $L(P)$ is the demand for labour by firms belonging to this subset, M is the relevant, exogenous number of members, W is the wage set by the union, and B is benefit income.[15] Taxes to finance the unemployment benefits are proportional to income

[15] Note that both types of households have similar preferences.

and apply to both labour income and benefit income. The consequence is that the tax rate does not affect the wage decision of unions.[16] The equilibrium defined in the preceding section will serve as a benchmark. The number of firms does not change, $N = N^*$. The case that the decision to start a firm is influenced by the expected actions of a union will not be analysed.

3.3.1 Wage-setting at the most decentralised and at an industry level

The symmetric case of wage-setting at the most decentralised level entails that there are as many unions as firms. A representative union tries to maximise the welfare function (3.15) subject to the marginality conditions of the firm by setting the real wage in terms of the consumption price. The wages set by other unions, the prices set by other firms and demand for consumption and investment goods are exogenous to a small union. A union does not take into account the actions or reactions by other unions, since the number of firms and unions is large. It also does not internalise the effects of its choices on other unions. Two effects may be distinguished. First, by raising the wage and the price of a product, demand shifts to other differentiated products. Second, by commanding a wage above its market-clearing level unemployment results and total income and total demand decreases in current and future periods. Owing to the perfect mobility of capital the dynamic problem for the firm to maximise profits now and in the future and for a union to maximise welfare of its members now and in the future is merely a static one. Optimisation in the short run, i.e. each period, does not disagree with intertemporal objectives.

Concentrating on the interior solution to the problem of the representative union, the before-tax wage is above the market-clearing level and the wage is a constant mark-up over benefit income,

$$\ln\frac{W}{B} = \frac{1}{\varepsilon_D}, \quad \varepsilon_D = \frac{1-\eta\alpha}{1-\eta(\alpha+\beta)}, \tag{3.16}$$

where ε^D is the wage elasticity of labour demand.[17] A measure for the monopoly power of a union is the inverse of this elasticity. The elasticity itself depends on the monopoly power of a firm ($\eta<1$) and the economies of scale in production ($\alpha+\beta>1$): $1-\eta(\alpha+\beta)>0$. So, the ability of a union to raise the wage above the competitive wage derives from the ability of a firm to make positive profits. A union tries to enrich the employees at the expense of the owners of a firm. Since capital is fully mobile, the possibility of

[16] The tax rate t follows, given the benefit income B, from the government budget constraint: $t\{LW + (N-L)B\} = (N-L)B$.

[17] Due to the choice of the Cobb-Douglas production function substitution possibilities between capital and labour are restricted and do not explicitly appear in the expression for the wage elasticity of labour demand.

income redistribution requires positive profits and that the initial investment to establish a firm is a sunk cost. The extent of the redistribution is however limited by the size of the profits.

Unions raise the wage rate above the market-clearing level, resulting in lasting unemployment.[18] This affects the marginal revenue of capital. The higher wage rate depresses the return on investment and households (= capitalists) save less, harming the prospects of growth. Note that in principle not only a tax on capital income but also a tax on labour income may distort the intertemporal choice between current and future consumption and the rate of economic growth. The tax scheme that is employed here does not affect the before-tax wage.[19] However, a tax on labour income, initially reducing the difference between the after-tax wage income and the after-tax benefit income, will put an upward pressure on before-tax wages. Unions try to pass on the tax burden. The result is more unemployment and a lower return on capital investment. The danger is therefore that government spending may crowd out private investment.

Bargaining over the wage at the level of an industry or sector is approximated by assuming that an arbitrary group of firms face one and the same union. This group is a subset of all existing firms. In the symmetric case all firms encounter a union and the unions are equal with respect to the number of firms in a group. The unions apply the same rule for determination of the wage rate as the unions at the most decentralised level, so that the margin between the wage and the unemployment benefit equals the inverse of the wage elasticity,

$$\ln\frac{W}{B} = \frac{1}{\varepsilon_S}, \quad \varepsilon_S = \frac{1-\eta\alpha(1-p)}{1-\eta(\alpha+\beta)(1-p)}, \quad 0 \le p < 1, \tag{3.17}$$

where p is the ratio between the number of firms in a group and the number of firms in total. Contrary to the analysis in the preceding paragraphs the relevant wage elasticity of labour demand (ε_S) depends on the market share of the group of firms. Owing to a difference in perceived monopoly power, i.e. the wage elasticity, the mark-up of the wage over the unemployment benefit is higher. The monopoly power on the labour market derives from monopoly power on the goods market. Because a union can ignore substitution between varieties within the subset, its monopoly power rises with the market share of the group. Wage-setting at the level of an industry therefore implies more unemployment and less growth than wage-setting at the level of a firm. The result that the demanded wage rate is positively related to the level of aggregation corresponds to Calmfors and Driffill (1988). An industry union may be seen as

[18] This assumes an interior solution exists.

[19] See footnote 4.

a coalition of (smaller) unions. Calmfors and Driffill assume that the coalitions are moulded within sectors that supply the nearest substitute, whereas here the coalitions could be formed randomly.

Wage setting at sectoral level appears to yield inferior results than wage-setting at firm level. The monopoly power of sectoral union is simply higher. However, investment externalities are reason why this simple conclusion is necessarily justified. The next section discusses wage-setting by a national, economy-wide union, that takes into account the effect of its actions on the pace of capital accumulation and the rate of economic growth. The learning-by-doing effect of investment is for a national union a reason to choose relatively low wages. If the investment externality is confined to a subset of firms, this result is also relevant for wage-setting by a sectoral union and qualifies the simple conclusion that sectoral wage-setting or wage-bargaining is inferior.[20]

3.3.2 Wage-setting at the most centralised level

Special-interest groups may serve the interest of their members either by trying to foster economic efficiency and growth or by trying to redistribute income in favour of the group and at the expense of the rest of society. According to Olson (1982) 'small' organizations tend to increase their share in income, whereas 'large' organizations have an incentive to raise income. An economy-wide union is torn between two forces. On the one hand an encompassing union has more power to raise wages than unions at industry or firm level, but on the other hand it cannot ignore the unfavourable macroeconomic consequences of its actions. In the above model one large union may internalise effects that are external to many small unions. First, it has to take into account the effect of (un)employment on the rate of interest and the rate of economic growth. Second, it may internalise the external effect of investment. Third, an economy-wide union may take into account the government budget constraint. After all, the employed members partly pay the unemployed members. Fourth, an economy-wide union may want to foster the research for and development of new products by redistributing income from workers to firms, as the introduction of new products does not require resources in the aggregate (or - alternatively - because product variety is not optimal). Below two case will be discussed in detail. In the first case an economy-wide union considers the negative effect of high wages on capital accumulation and economic growth. In the second case the union even opts for full employment, but also tries to increase the range of available intermediate goods.

[20] In the model firms equally benefit from investment by all other firms. Conceivable is however a symmetric situation in which each firm belongs to a subset and within the subset investment has an external effect on production.

An economy-wide union and capital accumulation

Before plunging into the intertemporal optimisation problem of the union, consider savings by the class of capitalists. The pace of capital accumulation solely depends on these savings. Using that the class of workers fully consumes its income and also pays the taxes to finance unemployment benefits, total savings are equal to $(s_K + s_N)\kappa^{-1}K - C_c$, where C_c is consumption by the class of capitalists. Consumption C_c obeys the Ramsey rule. Scaling it with the capital stock, indicated by a lower-case letter, gives

$$\dot{c}_c = c_c\left(c_c - \rho - s_N\kappa^{-1}\right),$$

since $r = s_K\kappa^{-1}$. The change in the capital stock becomes

$$\dot{K} = \left(s_K\kappa^{-1} - \rho - \frac{\dot{c}_c}{c_c}\right)K.$$

A union can thus affect the pace of capital accumulation in two ways. First, it could raise capital productivity κ^{-1}. A (permanently) higher return on investment brings about a (permanently) higher accumulation rate. Second, the union could let consumption by the capitalists grow at a lower rate than the capital stock. However, consumption trails the capital stock only temporarily. For example, rising wages in efficiency units, resulting in decreasing employment and declining profits ($s_N\kappa^{-1}$), leads initially to more savings, since current consumption already anticipates declining profits, whereas current profits are still relatively high. A policy of ever rising wages in efficiency units to boost savings is excluded from the following analysis. In other words, a union does not try to manipulate consumption by capitalists relative to the capital stock.[21] For this reason, the capital stock might as well be decomposed into two parts K_1 and K_2 such that the product of the two equals the capital stock, $K = K_1K_2$. The union ignores the changes in the second measure for the capital stock, but takes into account the consequences of its actions for the first measure. This measure evolves according to

$$\dot{K}_1 = \left(s_K\kappa^{-1} - \rho\right)K_1.$$

This is a relevant constraint for the union.

[21] This also avoids the problem of time-inconsistency. Now a union could announce a path of rising wages, but later it may want to choose a different path, boosting savings but also fooling other agents. Institutions to ensure commitment to an optimal but time-inconsistent plan may not exist. The solution to the dynamic problem should however be credible. This can be achieved in two, probably similar ways. First, a feedback solution rather than an open-loop solution can be calculated (see for example Cohen and Michel, 1988). Second, the Nash solution can be computed. This presupposes a loss in leadership, i.e. the union does not try to influence the behaviour of other agents. The latter approach is adopted here.

The union maximises the welfare function (3.15) subject to a labour demand function and the accumulation of capital by choosing a path of wages, where at any point of time the wage and the capital stock are perceived to influence employment as well as the capital productivity of capital. The number of varieties is given and the condition for no-entry does not necessarily hold with equality. To focus entirely on the main dynamic interaction between wages and the capital stock, the union is assumed to disregard the government budget constraint, linking unemployment and taxes. Later, the consequences of internalising the government budget constraint will be discussed. Contrary to analysis in the previous subsection, the setting of the wage entails an intertemporal choice between the immediate effect on welfare - income of employed members and unemployment - and the distant effect on welfare - the rate of capital accumulation. Consequently, the union maximises

$$U(t) = \int_{t}^{\infty} \left(L(v)\ln\left[W(v)\right] + \left[M - L(v)\right]B(v)\right)e^{-\rho(v-t)}dv, \tag{3.18}$$

subject to a labour demand function,

$$L = l\left(\frac{\bar{K}_1}{K_1}\right)^{\delta\varepsilon_C}\left(\frac{W}{K_1}\right)^{-\varepsilon_C}, \quad 0 \le \delta \le 1-\alpha, \quad \varepsilon_C = \frac{1}{1-\beta}, \tag{3.19}$$

the changes in the relevant measure for the capital stock

$$\dot{K}_1 = \left[s_K \kappa^{-1} - \rho\right]K_1, \tag{3.20}$$

and the changes in the value of firms, scaled with the first measure for the capital stock, $v = \frac{V}{K_1}$,

$$\dot{v} = \rho v - \frac{s_N \kappa^{-1} K_2}{N}, \tag{3.21}$$

where

$$\kappa^{-1} = N^{\theta} L^{\beta}\left(\frac{\bar{K}_1}{K_1}\right)^{-\delta}$$

and where l is a constant and ε_C is the wage elasticity of labour demand. Assume that the union does not always realise that in equilibrium $\bar{K} = K$. The extent to which the learning-by-doing effect of investment is external to the union is measured by the parameter δ: this effect is internalised by the union to the same extent as firms if δ equals 1-α, and fully if δ equals zero. Note that the interest rate equals $s_K \kappa^{-1}$.

The first-order conditions are,

$$-\varepsilon_C L(\ln W - \ln B) + L - \varepsilon_C \beta s_K \kappa^{-1} \lambda_K K_1 = 0, \tag{3.22}$$

$$\dot{(\lambda_K K_1)} - \rho(\lambda_K K_1) = +\delta s_{K_1} \kappa^{-1} (\lambda_K K_1) - \varepsilon_C (1-\delta)\left[L(\ln W - \ln B) + \beta s_K \kappa^{-1}\right], \tag{3.23}$$

$$\lambda_v = 0, \tag{3.24}$$

As before the wage affects employment and income of employed members immediately. However, unemployment in the present and in the future also diminishes capital productivity in the current and the following periods and therefore the pace of capital accumulation. The shadow prices related to the capital stock and the value of the firm, λ_K and λ_v, project the future state of affairs to the present. The (modified) shadow price of capital is the present and discounted value of the marginal value of the capital stock in the future. For a given wage, an increase in the capital stock leads to more employment and therefore also to a higher capital productivity. Besides, in the perception of the union an increase in the capital stock leads to a decrease of the real interest rate, unless the union fully internalises the learning-by-doing effect of capital investment and δ=0. The applied discount rate is equal to the union's rate of time preference and the perceived decrease in the interest rate owing to an expansion of the capital stock. The shadow price of capital is positive, and equation (3.22) reveals that a decrease in the capital productivity resulting from an increase in unemployment is an argument for the union to restrain wages. Since the no-entry condition is not binding in the presence of unemployment, the value of a representative firm can freely be determined by the union and the related shadow price is zero.

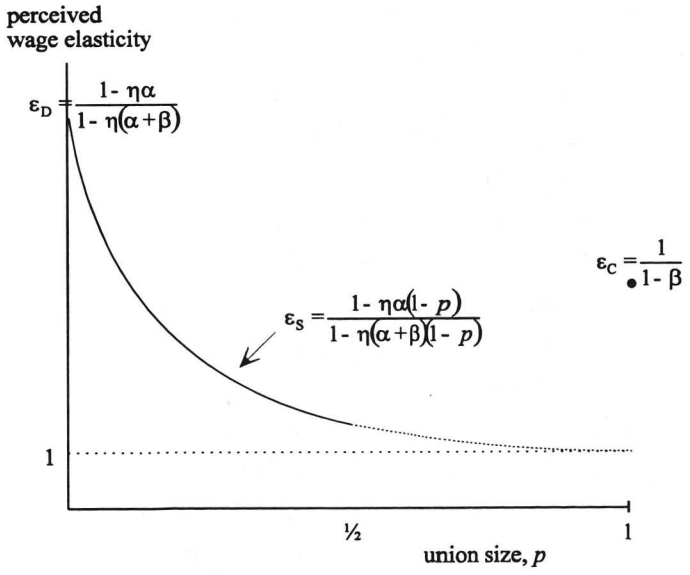
Contrary to unions at the level of a firm or an industry, an economy-wide union takes into account the adverse effect of unemployment on investment and economic growth. However, this does not necessarily imply that centralised wage-setting entails lower wages and higher employment than decentralised wage-setting, because the monopoly power of an economy-wide union may be large. The first-order condition along the balanced growth path clearly shows this trade-off,

$$\ln \frac{W}{B} = \frac{1}{\varepsilon_C} - \frac{\varepsilon_C^{-1}}{\varepsilon_C} \frac{(1-\delta)r}{\rho + \delta r}, \tag{3.25}$$

$$\lambda_K K_1 = \frac{(1-\delta)L}{\rho + \delta r}. \tag{3.26}$$

Figure 3.1 shows for the three cases -- decentralised, sectoral and centralised wage-setting -- the perceived wage elasticity. Clearly, trade unions have more market power when wages are set sectoral level rather than at firm level. The perceived wage elasticity falls when the sectoral unions increase in size and can set wages in more and/or larger sectors. To compare these two cases with wage-setting at an aggregate level is more difficult, since the outcome depends on more than one parameter. However, the figure shows the most plausible outcome where the perceived wage elasticity is lower for the one, economy-wide union than for the many, small unions at firm level: $\varepsilon_D < \varepsilon_C$.[22] In this configuration the economy-wide union has relatively much market power. It will not use this power to its full potential since this would discourage capital accumulation which is already too low.

Figure 3.1 *Union size and perceived wage elasticities*



In the model the intertemporal decisions are distorted for two reasons - except for the monopoly power of unions. First, by the nature of monopolistic competition the private marginal value of capital is below the social marginal value; an expansion of capital and production is perceived by the firm to lower the

[22] This outcome will prevail if the returns to scale are not too large and , in particular, if $\theta + \beta < 1$.

price of its output. Second, the learning-by-doing effect is external to firms. An economy-wide union has a different perception on the determination of prices and output than a small firm. It may also incorporate the learning-by-doing effect. If the union fully internalises the external effect of investment (δ=0) the present discounted value of the capital stock is higher than if it does not (δ=1-α). In the former case the union is more inclined to restrain wages than in the latter case. Internalising the external effect therefore shifts the choice from income to employment, and the union opts for more investment and higher economic growth.

To keep the above analysis tractable and clear some issues have not been addressed so far. First, the economy-wide union may incorporate the government budget constraint, linking taxes to unemployment. If the social security system is wholly or partly funded by workers this provides the union a strong incentive to restrain wage increases. Second, the members of the union may earn income from financial assets. This modifies the analysis considerably. For example, the union should take into account that high wages and unemployment depress profits and erode the non-human wealth of its members. The suggestion is thus that other considerations, the government budget constraint and non-human wealth of members, also change the balance for an economy-wide union in favour of employment rather than income.

An economy-wide union and product variety

For the above reasons the optimal wage in the case of centralised wage-setting may very well equal the competitive wage. Full employment does not necessarily imply that the union cannot influence the marginal revenue of capital by varying the wage. It could redistribute labour income to profit income, inducing more research for and development of new products and increasing specialisation of inputs in production. The union has to trade the level of the wages against investment in new varieties. The problem resembles the preceding one. The main difference is an additional constraint: owing to the no-entry condition (3.5) the value of the firm is not an instrument to the union. Only the case that the no-entry condition is binding at the start of the period will be considered. The wage is written as fraction (s_L) of the marginal revenue of labour to a firm in terms of final goods, and labour is assumed to be efficiently allocated among firms. Consequently, the union chooses s_L and to N(t) so as to maximise

$$U(t) = L\int_{t}^{\infty} \ln[W(v)]dv, \tag{3.27}$$

subject to,

$$\dot{K}_1 = \left(s_K \kappa^{-1} - \rho\right) K_1, \tag{3.28}$$

$$\dot{v} = \rho v - \left(1 - s_K - s_L\right) \frac{K_2}{\kappa N}, \tag{3.29}$$

$$W = \frac{s_L \kappa^{-1} K_1 K_2}{L}, \tag{3.30}$$

where L is given and constant. The optimal s_L and N can be derived from first-order conditions in equilibrium at the start of the planning period:

$$\frac{L}{s_L} = -\frac{\lambda_v}{\kappa N}, \tag{3.31}$$

$$\dot{\lambda}_K - \rho \lambda_K = -\frac{\dot{K}_1}{K_1} \lambda_K - \frac{L}{K_1}, \tag{3.32}$$

$$\dot{\lambda}_v = 0, \tag{3.33}$$

$$\theta\left[L + s_K \kappa^{-1} \lambda_K K\right] - (1-\theta) \frac{\lambda_v}{\kappa N} = 0. \tag{3.34}$$

The union has an incentive to restrain wages in order to raise the value of the firm and to expand the number of varieties. On the hand the diversity of inputs positively affects the productivity of labour and capital. On the other hand it depresses profits per firm, so that wages have to be decreased to meet the no-entry condition. The optimal fraction s_L exceeds zero if the production of final goods is concave in

the measure for variety, $\theta<1$. Combining the three first-order conditions along a balanced-growth path yields the share of profits in total income,[23]

$$s_N = 1 - s_K - s_L = (1 - s_K)\frac{\rho + r}{\frac{1}{\theta}\rho + r} . \tag{3.35}$$

or, equivalently, the share of labour,

$$\frac{s_L}{s_L + s_N} = \frac{1 - \theta}{\theta + \frac{r}{\rho}} . \tag{3.36}$$

Clearly, if the returns to investment in product variety do not diminish sharply, the union is inclined to set a high profit share and a low labour share. The choice between profits and wages depends on the rate of interest and the union's rate of time preference. Expanding the range of available intermediate goods leads to more capital accumulation and to higher wages. The gains of more product variety are partly in the future.

The research for and development of new varieties does not demand resources and does not temporarily temper accumulation of capital. As the union does not face the choice between expansion of the capital stock or an extension of the product range, its choice is likely to favour wage restraint. If the introduction of new products does require scarce resources, the union may still have an incentive to set the wage below the competitive wage. The external effect of aggregate investment and imperfect competition in the goods market bias directly or indirectly the supply of varieties and the interest rate downwards. The union may therefore act in its own interest by (partly) remedying the ensuing distortion, by redistributing income from employees to employers.

The success or failure of the union's strategy depends preponderantly on its ability or disability to commit to this strategy credibly. For once a firm has been established and a new product has been launched the union may decide to cheat; the union can harmlessly raise wages at the expense of profits, because investment expenditures to set up a firm are sunk costs. Production will not cease and a firm will not exit as long as profits are strictly positive, so that the wage can in fact be set at the level that just ensures full employment. Formally, the no-entry condition at a later date is not binding and the value of

[23] The system of equations, describing the economy and including the first-order conditions for the union, imply that the economy immediately jumps to a balanced-growth path.

a representative firm is an instrument to the union, so that the associated shadow price will then be equal to zero. The marked difference between the time-inconsistent and the time-consistent policy is intimately related to the character of the reproducible productive factor - variety of available products. Product variety is a stock that consists of past investments to establish firms or to introduce new products. The stock of this productive factor has no alternative use. In other words, the adjustment costs to employ the stock of past investments for an alternative, productive purpose are infinite.

3.4 Concluding remarks

For a union, economies of scale at firm level are a strong argument to choose relatively low wages. Increasing wages chokes demand for labour and also demand for capital goods. The smaller scale of production reduces efficiency and lowers labour productivity, leading to even less demand for labour. Similarly, a union taking into account external economies of scale or an investment externality, is inclined to set relatively low wages. This chapter has mainly focussed on a national, economy-wide union. Considering that employment is a determinant of capital accumulation, a national union is inclined to restrain wage demands. Wages will be lower the more the union incorporates a learning-by-doing effect of investment. A union may even want to transfer income from workers to firms in order to boost investment in R&D and expand product variety. Successfully pursuing this option requires that a union can commit itself to a time-inconsistent plan. A more general conclusion is that - in the presence of investment externalities - a union does not want to frustrate investment and may even want to boost investment. This conclusion may also apply to sectoral unions. The discussion of wage-setting by a national union is also relevant for sectoral wage-setting or wage-bargaining, if externalities are confined to a sector or a region. The idea that sectoral wage-bargaining is inferior to bargaining at firm level or at a national level, does not have to be true in the presence of local or regional externalities.

This chapter has not discussed the scope of externalities so far. Are they local, national or international? Evidence on this matter does not give an unequivocal outcome. Typically empirical studies in the United States trying to estimate the effect of R&D on production or factor productivity find that the return on R&D is relatively high (see Nadiri, 1993, Jones and Williams, 1998). This suggests that efforts to introduce new or better products are too little, and have external effects on production and investment elsewhere. Besides, more evidence for local and national externalities come from studies linking at sectoral or firm level R&D and productivity (see for example Jacobs, Nahuis and Tang, 1999). However, Coe and Helpman (1995) and others find that the benefits of R&D are not confined to regional

or national zones. Instead, they find that R&D in one country raises factor productivity in another country (within the group of rich countries).

The evidence on the (geographical) boundaries of externalities is thus mixed. This may very well reflect that local, national and international spillovers are not mutually exclusive and are equally important. Since sectoral spillovers seem to be significant and affect the outcome of wage-bargaining between employers and employees, sectoral wage bargaining is not necessarily inferior to wage bargaining at a national level or at firm level.

Appendix A Accumulation of varieties

The problem of the optimal variety cannot be settled explicitly within the context of the model, as the introduction of new varieties does not require resources, and the solution that the number of products should be infinite is trivial and uninteresting. The problem can however be approached by analogous reasoning. The model is therefore modified on two accounts: the introduction of products demands resources and takes time. The problem becomes to maximize

$$W(t) = \int_t^{\infty} \ln[C(v)] e^{-\rho(v-t)} dv, \tag{A1}$$

subject to,

$$\dot{K} = N^{\theta} K - C - RK, \tag{A2}$$

$$\dot{N} = BR, \tag{A3}$$

where A and B technology parameters. The range of available products is represented as before by a measure N, and expands with BR if RK goods are devoted to the research for and development of products. The size of the population is normalised to unity. The reproducible productive factors K and N will not be accumulated simultaneously; either N or K will be accumulated. These two cases have to be distinguished.

I $\lambda_N > \lambda_K K; \quad \dot{N} > 0, \dot{K} = 0$

$$C^{-1} = B\lambda_N \tag{A4}$$

$$\dot{\lambda}_K = (\rho - N^{\theta} - R)\lambda_K \tag{A5}$$

$$\dot{\lambda}_N = (\rho - \theta N^{\theta-1})\lambda_N \tag{A6}$$

II $\lambda_N \leq \lambda_K K; \quad \dot{N} = 0, \dot{K} > 0$

$$C^{-1} = \lambda_K \tag{A7}$$

$$\dot{\lambda}_K = (\rho - N^{\theta})\lambda_K \tag{A8}$$

$$\dot{\lambda}_N = \rho\lambda_N - \theta K N^{\theta}\lambda_K \tag{A9}$$

The change in regimes occurs if $B\lambda_N = \lambda_K K$, or equivalently, if

$$\frac{\theta N^{\theta-1}}{\rho} = B^{-1} . \tag{A10}$$

From this equality the optimal range of available products (N^{**}) can be deduced. Both regimes can be distinguished by the initial condition for N. If $N(t) < N^{**}$ regime I applies, and if $N(t) \geq N^{**}$ regime II applies. Owing to the concavity of the production function for goods with respect to variety the extension of the product range is more rewarding than the expansion of the capital stock if $N(t)$ is low. However, the return on investment to increase variety is decreasing. Therefore, the transition from regime I to regime II occurs if N has approached N^{**} and consumption in both regimes are equal.

The similarity between the no-entry condition (3.20) and the equality (A10) should be apparent. Clearly, monopolistic competition depresses the return on investment in both alternatives - the capital stock and product variety. The beneficial effect of specialization is not fully reflected by the reward to investors. Consequently, the number of available varieties is too low. The difference between the competitive and the optimal interest rate may either mitigate or aggravate this distortion. Note that this difference cannot only be attributed to monopolistic competition and the external effect of investment directly (η, $\alpha < 1$), but also indirectly ($N < N^{**}$).