Unionisation, Unemployment and Economic Growth

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1. Introduction

The voluminous literature on the sources of economic growth has identified a wide range of natural and government-imposed stimulants and impediments to economic growth. In particular, expenditure on R&D, a high level of educational attainment, an open trading regime, a low level of government consumption and political stability are generally seen as having a significant positive effect on growth\(^1\). However, most such studies typically assume a perfectly functioning labour market and focus their analysis on distortions in capital markets or on trade policy.

A relatively recent development in the literature on endogenous growth is its interest in the effects of institutions on economic growth, in particular the positive role of a legally sanctioned system of property rights and the growth-reducing effects of institutions conducive to rent seeking\(^2\).

This paper considers the role of an institution which frequently plays a key role in the rent seeking associated with distributive politics: the labour union. High rates of unionisation have been a notable characteristic of a number of economies with indifferent growth performance (Australia and New Zealand in the 1970s and ‘80s, the United Kingdom in the 1970s, Germany in the 1990s etc.). Although a probable link between unionisation and growth has frequently been noted, there has been little in the way of formal analysis. This paper attempts to fill this gap by developing a simple theoretical model to identify the role of unions in the growth process.

Our approach also permits us to consider unemployment in a growth context. This is in contrast to most recent growth theory, which customarily works with an undistorted labour market, implicitly assuming full employment in the steady state or

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\(^1\) See for example Barro and Sala-i-Martin (1995).

along the balanced growth path. Focusing on the determinants of long-run growth, the new growth theories tend to neglect the relationship between unemployment and economic growth.

This paper employs a simple overlapping-generations model (OLG) with an R&D sector to establish a link between union bargaining power, long-run unemployment and long-run growth. There are two intermediate goods produced in the economy. One intermediate good is produced under competitive conditions using labour and the common technology. This sector is non-unionised. The other intermediate good is produced by a monopolist, the patent holder, using unionised labour and the state-of-the-art technology. The monopolist bargains with its union over the wage resulting in wage differentials across sectors and unemployment. The engine of growth is the technological innovation carried out by a competitive R&D sector. Wage bargaining raises the labour cost and reduces profits of the monopolist, thus reducing the incentive to invest in R&D for higher returns in the future. A lower level of investment in R&D, in turn, slows down the rate of long-run growth. We derive a long-run steady-state unemployment rate and balanced growth rate and show that increased union power leads to a higher rate of long-run unemployment and a reduced long-run growth rate. This result is shown to be quite robust. It also applies to the case where the unionised sector produces a conventional, rather than high-tech, intermediate good and does not depend on whether the union is “closed-” or “open-shop”

The structure of the paper is as follows. Section 2 develops the basic model. Section 3 derives the equilibrium rate of unemployment, the unionised wage and the labour allocation between sectors. Section 4 focuses on the economy’s balanced growth path and derives the relationship between union bargaining power and the
long-run growth rate. Section 5 shows that the main results of the paper generalise to
the case of an open-shop union. Section 6 summarises the main conclusions of the
paper and suggests directions for further research.

2. The Model

We employ a variant of the influential Harris-Todaro (1970) model to analyse the
impact of unionism on employment and economic growth. The standard two-sector
model is extended to include one R&D sector. This is not only to allow for perpetual
growth, but also to capture the frequently cited relation between R&D investment and
unionisation.\(^3\)

2.1: Production

Consider a closed economy with agents who live for two periods. An individual \(s\)
born at time \(t\) possesses no wealth when she is young, but she can work and earn a
wage rate \(w_{s,t}\). At any point of time \(t\), there are two generations in the economy. The
members of the old generation, who were born at time \(t-1\), are the shareholders of the
monopolistic producer of the state-of-the-art intermediate good (see below). Young
people will save a part of their wage, invest in R&D and receive profits when they are
old.

There are four sectors in our model, a competitive final goods sector, two
intermediate goods, good \(Y\) produced under competitive conditions using freely
available technology and good \(X\) produced by a monopolist with patented state-of-the-
art technology. The fourth sector produces R&D under competitive conditions.
These four sectors are now described in more detail.

\(^3\) See Baldwin (1983) and Addison and Hirsch (1989).
2.1.1: Intermediate good X:

This monopolistic sector produces intermediate goods for the final good sector using labour and the state-of-the-art technology \( h_t \):

\[
X_t = h_t L_{X,t}
\]

The monopoly right is derived from possession of the patent for the state-of-the-art technology, which is the result of investment in R&D in the previous period. This patent has a life of one period after which the technology becomes freely available.

2.1.2: Intermediate good Y:

This sector uses labour and \( h_{t-1} \), the freely available technological vintage from the previous period. In contrast to the monopolistic sector, this sector is perfectly competitive because everyone has access to the technology. In aggregate:

\[
Y_t = h_{t-1} L_{Y,t}
\]

2.1.3: Consumption goods sector:

The consumption good for the economy, the numeraire in our model, is produced in a perfectly competitive sector, which just assembles the two intermediate goods according to a Cobb-Douglas technology:

\[
C_t = (\Theta_{X,t} X_t)^{1-b} (\Theta_{Y,t} Y_t)^b
\]

Where \( \Theta_{i,t} \) \( (i = X, Y) \) is the proportion of intermediate good i used in consumption good production at time \( t \).

2.1.4: R&D sector:

This sector carries out R&D activity using intermediate goods X and Y as inputs to produce a new technological vintage \( h_{t+1} \). R&D has the same technology as the final good sector except for the productivity parameter \( A \):
(4) \[ h_{t+1} - h_t = A \left( (1 - \Theta_{r,t}) Y_t \right)^{1-b} \left( (1 - \Theta_{x,t}) X_t \right)^b \]

It is implicitly assumed in equation (4) that the state-of-the-art technology \( h_t \) is not a public good for R&D activities. Because the state-of-the-art technology does not enter the process of R&D accumulation directly, there are no technological spillovers in our specification\(^4\). Our model thus differs from the majority of R&D-based growth models which assume that inventions contribute to a pool of public knowledge, which facilitates subsequent innovations because everyone has access to the newest knowledge. However, previous innovations do facilitate current innovations in our model in an indirect way because past inventions raise the flow of the resources (here, intermediate goods \( X \) and \( Y \)) available for the production of consumption goods and for R&D activities in the current period.

It should be pointed out that in equilibrium, there is only one R&D firm.\(^5\) This firm finances its innovation cost by selling shares to savers. Young agents born at time \( t \) then become shareholders of the sole producer of good \( X \) at time \( t+1 \).

2.2: Consumer preferences

Individuals are identical and an individual \( s \) born at time \( t \) has the following lifetime utility function:

\[
U_{s,s} = \left( C_{s,t}^\sigma + \rho C_{s,t+1}^\sigma \right)^{1/\sigma} \quad \sigma < 1, \quad 0 < \rho < 1
\]

Where \( \rho \) is the exogenously given discount factor.

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\(^4\) The assumption of technological spillovers is very common in endogenous growth models with an R&D sector. See Grossman and Helpman (1991, chs. 3 and 4), Aghion and Howitt (1990), Rivera-Batiz and Romer (1991)

\(^5\) A single-firm equilibrium of the R&D sector exists and is unique in a competitive environment if R&D firms entertain Stackelberg conjectures regarding their behaviour. Potential entrants threaten to enter so the active firm invests up to the amount that leads to a (intertemporal) zero-profit. See Dasgupta and Stiglitz (1980)
A young agent when born has no wealth. She can choose whether to work in the monopolistic sector or to be self-employed. Her wage income $w_s$ is partly consumed in the current period, partly saved for future consumption. Savings earn interest with the rate $R_t$ treated as given by individuals. As a result, the intertemporal budget constraint facing agent $s$ with income $w_{s,t}$ is:

$$c_{s,t} + \frac{c_{s,t+1}}{1+R_t} = w_{s,t}$$

2.3: Labour market

This paper departs from the mainstream of the growth literature by incorporating an imperfect labour market and unemployment. This is achieved by assuming that the monopolistic sector is unionised, with firm-union wage bargaining leading to a wage premium in the sector and consequent unemployment.

In order to focus on the main effects, the modelling of the bargaining outcome employs the simplest possible framework, that of wage-only bargaining. This “right-to-manage” model, familiar from the literature on unions, assumes that once the wage-contract is signed, the monopolistic firm chooses its employment level on its labour demand curve. Although this approach has been criticised for producing a solution which is \textit{ex-post} inefficient, it does seem more in line with observed wage practice which tends to eschew direct bargaining over employment levels.

The objective of the trade union is assumed to be maximisation of the difference between its members’ income and what they would get if working in the competitive self-employed sector at the ruling prices. For simplicity, the following functional form is assumed for the utility of the trade union:

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6 The results of the paper are qualitatively the same for the case of “efficient bargaining” where the firm and the union bargain over the wage and the employment level.

7 See McDonald and Solow (1981).
where \( w \) is the wage determined by bargaining in the monopolistic sector and \( w_Y \) is the wage rate prevailing in the self-employed competitive sector. This specification is widely used in the literature on trade unions because it is a simple means of incorporating the joint union objectives of a wage premium for members and a higher level of employment (and union membership). For simplicity, union membership is assumed to be a compulsory prerequisite of employment in the monopolistic sector, that is, we are analysing a “closed-shop” situation.

To model the bargaining between the firm and the union, we employ the Nash axiomatic bargaining approach, so that the negotiated wage will maximise the Nash “product”:

\[
(8) \quad J = \beta \ln U + (1 - \beta) \ln \Pi ,
\]

where \( U \) is the utility of the union as specified in Equation (7), and \( \Pi \) is the profit of the monopolistic firm. The parameter \( \beta \) \((0 \leq \beta \leq 1)\) represents the bargaining power of the union and is assumed to be exogenous. Moreover, the alternative wage \( w_Y \) is taken as given by both parties. It is also implicitly assumed that if negotiation breaks down, both parties get zero payoffs.

2.4: Sequencing of decisions

Within each period, the variables of the model are determined in three stages. In the first stage, young agents choose whether to work for the monopolistic firm or to

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8 Leontief (1946), McDonald and Solow (1981).
9 See for example, Oswald (1984), Brown and Ashenfelter (1986), Farber (1986).
10 See Booth and Chatterji (1995) for an analysis of an “open-shop” trade union.
11 The overlapping generations formulation used in this paper offers considerable advantages in simplifying the interaction between wage bargaining and savings. In an infinitely lived agent model, wage bargaining in period \( t \) would depend on wage bargaining in all future periods. In this respect, the approach employed in this paper offers a simple way of ensuring that current union members are not affected by future wage bargaining outcomes.
produce good $Y$. Decisions are made based on the individual’s expectation about the wage rates in different sectors. Once the decision has been made, the individual is committed to the selected sector for one period. The workforce of the monopolistic sector is unionised so the union knows its size before it begins wage negotiation. In the second stage, the owners of the monopoly bargain with the union over the wage. In the final stage, the firm chooses its employment level on its labour demand curve. Thus, demand for labour is determined as a function of the wage and this is taken into account in the prior wage bargaining in that period. The determination of wage and employment in the monopolistic sector can be viewed as the outcome of a two-stage game which occurs after young agents select their working location.

3. **Equilibrium**

3.1: *Labour demand*

In equilibrium, investing in the consumption good sector must yield the same rate of returns as investing in the R&O sector. This condition together with similar linear homogeneous technologies implies these two competitive activities must also have the same composition of intermediate inputs. Therefore, the same proportion of good $X$ and good $Y$ will be used for the production of final goods as well as for the new technology, that is $\Theta_{x,t} = \Theta_{y,t}$. In addition, the similarity of technologies implies that resources needed to produce one unit of the consumption good can be used in R&O sector to improve technology by $A$ units. As both these two sectors are competitive, the market price of newly invented technology is $1/A$. Combining these results, we can express the total output of this economy as follows:

$$
\text{Equation 13:}
$$

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12 Therefore, from now on, we drop the good subscript when referring to $\Theta$. To simplify notation, we shall also omit the time subscripts in equations if the variables in question refer to the same period. For intertemporal equations, time subscripts will be added to avoid unnecessary confusion.

13 In what follows the sector using intermediate goods to produce either consumption goods or technological vintage will be referred to as the final good sector.
An immediate consequence of equation (9) is that the demand for each intermediate good will be determined only by the relative stock of the intermediate goods, but not by the allocation of resources between the two final good activities.

As mentioned in Section 2.4, young agents choose and commit to a sector before wage negotiation occurs in the monopolistic sector. Therefore, the intermediate goods sector producing $X$ takes $Y$, the level of output in the competitive intermediate sector as given. This applies when the firm is choosing its profit-maximising labour input and when the firm and the union are bargaining over the wage. Then, if $w$ is the wage negotiated between the firm producing intermediate good $X$ and its trade union, the labour demand curve for this producer is given by the condition that the wage equals the marginal revenue product of labour.

\[
\frac{\partial (p_x X)}{\partial L_x} = w = b^2 Y^{1-b} h^b L^{b-1}_x
\]

If she chooses to be employed in sector $Y$, a young agent can produce good $Y$ according to the technology given by equation (2), and the aggregate demand for good $Y$ which can be derived from the total output of the economy as given in (9). Because this sector is competitive, this agent can receive a wage rate $w_Y$ equal to the value of the marginal product of labour in sector $Y$ as given by:

\[
w_{Y,t} = (1 - b) h_{t-1} \left( \frac{X_t}{Y_t} \right)^b
\]

### 3.2: Equilibrium labour allocation and unemployment

The existence of trade unions causes a difference between the wage rates of the unionised and the competitive intermediate good sector and the resulting wage premium affects individual career decision. At the beginning of the first period of life,
each young worker has to make the decision whether to stay in the unionised sector with a probability of getting a job $\delta$, or to get a job in the competitive sector at a wage rate $w_Y$ with certainty (the labour market for the competitive sector always clears). In equilibrium, she is indifferent between the two alternatives. Therefore, we should have equality of expected utilities as an equilibrium condition in the labour market.

To focus on the impact of unionisation on R&D investment and growth, we assume that a worker deciding to stay in the monopolistic sector gets nothing if she is unemployed. Consequently, equality of expected utilities implies $U(w_Y) = \delta U(w)$, which is equivalent to the equality of expected wages, $w_Y = \delta w$, because of linear homogeneity of the utility function.

Suppose that the X-firm randomly selects employees from a pool of workers. The probability of getting a job is then the ratio between the number of employees and the total work force of this sector. Since the probability of being employed and the unemployment rate sum to unity, the equality of expected wages can be rewritten as

$$ (12) \quad (1-u)w = w_Y $$

where the unemployment rate of the unionised sector is $u \equiv \frac{N_X - L_X}{N_X} = 1 - \delta$ and $N_X$ is the total workforce of sector $X$.

The equilibrium unemployment rate is then determined by Nash bargaining so as to maximise the Nash product as given in (8). This can be shown to yield the following expression (see Appendix)

$$ (13) \quad u^* = \frac{\beta(1-b)}{b + \beta(1-b)} $$

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14 This assumption is readily relaxed without affecting the qualitative results, but we choose to retain it for ease of exposition.
Clearly from (13), the unemployment rate is positive and less than unity as all the parameters in (13) are positive and less than unity. The level of unemployment depends only on $b$, the union’s bargaining strength parameter, and $b$, the share of good $X$ in the production of both the final good and the new technology, but does not depend on the share of intermediate goods devoted to R&D, $(1-\Theta)$. Moreover, the more powerful the union (the higher is $\beta$), the higher the rate of unemployment.

The equilibrium condition for the labour market of the economy as a whole is then:

$$N = N_x + L_y = \frac{L_x}{1-u} + L_y$$

From (10), (11), (12) and (14), we can derive the equilibrium employment level of each sector in terms of the unemployment rate:

$$L_y^* = \frac{N(1-b)}{1-b+b^2}$$

$$L_x^* = \frac{Nb^2 (1-u^*)}{1-b+b^2}$$

It is clear from Equation (15) that $L_y^*$ is independent of the union power parameter $\beta$ despite the fact that an exogenous change in $\beta$ will alter the wage premium of unionised workers. In contrast, an increase in the unionised wage rate caused by a rise in $\beta$ will lead to a higher rate of unemployment and hence a lower level of employment and output in the unionised sector ($L_x$ falls). A higher price charged by the monopolist causes a shift in demand of final good producers from $X$ to $Y$ intermediate goods. Increasing demand leads to a rise in price and thus wages for $Y$-producers, and this rise induces people to stay in the $Y$ sector despite the increase in the unionised wage. On the other hand, wage $w$ increases and keeps risk-neutral
people queuing for a job in the monopolistic sector despite the increase in the unemployment rate.

4. Balanced Growth

4.1: Short-run equilibrium:

In this paper, the short-run equilibrium is attained when at a given growth rate in the previous period, both the labour market and the capital market are clear; that is, the labour allocation across sectors correctly reflects workers’ wage expectation and R&D investment is paid the value of its marginal product. In equilibrium, total savings of the young generation are equal to total investment in the R&D sector. This condition, together with the condition of zero profits in the competitive patent race, implies:

\[ \mu(w_x L_x + w_y L_y) = (1 - \theta) Y^{1-b} \]

where \( \mu \) is simply the average propensity to save of individuals. Because \( R \) is taken as given by all individuals, the savings rate \( \mu \) is equal for all young agents born at the same time. A rise in the interest rate increases the opportunity cost of present consumption thus result in a higher propensity to save which in turn leads to a higher proportion of intermediate goods invested in the R&D sector.

There is another equilibrium condition relating the monopoly profits resulting from investment in R&D and the opportunity cost of this investment, the interest rate. The young generation born at time \( t \) invests its savings in R&D to invent a new technology \( h_{t+1} \). The patent of this newly invented technology gives them the monopoly right and profits in the next period. Because of the competitive patent race, in equilibrium, investing in R&D must yield the same rate of return as the interest rate
Substituting the equilibrium values of labour allocation and saving ratio into this no arbitrage condition, we obtain the following expression (see Appendix):

\[
(1 + R_t)g_t = (b - b^2)(1 + g_t)^b L_y^{1-b} L_X^b = \\
N(1 - b^2) (1-b)^{1-b} b^{2b} (1 + g_t)^b (1 - u)^b
\]

Equation (18) states that the growth rate of human capital \( g_t \) will adjust to equate the gross rate of profit from R&D to the return from investing at interest rate \( R_t \). Equivalently, a higher interest rate will increase the opportunity cost of investing in R&D. Because the return from investing in R&D is a decreasing function of the level of investment, investment will fall to restore equilibrium. This fall in investment will necessarily imply a lower rate of growth. Thus, in equation (18), \( g_t \) is a decreasing function of \( R_t \).

Substituting the R&D production function (4) and the labour market allocation in (15) and (16) into the growth definition \( g_t = \frac{\Delta h_t}{h_t} \), we obtain a dynamic difference equation relating current growth to past growth:

\[
g_t (1 + g_{t-1})^{1-b} = A(1 - \Theta_t) L_y^{1-b} L_X^b = \\
AN(1 - \Theta_t) (1-b)^{1-b} b^{2b} (1 - u)^b
\]

where \((1 - \Theta_t)\) is the proportion of intermediate inputs devoted to R&D investment and is increasing in the interest rate \( R_t \). Therefore, equation (19) simply states that a higher interest rate will be associated with higher growth in the same time period. A higher interest rate in the economy encourages consumers to save more and the resulting increase in R&D investment in turn leads to a higher rate of growth. It is worth noting that the structure of the dynamics in (19) is greatly simplified by our assumptions that make the equilibrium allocation of workers between sectors depends only on the unemployment rate, not on time. The system of
equations (18) and (19) determines the economy’s short-run interest rate and growth rate in period \( t \), given the growth rate in period \( t-1 \).

Figure 1: Determination of short-run interest rate and growth rate

Figure 1 depicts the determination of the short-run interest rate and the growth rate in period \( t \) for a given rate of growth \( g_{t-1} \) in the previous period. Loci RR and GG represent equations (18) and (19) respectively. It is straightforward to show GG is monotonically upward sloping and RR is monotonically downward sloping. As a result, the solution of (18) and (19) is unique, represented by \( E_0 \), the intersection of GG and RR.

4.2: Long-run equilibrium:

In our model, the growth rate of output is solely determined by \( g \), the growth rate of technology. In the long run, \( g_t = g_{t-1} = \bar{g} \), so the rate of long-run growth is determined by the solution of equations (18) and (19) and the condition that the rate is constant in the long run.
Figure 2 illustrates the determination of the long-run growth rate. Locus DD, derived from (18) and (19), depicts the current rate $g_t$ of growth as a function of the growth rate in the previous period. It is straightforward to show that DD is monotonically downward sloping. The intersection between DD and the 45-degree line, point $S_0$, gives us the long-run rate of growth. Because the rate of growth in the present period is monotonically decreasing in the rate of growth in the previous period, the solution of the system, if exists, is unique. Moreover, the system may be shown to be locally stable at $S_0$ because the slope of DD at $S_0$ is less than unity in absolute value (proof available from authors on request).

The long-run interest rate is obtained by substituting the long-run rate of economic growth back into Equation (18). We can also obtain the long-run values of the growth rate and the interest rate algebraically by substituting $g_t = g_{t-1} = \tilde{g}$ into equation (19) and solving the system of two equations (18) and (19).

Suppose there is an exogenous increase in $\beta$, the bargaining power of the union. This will raise the wage rate in the monopolistic sector and widen the gap
between wages of unionised workers and self-employed workers. Facing a higher labour cost, the monopolist will reduce the level of employment ($L_X$), which lowers the demand for the intermediate good $Y$. The wage faced by $Y$-producers falls, and unemployment rises.

The increase in the bargaining power of the union has two effects. First, the resulting increase in the unionised wage reduces the return to investment in R&D. At a given opportunity cost of such investment (given $R_t$) this induces a fall in the rate of innovation and hence a fall in the growth rate. This is illustrated by the leftward shift in the $RR$ locus in Figure 1. In the second effect, at given $R_t$, the fall in output of good $X$ causes a fall in savings and hence a fall in the growth rate. This is illustrated by the leftward shift in $GG$ in Figure 1. These two effects reinforce one another to yield a fall in the growth rate.

At the same time, the change in the interest rate is ambiguous. The first of the above effects yields a fall in the interest rate at given $g_t$ (a downward shift in $RR$) because the fall in output of $X$ yields a fall in the rate of return to R&D. To restore equilibrium, $R_t$, the opportunity cost of investing in R&D must also rise. However the second effect yields a rise in the interest rate at given $g_t$ (an upward shift in $GG$) because the fall in $X$ output has to be offset by a rise in $(1-\Theta^*)$, the proportion of intermediate goods devoted to R&D. This requires an increase in $R_t$ since $(1-\Theta^*)$ is an increasing function of $R_t$. Thus the two effects shift the interest rate in opposite directions. Its net change is ambiguous.

These effects of an increase in $\beta$ at time $t = 1$ are illustrated in Figures 1 and 2. Initially the economy is in equilibrium at point $E_0$ in Figure 1 and the corresponding steady state is at $S_0$ in Figure 2. The long-run rate of growth is $g_0$. An increase in the power of the union lowers the level of employment in sector $X$ ($L_X$) and shifts the
curve GG left to $G'G'$ and the curve RR down to $R'R'$. The new short-run equilibrium is $E_1$, with lower growth, but the change in the interest rate is ambiguous. As a result, for given $g_0$, the short-run growth rate in period 1 is $g_1$, lower than $g_0$. In Figure 2, the resulting decrease in the short-run growth rate $g_1$ corresponds to a downward shift of the curve DD to $D'D'$. The short-run equilibrium $E_1$ in Figure 1 corresponds to the point $S_2$ in Figure 2. Given the rate of growth $g_1$ in period 1, the economy will grow at the rate $g_2$ in period 2 and the economy moves in an oscillatory manner toward the new equilibrium $S_1$ with a lower rate of long-run growth $g^*$. 

4.3: Growth in the case where sector Y is unionised

It might be argued that the union in our model acts as a tax on output of the high-tech sector, and unionisation might be pro-growth if the sector producing the conventional intermediate good (good Y in our model) is unionised. The operation of a trade union in the low-tech sector would, in this sense, reallocate resources to the high-tech sector, and consequently raise growth. However, as is shown in the Appendix, this is not the case. In fact, unionisation in the Y sector has the same growth-reducing long-run effects as unionisation in the X sector. To show this we keep the same framework for the purpose of comparison. However, because there are no profits or physical capital in sector Y, there would be no profits or quasi-rents needed for the same bargaining framework. Accordingly, we assume that there is a monopoly union seeking to maximise the same utility function and compare the results with the case of perfectly functioning labour markets. As noted above, we obtain qualitatively the same results as when the X sector is unionised. This is because the negative growth effects of unionisation result from a wasteful use of labour
resources, rather than the reallocation of resources from the unionised sector to the non-unionised sector.

5. **An Open-Shop Union**

The analysis in the previous sections relies on a closed-shop framework in which membership is compulsory for obtaining a job in the monopolistic sector. The power of the union is solely represented by $\beta$. In this section, another measure of the power of the union is introduced, namely the proportion of the workforce of the monopolistic sector which is unionised. This parameter is measurable and thus likely to have more empirical relevance than $\beta$.

Suppose that after committing to stay in one intermediate good sector, only an exogenous proportion, $\lambda$, of workers in the $X$-sector is unionised.\(^{15}\) If negotiations break down, assume that $(1-\lambda)N_{X}$ workers will continue to work at the competitive wage rate to produce $X$. If a wage contract is agreed and the firm hires $L_{X}$ employees, $\lambda L_{X}$ will be unionised workers.

Compared to the closed-shop framework, the threat point facing the monopolist is no longer zero. If wage negotiations break down, the monopoly could still maintain its production and get profits $\Pi_{0}$ by employing $(1-\lambda)N_{X}$ nonunionised workers. Since the size of the workforce and the union density are known by both bargaining parties before the negotiation, $\Pi_{0}$ is treated by two parties as given. Therefore, we can employ a similar approach to that in section 3 to yield the following expression of the sectoral unemployment rate (see Appendix):

\(^{15}\) To focus on the relationship between unionisation and economic growth, the endogeneity of membership is left for further research. For literature on endogenous membership, see, for instance, Booth and Chatterji (1993, 1995).
\begin{equation}
\frac{\beta}{u} - \frac{\beta}{1-b} - \frac{b(1-\beta)}{1-\left(\frac{1-\lambda}{1-u}\right)^{1-b}} = 0
\end{equation}

where it is implicitly assumed that $\lambda$ is sufficiently large so that $\Pi_0 < \Pi$. Otherwise the union would not have any power in wage negotiation because the unemployment pool is large enough to replace the unionised workers going on strike (it can be shown that $\lambda > u$ is a necessary condition for this requirement).

Standard comparative statics show that the unemployment rate $u$ and the unionised wage $w$ are both increasing in $\lambda$, the proportion of the $X$-sector workforce which is unionised. $\lambda$ may be viewed as an acceptable empirical measure of union power. As the above results show, an exogenous increase in $\lambda$ has the same impact on the economy and the long-run growth rate as a rise in $\beta$, the parameter used to capture union bargaining power in the closed shop model.

6. Conclusions

This paper has presented a simple OLG model in which one sector is unionised and produces intermediate goods for final good and R&D sectors. With appropriate assumptions about the patent race in a competitive R&D sector, it is possible to focus on the link between unionisation and savings in the growth process. In particular, it is shown that a higher proportion of workers unionised results in a lower long-run balanced growth rate of innovation and of output per capita.

The engine of growth in our model is investment in R&D. The incentive for R&D investment, which serves as a type of fixed cost, is the monopoly profits in the next period. Wage negotiation between union and firm drives up wages and reduces employment in the unionised sector. This affects growth in two ways. First, lower output reduces the level of investment in new technology. Second, higher labour costs
lower profitability of investing in R&D and thus discourage savings. Both factors work in the same direction to yield a lower rate of long-run growth.

The model developed in this paper is simple and extensions can be made to capture a richer menu of effects of unionisation on economic growth. One possible extension is to examine the effects of collusion between unions in wage bargaining. To address the distinction between enterprise and union, it is necessary to have a model with more than one firm in the unionised sector and the labour demand for one firm depending on the wages of all firms in the industry.

In addition, the model employed here assumes a closed economy. However, in the light of recent interest in trade and labour markets, there are clearly a number of important issues to be addressed in an open economy framework. The question of how unionisation influences the effects of international trade liberalisation on wages, unemployment and growth is the subject of further work by one of the authors.
References.


Appendix

1. Derivation of the equilibrium unemployment rate

In the first stage of the game, the union and the monopolist negotiate over the wage, which will maximise the Nash product

\[ J = \beta \ln U + (1 - \beta) \ln \Pi, \]

where \( U \) is the utility of the union, \( U = (w - w_Y) L_X \), and \( \Pi \) is the profit of the monopolistic firm, given by

\[ \Pi = p_X X - w L_X = b Y^{1-b} X^b - w L_X \]

In the second stage, the monopolist takes the wage as given and selects employment so as to maximise profit. This yields the following labour demand

\[ w = b^2 Y^{1-b} h^b L_X^{b-1} \]

The game is solved backward, so both parties take the labour demand as in (A.3) into wage bargaining process. The first-order condition is

\[ \frac{\partial J}{\partial w} = \frac{\beta}{U} \frac{\partial U}{\partial w} + \frac{1 - \beta}{\Pi} \frac{\partial \Pi}{\partial w} = 0 \]

Substituting the expressions for the utility of the union into (A.4), and noting that both parties take the other wage \( w_Y \) as given, the first term in (A.4) becomes

\[ \frac{\beta}{U} \frac{\partial U}{\partial w} = \frac{\beta}{(w - w_Y) L_X} \left( L_X + (w - w_Y) \frac{\partial L_X}{\partial w} \right) \]

The labour demand given in (A.3) has a constant elasticity \( \varepsilon \equiv \frac{\partial \ln L_X}{\partial \ln w} = \frac{1}{b-1} \) with respect to the unionised wage. Moreover in equilibrium, workers have equal expected wages, that is, \( w(1-u) = w_Y \) where \( u \) is the rate of sectoral unemployment. Substitute these into (A.5) to obtain

\[ \frac{\beta}{U} \frac{\partial U}{\partial w} = \frac{\beta}{uw} (1 + u \varepsilon) \]
On the other hand, the demand for $X$ given in Equation (10) and the demand for labour in (A.3) imply $p_X = \frac{w}{bh}$ so profits of the monopoly can be rewritten as

(A.7) \[ \Pi = p_X X - wL_X = wL_X \left( \frac{1}{b} - 1 \right) \]

From (A.7) the derivative of profits with respect to $w$ is

(A.8) \[ \frac{\partial \Pi}{\partial w} = \frac{1 - b}{b} \left( L_X + w \frac{\partial L_X}{\partial w} \right) = \frac{(1 - b)}{b} L_X (1 + \varepsilon) \]

Substitute (A.6), (A.7) and (A.8) into the first-order condition (A.4) to yield

(A.9) \[ \frac{\beta}{uw} (1 + u\varepsilon) + \frac{1 - \beta}{w} (1 + \varepsilon) = 0 \]

Eliminating $w$ from (A.9), we obtain an equation with the unemployment rate $u$ as the only unknown variable. Substitute $\varepsilon = \frac{1}{b - 1}$ into this and solve to obtain the equilibrium rate $u^*$ of unemployment

(A.10) \[ u^* = \frac{\beta(1 - b)}{b + \beta(1 - b)} \]

2. Derivation of unemployment rate in case of an open-shop union

If union membership is not compulsory, the monopoly gets $\Pi_0$, the profits associated with $(1 - \lambda)N_X$ workers in case that no wage agreement is achieved. Therefore, $\Pi_0$ is the threat point facing the monopolist and the bargaining problem then becomes

Max $J = \beta ln(w - w_Y) + \beta ln(\lambda L_X) + (1 - \beta) ln(\Pi - \Pi_0)$

where $\Pi_0 = bY^{1-b}h^b \left[ (1 - \lambda) N_X \right]^b - w_Y (1 - \lambda) N_X$. It is implicitly assumed that $\lambda$ is sufficiently large so that $\Pi_0 < \Pi$. Otherwise the union would not have any power in wage negotiation because the unemployment pool is large enough to replace the unionised workers going on strike.

The first-order condition becomes
(A.11) \[ \frac{\beta}{uw} - \frac{\beta}{w(1-b)} - \frac{L_X (1 - \beta)}{\Pi - \Pi_0} = 0 \]

Substitute (12), the equation of equality of expected wages and \( N_X (1-u) = L_X \) into the expression for \( \Pi - \Pi_0 \):

(A.12) \[ \Pi - \Pi_0 = wL_X \left[ \frac{1}{b} \frac{1}{b} (1 - \lambda) - \lambda \right] \]

Substitute (A.12) into (A.11) and eliminate \( w \) to obtain the unemployment rate as a function of the power of the union

(A.13) \[ \frac{\beta}{u} - \frac{\beta}{1-b} - \frac{b(1 - \beta)}{1 - \left( \frac{1 - \lambda}{1 - u} \right)^b} = 0 \]

3. **Derivation of equation (18)**

Maximising utility as in (5) subject to the intertemporal budget constraint (6) yields:

(A.14) \[ c_{s,t} = \frac{w_{t,t}}{1 + \rho^{1-\sigma} (1 + R^*_t)^{-\sigma}} \] and

(A.15) \[ c_{s,t+1} = w_{t,t} \left( \frac{\rho^{1-\sigma} (1 + R^*_t)^{-\sigma}}{1 + \rho^{1-\sigma} (1 + R^*_t)^{-\sigma}} \right) \]

where \( w_{s,t} \) is the wage income of an agent \( s \) born at time \( t \).

From the wage equations (10) and (11) we have \( \rho X L = b^2 Y^{1-b} X^b \) and

\( w_t L_Y = (1 - b) Y^{1-b} X^b \). Substituting these into (A.14) and dividing both sides by

\( Y^{1-b} X^b \) yields the proportion of intermediate goods devoted to R&D investment

(A.16) \[ 1 - \Theta^* = \frac{\mu^* (1 - b + b^2) - (1 - b + b^2)^\alpha}{\mu^* (1 + R^*_t)^{\alpha} (1 + R^*_t)^{\alpha}} \]

Equality of the rate of returns to R&D investment and the interest rate \( R \) implies
(A.17) \[ \mu_t(w_t L_{X_t} + w_{Y_t} L_{Y_t})(1 + R_t) = \Delta h_t (1 + R_t) = \Pi_{t+1} \]

where \( \Pi_{t+1} \) is monopoly profits obtained in the unionised sector at time \( t+1 \). Given the constant elasticity of the monopoly’s labour demand function, the profit function of the X-producer in any period is given by:

(A.18) \[ \Pi = (1/b - 1) w L_X \]

Denoting \( g_t \) as the growth rate of knowledge at time \( t \) ( \( g_t \equiv \frac{h_{t+1}}{h_t} - 1 \equiv \frac{\Delta h_t}{h_t} \) ), divide both sides of (A.17) by \( h_t \) to obtain \( (1 + R_t) g_t = \frac{\Pi_{t+1}}{h_t} \). Appropriate substitutions of the wage as given by equation (10), profit as given by equation (A.18), and the labour market equilibrium allocation as given by (15) and (16) into this result yields equation (18) which relates the equilibrium interest rate and the rate of growth at time \( t \):

(A.19) \[ (1 + R_t) g_t = (b - b^2)(1 + g_t)^b L_{Y_t}^b L_{X_t}^b = \]

\[ = \frac{N(b - b^2)}{1 - b + b^2} (1 - b)^{1-b} b^{2b} (1 + g_t)^b (1 - u)^b \]

4. **Derivation of growth rate when sector Y is unionised**

Suppose that sector \( Y \) is unionised and the employees in sector \( Y \) seek to maximise their utility which also depends on the level of employment \( L_Y \) and the wage premium as in (7)

(A.20) \[ U = (w_Y - w) L_Y \]

where \( w \) is the wage a worker obtains when she works in sector \( X \). The labour market in sector \( X \) is assumed to be competitive, so \( w \) adjusts to clear this labour market. The monopolist producing \( X \) takes \( w \) as given, and chooses employment to maximise profits.

Because sector \( Y \) is competitive, there are no profits for \( Y \)-producers. Therefore we cannot employ the same wage bargaining framework, which maximises
the product of union utility and firm’s profits. To capture the effects of unionisation on growth, we consider the case of a monopoly union, which selects an optimal level of wage to maximise (A.20) and compare the results with that under perfectly functioning labour markets.

As in the other framework, both $X$ and $Y$ producers take wages as given. Therefore, we shall obtain the same labour demand functions as in (10) and (11). This implies a wage mark-up of

\begin{equation}
\frac{w}{w_Y} = \frac{b^2}{1-b} \frac{L_Y}{L_X} \tag{A.21}
\end{equation}

In equilibrium this wage ratio must be equal to the probability $(1-u_Y)$ of getting a job in the $Y$ sector. Thus

\begin{equation}
\frac{b^2}{1-b} \frac{L_Y}{L_X} = 1 - u_Y \tag{A.22}
\end{equation}

where $u_Y$ is the sectoral unemployment rate.

The union maximises (A.20) subject to the labour demand by $Y$ producers as in (11). The first-order condition is

\begin{equation}
\frac{\partial U}{\partial w_Y} = L_Y + (w_Y - w) \frac{\partial L_Y}{\partial w_Y} = 0 \tag{A.23}
\end{equation}

Divide both sides of (A.23) by $L_Y$ and substitute the equilibrium condition $w_Y (1-u_Y) = w$ into it to yield

\begin{equation}
1 + u \varepsilon_Y = 0 \tag{A.24}
\end{equation}

where $\varepsilon_Y \equiv \frac{\partial \ln L_Y}{\partial \ln w_Y}$ is the wage elasticity of labour demand. From (11), we have

\[ \varepsilon_Y = -\frac{1}{b} \]

Therefore, we can derive the equilibrium rate of unemployment

\begin{equation}
u_Y = b \tag{A.25}\end{equation}
From (A.22) and (A.25) we can solve for the equilibrium allocation of labour across sectors

\[ L_x = \frac{N(1-b)^2}{1-b+b^2} \]
\[ L_y = \frac{Nb^2}{1-b+b^2} \]  

(A.26)

On the other hand, it is straightforward to derive the expressions for labour allocation when there is no union in our economy

\[ \tilde{L}_x = \frac{N(1-b)^2}{1-2b+2b^2} \]
\[ \tilde{L}_y = \frac{Nb^2}{1-2b+2b^2} \]  

(A.27)

Clearly from (A.26) and (A.27), for \( 0 < b < 1 \), the level of employment in both sectors are lower when sector \( Y \) is unionised. The rates of long-run growth can be derived by the same manner as in Section 4. Obviously from (18) and (19), the economy would grow faster if there were no union in sector \( Y \).