UNIVERSITY OF NOTTINGHAM

Discussion Papers in Economics

Discussion Paper
No. 09/11

Is investment always lower, if it precedes the wage bargain?

By Mark A. Roberts

December 2009

2009 DP 09/11

Is investment always lower, if it precedes the wage bargain?[1]

Mark A. Roberts[2]

University of Nottingham

6 December 2009

Key words:

Wage bargaining, investment, hold-up, labour mobility, signalling

Abstract

It is known from Grout (1984) that if the investment decision by the firm precedes the wage bargain, it will be unable implicitly to share the cost of capital with its workforce through negotiating a lower wage, and that this leads to under-investment. However, in a model, where there is asymmetric information of firms' differing levels of productivity and where workers are mobile between firms before but not after the wage bargain, firms may invest also to signal their relative productivities in order to attract workers. Thus, asymmetric information leads to an additional over-investment effect that may outweigh the under-investment effect of the hold-up, so that the capital stock may be higher if investment precedes the wage bargain.

[1] I would like to thank Arijit Mukherjee and the other participants of a 2009 *Thursday Workshop* in the School of Economics at the University of Nottingham for helpful coments as well as acknowledging sole responsibility for any errors or shortcomings.

[2] ***Address for correspondence:*** School of Economics, University of Nottingham, University Park, Nottingham, NG7 2RD. UK. ***Fax:*** +44 1159 514159. ***Email:*** mark.roberts@nottingham.ac.uk

1. Introduction

A well established result from Grout (1984) is that firms will under-invest if their investment decisions precede the wage bargain. The rationale is that by that time the cost of capital will already have been incurred, so that the workforce will be absolved of sharing in any of its cost implicitly through accepting a lower wage. Even if the wage bargain and the investment decision are simultaneous, so that there is the potential for the both parties to share the cost of investment, the workforce may still be able to avoid sharing in the cost by renegotiating the wage where contracts are non-binding. A statutory requirement that wage contracts are binding will have a limited application, if the life of the capital stock acquired through the investment exceeds the length of the wage contract. [3]

These basic insights are maintained in the following analysis but with extension to a market model where firms vary in productivity and where workers are mobile between firms before but not after the wage bargain. As, at the start, there is asymmetric information, because firms know their own productivities but, initially, workers do not, firms have an incentive to signal their productivities to workers through their investment decisions. This rests on the full employment result that profits are increasing in workforce size and the assumption that once allocated workers will subsequently become immobile. This gives rise to two positive effects on investment alongside the negative one of the hold-up. One is an over-investment effect, since capital is employed not only as a factor input in its own right but also as a signal in order to attract the other initially mobile factor of labour. The second is an allocative efficiency effect, since investment signalling ensures that the more productive firms attract proportionally more workers, causing an overall increase in productivity as an average across firms. These two positive effects will dominate the negative one, if workers' relative bargaining power is not too high, which would cause the hold-up effect to be the dominating factor. A subsidiary result is that workers will prefer investment to come first for a broader

[3] The analysis throughout is concerned with the *demand* for investment. Alternatively, Devereux and Lockwood (1991) considered the *supply* of investment in a two-period overlapping generations model where workers are the only households that save, so that non-binding contracts may increase the rate of endogenous economic growth through raising wages.

range of parameter values and that firms in general will be even more adverse to this possibility.

The paper is organized as follows. The next one contains the main analysis by looking at three cases of where the investment decision lies in the overall sequence of events. The first case is where the investment and the wage bargain are simultaneous, the standard binding contracts case. The second is where investment precedes the wage bargain, so the classic problem of the hold-up arises, but it also follows the allocation of workers to firms, precluding a role for signalling. The third and final case is where investment precedes both the wage bargain and the allocation of workers to firms, so that there is both a hold-up effect and a signalling effect. The main proposition of the paper is that investment may be highest in this third case where it comes sufficiently far in advance. Section 3 extends the discussion a little and Section 4 draws the analysis to an end.

2. Analysis

2.1 Where the wage bargain and investment are simultaneous

There is a unit measure of firms, indexed i, each with the profit function,

$$\pi_i = A_i k_i^{\alpha} m_i^{\beta} - Rk_i - m_i w_i, \quad 0 < \alpha + \beta < 1 \tag{1}$$

where A_i is *total factor productivity* that varies across firms and may thus be a source of variation in both the factor inputs of capital and labour, k_i and m_i. The Cobb-Douglas form of the revenue function enables us to obtain analytical solutions to the model. The term R is the cost of capital which is exogenous in this partial equilibrium model, while w_i, the wage of firm i, is a key variable to be determined. The firm wishes to maximize profit as given by (1) while the workforce wants to maximize the wage bill, $w_i m_i$. Since the demand for labour, m_i^D, for a predetermined supply of workers, m_i, is elastic given a Cobb-Douglas production function where $m_i^D < m_i$, it follows that $\partial\left(w_i m_i^D / \partial w_i\right) < 0$, so that the firm and the workforce would of one mind in wanting to reduce the wage until $m_i^D = m_i$, where all workers are employed.

For the first two cases, there is no basis initially on which workers may ascertain whether any firm is more productive than any another, neither is there a scope for workers to re-allocate subsequently when they do find out. The best assumption in the absence of any other factors determining the movement of workers is that their initial allocation across firms is uniform. The absence of *ex post* mobility means, by definition, that this initial allocation persists,

$$m_i = \overline{m} \quad \forall i \tag{2}$$

The firm's agreement payoff is given by (1) as $\pi_i^A = A_i k_i^{\alpha} \overline{m}^{\beta} - Rk_i - \overline{m} w_i$, while in the event of a disagreement it receives zero, $\pi_i^D = 0$ in the case where the investment decision and the wage bargain are simultaneous. If there is no deal, there is no production, no employment, nor the incurring of any cost. Similarly, the workforce's respective agreement and disagreement payoffs are $U_i^A = m w_i$ and $U_i^D = 0$.

It is well known that the solution to the *Nash bargain* can be obtained by maximizing the *Nash function*, the geometrically weighted sum of the two bargaining surpluses where the weights represent the relative bargaining powers of the parties, [4]

$$N_i = \left(\pi_i^A - \pi_i^D\right)^{1-\varpi} \left(U_i^A - U_i^D\right)^{\varpi}$$

The demand for capital as implied by equation (1),

$$k_i = \left(\alpha A_i m^{\beta} / R\right)^{1/(1-\alpha)}, \tag{3}$$

which in conjunction with the solution to the Nash bargain gives the wage and profit solution as

[4] A foundational treatment of Nash bargaining is to be found in Binmore, Rubinstein and Wolinsky (1986).

$$w_i = \varpi(1-\alpha)(\alpha/R)^{\alpha/(1-\alpha)}\,\overline{m}^{-(1-\alpha-\beta)/(1-\alpha)}A_i^{1/(1-\alpha)} \tag{4}$$

$$\pi_i = (1-\varpi)(1-\alpha)(\alpha/R)^{\alpha/(1-\alpha)}\,\overline{m}^{\beta/(1-\alpha)}A_i^{1/(1-\alpha)} \tag{5}$$

The wage and the profit for each firm are, respectively, increasing and decreasing, monotonic functions, of the bargaining parameter, ϖ_i. A distribution of *total factor productivities* entails distributions for both wages and profits under the assumption that the initial allocation remains unchanged, according to equation (1).

Note that the wage is decreasing in the number employed, $\partial w_i / \partial m_i < 0$. This suggests that the workers who allocated to a particular firm at the first stage have an incentive to prevent others from joining them later. These respective groups could be designated "insiders" and "outsiders", and the analysis of Lindbeck and Snower (2002) could provide a possible rationale, but not the only one, for the assumption of *ex post* labour immobility.

2.2 *Where investment precedes the wage bargain (the hold-up case)*

If investment precedes the wage bargain, firms anticipate that they will be left incurring the whole of the cost of capital in the event of disagreement, so that $\hat{\pi}_i^D = -R\hat{k}_i$, which implies a higher value for their bargaining surplus at $A_i\hat{k}_i^{\alpha}\overline{m}^{\beta} - \overline{m}\hat{w}_i$. Note that throughout this subsection the key variables are *hatted* in order to distinguish them from their outcomes in the previous case. As a consequence, the workforce - *for a given level of capital* – will be able to negotiate a higher wage,

$$\hat{w}_i = \varpi A_i \hat{k}_i^{\alpha}\overline{m}^{\beta-1} \tag{6}$$

Firms anticipate this at any earlier stage and that their profits will be

$$\hat{\pi}_i = (1-\varpi)A_i\hat{k}_i^{\alpha}\overline{m}^{\beta} - R\hat{k}_i\,, \tag{7}$$

which are maximized at the investment level,

$$\hat{k}_i = \left((1-\varpi)\alpha A_i \overline{m}^{\beta} / R\right)^{1/(1-\alpha)}, \tag{8}$$

Substituting this into equations (6) and (7) implies the following wage and profit solutions,

$$\hat{w}_i = \varpi\left((1-\varpi)\alpha / R\right)^{\alpha/(1-\alpha)} \overline{m}^{-(1-\alpha-\beta)/(1-\alpha)} A_i^{1/(1-\alpha)} \tag{9}$$

$$\hat{\pi}_i = (1-\alpha)\left(\alpha/R\right)^{\alpha/(1-\alpha)}\left((1-\varpi)\overline{m}^{\beta}\right)^{1/(1-\alpha)} A_i^{1/(1-\alpha)} \tag{10}$$

A comparison of (8)-(10) with (3)-(5) shows that the hold-up will reduce the capital stock to the proportion $(1-\varpi)^{1/(1-\alpha)}$, profit by the proportion $(1-\varpi)^{\alpha/(1-\alpha)}$ and that the wage will rise/fall if $\varpi < / > 1-(1-\alpha)^{(1-\alpha)/\alpha}$. The ambiguous response of the wage is because increase workforce bargaining power raises the wage *for a given capital stock* but the anticipation of a higher wage also reduces the predetermined capital stock and, thence, the average product of labour. Both parties have an incentive to agree to binding contracts, if possible, where unions are so strong that $\varpi > 1-(1-\alpha)^{(1-\alpha)/\alpha}$.

2.3 Where investment precedes the initial allocation of workers to firms

We now consider the possibility that firms' may install their capital stocks before they recruit their workforces. In a casual sense, a firm will be seen to be viable to workers, only if it has acquired access to complementary factors of production. The capital stock will not only be generally indicative of its future labour productivity and wage, for a given *total factor productivity*, but will also be a specific signal of its *total factor productivity*. Firms' investment decisions are now part of their calculation for attracting prospective workers.

The previous aspect of the hold-up still applies, so that equation (6) is replicated for the anticipation of the wage,

$$\tilde{w}_i = \varpi A_i \tilde{k}_i^{\alpha} m_i^{\beta-1}, \tag{11}$$

except *tildes* are now used to distinguish this final case. As previously, the firm anticipates its profit will similarly be,

$$\tilde{\pi}_i = (1-\varpi)A_i\tilde{k}_i^{\alpha} m_i^{\beta} - R\tilde{k}_i\,, \tag{12}$$

However, returning to equation (11), firms realise that a higher investment level, *ceteris paribus*, implies a higher wage will be subsequently bargained. They, therefore, conjecture there is a relative labour supply that is determined by relative capital stocks,

$$m_i = \left(\tilde{k}_i / \tilde{k}\right)^{\phi} \overline{m} \tag{13}$$

The log-logarithmic specification of equation (11) is anticipated on the basis of the Cobb-Douglas form for the production function, and the parameter ϕ is, as yet, an undetermined coefficient. A firm believe that if it invests, $\tilde{k}_i$, more than the average firm, it will attract more workers, m_i, than the average, $\overline{m}$. The only constraint is that the average number of workers per firm, $\overline{m}$, is fixed for a given population of workers and a given number of firms, so that there will be a zero-sum game with respect to employment.

The conjectured function is now to be determined in a way that is consistent with the model by solving for the *undetermined coefficient*. The conjecture feeds in to the actual outcome, which in turn either supports or invalidates the initial conjecture. Equation (13) is substituted into (12) to give

$$\tilde{\pi}_i = (1-\varpi)A_i\tilde{k}_i^{\alpha+\beta\phi}\tilde{k}^{-\beta\phi}\overline{m}^{\beta} - R\tilde{k}_i\,,$$

Profit is then maximized by each firm at an investment level of

$$\tilde{k}_i = \left((1-\varpi)(\alpha+\beta\phi)A_i\tilde{k}^{-\beta\phi}\overline{m}^{\beta} / R\right)^{1/(1-\alpha-\beta\phi)} \tag{14}$$

Equation (14) shows that firms' investments relate differ only according to their *TFP* levels, A_i. Under the rational expectations assumption that all the model's parameter values are known, the capital stock on the right-hand-side is a (noiseless) signal of *TFP* on the left-hand-side, so that that prospective workers may exactly infer the level of *TFP* of any particular firm from its investment level, which is represented by inversion of equation (14),

$$E\left(A_i \middle| \tilde{k}_i\right) = \left((1-\varpi)(\alpha+\beta\phi)\overline{m}^{\beta}\tilde{k}^{-\beta\phi} / R\right)^{-1} \tilde{k}_i^{1-\alpha-\beta\phi} \tag{15}$$

As a matter of deduction and through substituting (15) into (11), it is anticipated that each firm's wage is

$$E\left(w_i \middle| \tilde{k}_i\right) = \varpi\left((1-\varpi)(\alpha+\beta\phi)\overline{m}^{\beta}\tilde{k}^{-\beta\phi} / R\right)^{-1} m_i^{\beta-1}\tilde{k}_i^{1-\beta\phi} \tag{16}$$

As the assumption is that labour is completely mobile at the first stage and as $\partial E\left(\tilde{w}_i \middle| A_i\right)/\partial m_i < 0$, an "arbitraging" process will ensue until anticipated wages are equalized across firms, $E\left(w_i \middle| \tilde{k}_i\right) = E\left(w_j \middle| \tilde{k}_j\right),\ \forall i, j$. Equation (16) shows that this obtains where $m_i = \left(\tilde{k}_i / \tilde{k}_j\right)^{(1-\beta\phi)/(1-\beta)} m_j$, $\forall i, j$ or where

$$m_i = \left(\tilde{k}_i / \tilde{k}\right)^{(1-\beta\phi)/(1-\beta)} \overline{m} \quad \forall i \tag{17}$$

Consistency between the conjectured relationship in (13) and the actual relationship in (17) requires $\phi = (1-\beta\phi)/(1-\beta)$ or

$$\phi = 1 \tag{18}$$

Substituting this condition into equation (14) then gives

$$\tilde{k}_i = \left((1-\varpi)(\alpha+\beta)A_i\overline{m}^{\beta}\tilde{k}^{-\beta} / R\right)^{1/(1-\alpha-\beta)}$$

As $\tilde{k}$ is the mean of $\tilde{k}_i$, some manipulation gives

$$\tilde{k} = \left((1-\varpi)(\alpha+\beta)\overline{m}^{\beta} / R\right)^{1/(1-\alpha)} E\left(A^{1/(1-\alpha-\beta)}\right)^{(1-\alpha-\beta)/(1-\alpha)}, \tag{19}$$

where $E(.)$ is notation for the mean, so that each firm's investment is

$$\tilde{k}_i = \left((1-\varpi)(\alpha+\beta)\overline{m}^{\beta} / R\right)^{1/(1-\alpha)} E\left(A^{1/(1-\alpha-\beta)}\right)^{-\beta/(1-\alpha)} A_i^{1/(1-\alpha-\beta)} \tag{20}$$

Equations (11)-(13) and (18)-(20) give solutions for the common wage and the firm-specific profit a

$$\tilde{w} = \varpi\left((1-\varpi)(\alpha+\beta)/R\right)^{\alpha/(1-\alpha)} E\left(A^{1/(1-\alpha-\beta)}\right)^{(1-\alpha-\beta)/(1-\alpha)} \overline{m}^{-(1-\alpha-\beta)/(1-\alpha)} \tag{21}$$

$$\tilde{\pi}_i = (1-\alpha-\beta)\left((\alpha+\beta)/R\right)^{\alpha/(1-\alpha)} \left((1-\varpi)m^{\beta}\right)^{1/(1-\alpha)} \left(E\left(A^{1/(1-\alpha-\beta)}\right)\right)^{-\beta/(1-\alpha)} A^{1/(1-\alpha-\beta)} \tag{22}$$

A subsidiary point is that the initial mobility of labour eliminates the wage distribution but causes there to be a wider distribution of profits, since the variance of the logarithm of profits, which was previously $(1-\alpha)^{-2}\operatorname{var}(\ln A)$, now becomes $(1-\alpha-\beta)^{-2}\operatorname{var}(\ln A)$. The main point of the analysis is stated as follows.

Proposition One: ***If*** $\varpi < \beta/(\alpha+\beta)$***, the capital stock will be higher where the investment decision precedes both the wage-bargain and the allocation of workers to firms,*** $\tilde{k} > k$.

Proof: The average capital stock from equation (3) is

$k = \left(\alpha A_i m^{\beta}/R\right)^{1/(1-\alpha)} E\left(A^{1/(1-\alpha)}\right)$. Equation (19) shows that $\tilde{k} > k$ if

$(1-\varpi)(\alpha+\beta)E\left(A^{1/(1-\alpha-\beta)}\right)^{1-\alpha-\beta} > \alpha\left(E\left(A^{1/(1-\alpha)}\right)\right)^{1-\alpha}$. Since there is a distribution for A and since $E\left(A^{1/(1-\alpha-\beta)}\right)^{1-\alpha-\beta} > \left(E\left(A^{1/(1-\alpha)}\right)\right)^{1-\alpha}$, $\varpi \le \beta/(\alpha+\beta)$ is a sufficient condition.

This is to say, there is a positive effect on the capital stock if firms invest also to attract workers, and that this will dominate the negative effect of the hold-up if workers bargaining power is not too great. All firms over-invest relative to the case where the allocation of workers precedes the investment decision. However, no firm has an incentive to invest less, unless all others do too, because it will then attract a number of workers that is individually suboptimal.

It is also of some interest to consider the effects on factor returns, and these for all three cases are summarized in the *Table* below.

Table: Wages and profits

Investment is simultaneous with the wage bargain
$w_i = \varpi(1-\alpha)\alpha^{\alpha/(1-\alpha)} A_i^{1/(1-\alpha)}\Omega$
$\pi_i = (1-\varpi)(1-\alpha)\alpha^{\alpha/(1-\alpha)} A_i^{1/(1-\alpha)}\overline{m}\Omega$
Investment precedes the wage bargain but follows the initial allocation of workers
$\hat{w}_i = \varpi\left((1-\varpi)\alpha\right)^{\alpha/(1-\alpha)} A_i^{1/(1-\alpha)}\Omega$
$\hat{\pi}_i = (1-\alpha)\alpha^{\alpha/(1-\alpha)}\left((1-\varpi)\right)^{1/(1-\alpha)} A_i^{1/(1-\alpha)}\overline{m}\Omega$
Investment precedes both the wage bargain and the initial allocation of workers
$\tilde{w} = \varpi\left((1-\varpi)(\alpha+\beta)\right)^{\alpha/(1-\alpha)} E\left(A^{1/(1-\alpha-\beta)}\right)^{(1-\alpha-\beta)/(1-\alpha)}\Omega$
$\tilde{\pi}_i = (1-\alpha-\beta)\left(\alpha+\beta\right)^{\alpha/(1-\alpha)}\left((1-\varpi)\right)^{1/(1-\alpha)}\left(E\left(A^{1/(1-\alpha-\beta)}\right)\right)^{-\beta/(1-\alpha)} A_i^{1/(1-\alpha-\beta)}\overline{m}\Omega$

where $\Omega \equiv R^{-\alpha/(1-\alpha)}\overline{m}^{-(1-\alpha-\beta)/(1-\alpha)}$

On the basis of these values, it is also insightful to state the effect of investment-signalling on the factor payments in a final *proposition*.

Proposition Two: ***If the investment decision precedes both the wage-bargain and the allocation of workers, in comparison with the simultaneous case, (a) workers on average***

will be better off if $\varpi \le 1-(\alpha/(\alpha+\beta))(1-\alpha)^{(1-\alpha)/\alpha}$, and (b) firms on average will be worse off under reasonable parameters values.

Proof: (a) Calculating the average wage from equation (4) as $w=\varpi(1-\alpha)(\alpha/R)^{1/(1-\alpha)}m^{-(1-\alpha-\beta)/(1-\alpha)}E\left(A^{1/(1-\alpha)}\right)$ and comparing it with $\tilde{w}$ from equation (21) shows that $\tilde{w}>w$ if $\varpi \le 1-(\alpha/(\alpha+\beta))(1-\alpha)^{(1-\alpha)/\alpha}$. (b) Profit for each firm always falls in moving from case 1 to case 2. It can be shown that average profit will also fall moving from case 2 to case 3, $\hat{\pi}>\tilde{\pi}$, for reasonable parameter values, where

$\hat{\pi}=\Psi(1-\alpha)\alpha^{\alpha/(1-\alpha)}((1-\varpi))^{1/(1-\alpha)}E\left(A^{1/(1-\alpha)}\right)$ and

$$\tilde{\pi}(\beta)=\Psi(1-\alpha-\beta)(\alpha+\beta)^{\alpha/(1-\alpha)}((1-\varpi))^{1/(1-\alpha)}\left(E\left(A^{1/(1-\alpha-\beta)}\right)\right)^{(1-\alpha-\beta)/(1-\alpha)}.$$

Clearly, $\tilde{\pi}(\beta)=\hat{\pi}$, if $\beta=0$. First, in the limiting case where A is constant across firms, $\tilde{\pi}(\beta)<\hat{\pi}$, if $\beta>0$ since $\partial\tilde{\pi}(\beta)/\partial\beta<0$. Secondly, this inequality also holds where there a distribution of A across firms, $\tilde{\pi}(\beta)$ and where returns to scale are high. Using a first-order Taylor series expansion, we find

$$\left(E\left(A^{1/(1-\alpha-\beta)}\right)\right)^{1-\alpha-\beta}\approx\left(1+\frac{\alpha+\beta}{2(1-\alpha-\beta)^2}\sigma^2\right)^{1-\alpha-\beta}E(A)$$ where σ^2 is the variance of A, normalized in terms of its squared mean, $\sigma^2\equiv E(A-E(A))^2/(E(A))^2$, and then applying L'hopital's rule, it can be shown that as $\beta\to 1-\alpha$, $$(1-\alpha-\beta)\left(1+\frac{\alpha+\beta}{2(1-\alpha-\beta)^2}\sigma^2\right)^{1-\alpha-\beta}E(A)\to 0$$, so that $\tilde{\pi}(\beta)<\hat{\pi}$ where β is large and $\sigma^2>0$.

Workers will be better off if the investment decision precedes their allocation to firms, since the resulting increase in investment implies a higher average productivity of labour and wage. *Vis a vis* the simultaneous case, however, they will be better off for a wider range of their bargaining power parameter, ϖ , where $\varpi \le 1-\left(\alpha/(\alpha+\beta)\right)(1-\alpha)^{(1-\alpha)/\alpha}$ instead of $\varpi \le 1-(1-\alpha)^{(1-\alpha)/\alpha}$. Firms, as a whole, are worse off because they are not only incurring an implicitly higher cost through the hold-up, but they are also investing inefficiently *ex post* by engaging in a zero-sum game over a fixed average number of workers at $\overline{m}$. However, if there is a sufficiently wide distribution of *total factor productivities*, firms for which $A_i >> \left(E\left(A^{1/(1-\alpha-\beta)}\right)\right)^{1-\alpha-\beta}\left(> E(A)\right)$ will gain from investment signalling, since for them the allocative efficiency effect will of over-riding benefit.

The question also arises whether there are general incentives for firms to act cooperatively behaviour by holding back on their investment decisions until a later stage? On the one hand, this is not plausible for this particular model, because of firms are deemed to be continuously distributed along a unit measure. On the other hand, if it were plausible, it is difficult to envisage a precommitment device for individually-specific, lower investment levels that are *ex ante* suboptimal.

3. Some further considerations

First, in the joint absence of an *ex ante* signalling effect and *ex post* labour mobility, there is a wage distribution that reflects the distribution of tot*al factor productivities*. The other polar case of completely mobile labour mobility leads to wage equalization and the alternative of a distribution of employment across firms. One might suspect that reality rests somewhere between these two extremes, that labour is imperfectly mobile, so that there is a positive correlation between wages and employment across firms. This is supported by the empirical evidence of the employer size-wage effect, for which Brown and Medoff (1989) have provided a number of alternative explanations, but which is intimately connected with the both the assumptions and the conclusions of this particular model.

It was also assumed that workers do not initially know the productivity levels of firms. This assumption might be more sustainable for new firms starting up rather than for older established firms with a track record. There are at least two possible ways in which the current analysis may be sustained. One is where *total factor productivity levels* are stochastic over time, so that track records are of limited importance. Another is to specify a mix of new firms and old firms, where entrants are more disadvantaged than incumbents by the asymmetric information problem. This promises to have interesting implications for economic growth with the possible result that aggregate investment is positively related to the level of firm turnover.

Finally, as profits differ in the three cases considered, there are implications for the entry of firms within a longer-run perspective and a setting of general equilibrium. There would then be further aggregate effects, both because firms are heterogeneous and because they operate under decreasing returns. The existing results could either be endorsed or undermined, depending on the relationship between the number of firms and aggregate investment. However, in admitting one particular feature of long-run general equilibrium, it is difficult to exclude others, especially, the effect of the investment timing on the supply of investment funds in Devereux and Lockwood (1991).

3. Concluding comments

The hypothesis that investment is decided simultaneously with the wage bargain, so that workers implicitly share in its cost, is probably atypical of many labour markets. The known result that the firm will then have a lower demand for capital was replicated in Section 2.2. However, if the investment decision is made further back in time, even before workers allocate to firms, there may be a countervailing over-investment effect because firms invest also to signal their relative productivities in order to attract workers. This additional, positive effect will dominate the negative hold-up effect, if workers are not too powerful at bargaining. The assumption that wage bargaining lags investment may not only be more plausible empirically but may also be conducive to over- rather than under-investment.

The analysis is predicated implicitly on symmetric information between production firms and the financial institutions in the background that enable them to acquire capital. Since, there is asymmetric information between the firms and workers, the efficacy of screening by financial institutions would play an important, although, up to now, hidden, role in the analysis. This suggests that further research might investigate how extending asymmetric information to the arena of finance – one with which it is more popularly associated - might affect the main labour market and investment issues that have already been discussed.

References

Binmore, K. Rubinstein, A, and A. Wolinsky (1986), "The Nash bargaining solution in economic modelling", *Rand Journal of Economics*, 17, 176-188.

Brown, C. And J. Medoff (1989), "The employer size effect", *Journal of Political Economy*, 97, 5. 1027-1059

Devereux, M.B. and B. Lockwood (1991), "Trade unions, non-binding wage agreements and capital accumulation", *European Economic Review*, 35, 1411-1426

Grout, P.A (1984), "Investment and wages in the absence of binding contracts: A Nash bargaining approach", *Econometrica*, 52, 2, 449-460

Lindbeck, A. and D. Snower, (2002), "The insider-outsider theory: a survey", IZA Discussion Paper No. 534.