Incentive contracts in labour market equilibrium

The intent of this research project is to examine the relationship between wage contracts in individual firms and the equilibrium in the labour market. We will analyse the relationship between wage contracts and unemployment, human capital investment, innovation and welfare. The project will to a large extent be undertaken by the head of the project Espen R. Moen in collaboration with Åsa Rosen at the University of Stockholm.

In the 1980s, the relationship between wage contracts and macroeconomic performance, in particular the unemployment rate, was much in focus. Prominent examples are the work on profit sharing (Weitzman 1985) and efficiency wage models (Shapiro and Stiglitz 1984). Our theoretical analysis deviates from this literature in two directions:

First, our analysis employs more sophisticated models of contracts. In the early literature, wage contracts were modelled in a rather parsimoniously way. Since then theories of contracts have developed considerably. New developments include rent extraction models (Laffont and Tirole 1993), multi-tasking (Homstrøm and Milgrom 1991), and theories of promotions and deferred compensation (here the seminal contribution came early, see Lazear and Rosen 1981). Based on these recent theoretical models of contract theory, we intend to study the relationship between wage contracts and macroeconomic performance.

Second, our analysis includes search frictions in the labour market. Search and matching models of the labour market have become increasingly popular over the last decade, in particular the Diamon-Mortensen-Pissarides equilibrium search model (see Diamond 1982, Mortensen 1986, and Pissarides 2000 for an overview of the literature). We will apply the competitive search equilibrium concept, developed in Moen (1997). A core element in our analysis is what we refer to as *equilibrium feedback* mechanisms. Equilibrium feedback exists if a given agent's outcome depends on the behaviour of agents on the same side of the market, because their behaviour influences the actions of agents on the other side of the market.

The project will be segmented into four parts. We will focus on developing theoretical models in the following four areas:

1. The effects of performance pay on unemployment and welfare
2. Human capital formation in labour markets with frictions
3. Labour market determinants of turnover and entrepreneurship
4. Behavioural job-search: the role of contracts and institutions

We believe that the project may shed light on issues of great practical interest, particularly for a country like Norway. For several reasons, the Norwegian economy will have to restructure in the future, primarily because the petroleum sector is diminishing and demographics are changing (the population is aging). In order to obtain an efficient allocation of workers across sectors and firms it is imperative that the market for employed workers function well. Furthermore, as the petroleum sector diminishes it is vital that the entrepreneurial potential in the economy is utilized fully and not locked into existing firms. A deeper understanding of the processes that jointly determine wage contracts, turnover decisions, the supply of entrepreneurs and the unemployment rate will therefore be in high demand.

Espen R. Moen plans to spend the academic year 2004-2005 as a Visiting Professor at the Economics Department of Northwestern University, at the invitation of Professor Dale T. Mortensen. Mortensen is one of the leading experts in labour economics and was one of the founders of equilibrium search theory. His formal invitation to stay at Northwestern may be produced upon request.

During the remainder of the project Moen plans to make several visits to universities in the U.S. and to the London School of Economics, which houses leading economists in both labour economics and contract theory. The doctoral student on the project is also supposed to stay one year at a leading university in the US or Europe.

1. Performance contracts and labour market efficiency

Performance pay may improve efficiency for two reasons. First, performance pay gives the employees incentives to exert more effort. Second, it gives rise to a selection effect, as productive workers will self-select into jobs offering a strong relationship between productivity and wages. In this part of the project, we separately analyse the equilibrium consequences of both the incentive effect and the selection effect.

Equilibrium incentive contracts and efficiency wages

In this part of the project we model individual wage contracts under the following two assumptions: First, there exists heterogeneity between workers that are given the same (non-linear) contracts. Second, it is costly to replace workers.

These assumptions are supported by empirical evidence in Lazear (2000). Since workers differ in productivity in a given firm[1], the firm cannot profitably force all their workers down at their participation constraints, as low-productivity workers would then quit (and are costly to replace). When choosing between wage contracts, firms therefore trade off incentive provision and rent extraction from high-productivity workers. As workers do not know (perfectly) their productivity prior to employment, it follows that unemployed workers earn rents by finding a job. In labour market equilibrium, this rent translates into unemployment.

In ongoing work (Moen and Rosen 2003) we show that these effects give rise to efficiency wages and unemployment with observable output and general (non-linear) contracts. We find that the incentive power of the equilibrium wage contract is constrained socially optimal. The incentive power of the wage contracts tends to increase whenever (i) the importance of non-observable effort increases; (ii) the marginal income tax falls; (iii) the heterogeneity of workers performing the same task decreases. All three factors are likely to increase the equilibrium unemployment rate. Furthermore, our model predicts that the number of applicants per vacancy is higher in jobs with performance contracts and that performance contracts are more prevalent in industries with high rents. This latter implication may help explain observed inter-industry wage differentials.

We plan to extend the model by including search frictions in the market. Our conjecture is that with search frictions, leaving rents to the workers is likely to be less costly for a firm than without search frictions, because worker rents speed up the hiring process. As a result, search frictions should lead to more incentive-powered wage contracts (stronger incentives).

[1] Technically, we assume that a worker's productivity in a given firm is influenced by a worker-firm specific productivity term that is i.i.d. over all worker-firm pairs.

Incentive contracts and adverse selection

Our ongoing work also studies the equilibrium selection effect of performance pay. The main point is that good workers self-select into jobs offering more performance sensitive compensations, e.g. large bonus packages. Although this is a private gain for the firm in question, it is not, to the same extent, a social gain. If there are agency costs associated with incentive contracts, the market may deliver incentive contracts that are too high-powered relative to the socially optimal level. Thus, depending on the type of agency costs considered, there may be excessive involuntary unemployment, inefficient risk allocation between workers and firms, or misallocation of effort towards more easily measurable tasks. Interestingly, taxes may give rise to second-best effects that reduce deviations from the socially efficient outcome.

2. Investment in Human Capital and Labour Market Efficiency

An important determinant of economic welfare is the extent to which the market induces firms and workers to invest in on-the-job training. Recently, several authors have argued that there is underinvestment in on-the-job-training when wages (due to e.g., search frictions) are set below the marginal product (e.g. Acemoglu and Pischke 1999, Stevens 2001). Underinvestment may (among other factors) be caused by the so-called poaching externality. When choosing the investment level, firms and worker do not consider the benefits of training to future employers. This literature typically advocates government intervention through subsidising training to improve economic welfare.

In a recent paper (Moen and Rosen 2004), we scrutinize these findings in a search model that includes on-the-job training. In this model matching workers to jobs efficiently requires some turnover, and firms set wages in a competitive fashion (as discussed in Moen 1997). Our first main result is that labour market outcome is efficient provided that 1) firms can announce and commit to long-term wage contracts, and 2) the search market separates fully into submarkets so that workers with different human capital levels search in different submarkets and thus do not create search externalities for each-other. If firms cannot commit to long-term wage contracts, but set wages for trained workers so as to maximise their *ex post* profit, investment in general training tends to be lower than the socially optimal level. However, human capital formation is constrained efficient, and subsidising general training reduces welfare.

Our efficiency results can easily be understood by referring to the feedback-mechanisms described above. If all agents search in the same search market, an increase in the average level of human capital among searching workers makes it more attractive for firms to enter the market. More firms thus open up vacancies, which also benefits workers that have not increased their human capital level.[2] This positive externality leads to underinvestment in human capital. If workers search in distinct search markets, this feedback mechanism vanishes, no externality arises from human capital investment, and efficiency is restored.

We believe that our model is highly suited to explore a number of other interesting issues. One avenue may be to analyse investment in training generated in the market under a richer set of wage contracts, and derive more robust policy conclusions. An interesting case is the situation in which firms, although not able to commit fully to future wages, may commit not to lower wages in the future (as discussed in Salop 1979). In this case, a high initial wage will serve as a

[2] Note that there may also be opposing effects. In a given job market, firms will generally prefer to hire the most productive workers. This may imply that workers with more training will squeeze out workers with less training, thus creating a negative equilibrium feedback. This is discussed in detail in Moen (1999).

commitment device. Another interesting case is whether the minimum wage is the cause of underinvestment in training.

An even more interesting extension will be to scrutinise the assumption of distinct search markets. The division of a search market into submarkets is fundamental in order to obtain an efficient allocation of resources. In the literature, the assumption made is either that there is no division, or that the market divides completely so that no worker- or firm heterogeneity exists within a given market segment. A more satisfactory approach would be to model the degree of market segmentation explicitly, so that the number of active submarkets becomes endogenous. In order to do so, we will take into account that the division of a given market into submarkets, either by a market maker or indirectly by firms through their choices of contingent wage offers, will be costly. The cost may reflect measurement costs, which are higher the more accurately worker types are measured. Fascinating questions are then a) whether the market will divide into submarkets at a socially optimal degree, b) whether investments in human capital remain optimal, and if not, c) whether subsidised human capital investment improves welfare.[3]

3. Labour market determinants of job turnover, human capital investments and entrepreneurship.

Labour markets in different economies vary significantly with respect to remuneration practices and career paths. Japan (and to a lesser degree Europe) is characterised by low worker turnover. Employees are typically promoted in-firm and relatively late in their careers. In the US, by contrast, turnover rates are much higher, and short-term bonuses are more likely to be used to motivate the work force (Aoki 1990, Morita 2001). Furthermore, compared to Japan and Europe, economic growth processes in the US are more likely to be fuelled by employee-driven start-ups, often financed by venture capital (Hellman 2001). Even between regions in the same country, labour markets behave differently. Turnover rates in Silicon Valley, for example, are extremely high. In Massachusetts, another prosperous US state, they are much lower (Saxenian 1994).[4]

In this part of the project, the aim is to explain how such differences in labour market outcomes may arise endogenously, and how this in turn may affect human capital investment, entrepreneurship, and welfare. As in part two of the project, an underlying assumption in our analysis is that turnover is important for allocational efficiency of the economy, ensuring that workers are optimally allocated across firms at any given time. Our analysis will consist of two building blocks:

Choice of wage contracts. As described above, it is well documented in the literature that both short-term incentives (bonuses) and long-term incentives (promotions, seniority-based pay, and other forms of deferred compensation) may give employees incentives to exert effort. It is surprising therefore, that the relative costs and merits of short-term and long-term incentives have not been given more attention in the literature. This is the main purpose of the first building block. Short-term incentive contracts may give rise to short-sighted behaviour and

[3] The analysis at this point will be akin to the analysis of market micro structure in product- and labour markets, see Spulber (1999, 2002).

[4]Hellman (2001) studies the decision of employees with ideas concerning whether to pursue their ideas within the firm or to form new start-ups. Gromb and Scharfstein (2001) consider the effects of failure for the incentives to become entrepreneurs. Hamilton (2001) analyses the (negative) wage premium for entrepreneurs (self-employed workers) relative to employed workers, just to mention a few.

opportunism by workers, while long-term incentives with deferred compensation may distort turnover decisions and lock workers in with their current employers.

The labour market for employed (experienced) workers. The second building block is the labour market for employed workers, which we model using the Diamond-Mortensen-Pissarides equilibrium search framework. Particularly important in this context are feedback mechanisms created by the present wage of searching workers on this group's probability of obtaining a job. If the present wage for a subgroup of workers increases, this makes it less attractive to open vacancies directed towards the entire group of workers, as the expected wage necessary to attract worker increases. This in turn influences all the workers in the market. In a preliminary model we show that this feedback mechanism exists if workers with different current wages search in the same submarket, or if the firms cannot advertise wages contingent on a worker's current wage.[5]

Intuition suggests that equilibrium feedback mechanisms may create multiple equilibria. If all the other firms in the market choose long-term wage contracts with deferred compensation, few firms open vacancies for employed workers, because the wages they have to pay in order to attract such workers are so high. The turnover rate is thus low, and the costs of using long-term wage contracts due to distorted turnover decisions are small. We refer to this as low-turnover equilibrium. By contrast, if the other firms in the market choose short-term wage contracts, more firms open vacancies for experienced workers, since these are easier to attract, and the cost associated with distorted turnover decisions are higher. Thus, short-term wage contracts may be optimal. We refer to this as high-turnover equilibrium.

This research idea contributes to the literature on multiple equilibria and labour market turnover. One branch of this literature argues that adverse selection problems can give rise to multiple equilibria (e.g. Chang and Wang, 1995; Acemoglu and Pischke, 1998). Saint-Paul (1995) shows that equilibria with different turnover rates may arise in a matching model in which firing costs are paid by the firms. Moene and Wallerstein (1997) obtain multiple equilibria in a shirking model with search frictions and a matching technology with increasing returns to scale. We differ from these papers by relying on a new mechanism: We let firms choose between short-term and long-term incentive contracts.

The differences in turnover rates between the two equilibria may trigger other differences as well:

Firm-specific versus general human capital: In low-turnover equilibrium, the importance of long-term wage contracts and the lock-in of experienced workers tends to reduce the importance of general relative to firm-specific human capital investment.[6]

Supply of entrepreneurs. Entrepreneurs are often former employees that quit the firm and instead start up their own firms. Long-term wage contracts with deferred compensation increase the opportunity cost of becoming an entrepreneur, and may thereby reduce the supply of entrepreneurs relative to a situation with short-term wage contracts. Furthermore, entrepreneurs frequently have particular needs for financial resources and expertise, which for instance may be supplied by venture capitalists. Again feedback mechanisms play an important role: if there are few entrepreneurs with lucrative ideas, this may reduce the venture capitalists'

[5] If firms advertise wages, this statement needs the qualifier that workers only observe a finite (out of an infinite) number of jobs. This contrasts with Acemoglu and Shimer (1999) who argue that in order to obtain efficiency with homogeneous workers, it is sufficient that workers observe two job offers.

[6] Morita (2001) obtains multiple equilibria associated with firm-specific human capital and turnover due to a thin-market externality.

incentives to enter the market in order to search for viable projects. Accordingly, this may affect workers' incentives to become entrepreneurs.[7]

It is tempting to interpret the Japanese labour market as being in a state of low-turnover equilibrium. The US labour market, by contrast, may be seen as being in a state of high-turnover equilibrium, with more emphasis on short-term contracts and high turnover, and less emphasis on firm-specific human capital, fostering more entrepreneurship and new start-ups. Both systems have their strengths and weaknesses, the Japanese system fosters long-term decision making, while the US system gives rise to an efficient allocation of workers across firms and a large supply of entrepreneurs.

4. Behavioural job-search: the role of contracts and institutions

A growing body of research explores economic behaviour outside the classical paradigm of rational agents maximizing a time-invariant utility function with time-independent discount rates (se for instance Brocas and Carillo 2003). In this part of the project we will explore the labour market consequences of one such deviation from the classical paradigm, and allow for time-dependent (hyperbolic) discounting.

Hyperbolic discounting is present if a person's discount rate (relative to a given point in time) diminishes as the time horizon increases. Thus, at any given point in time, it is considered relatively more unattractive for a consumer to delay consumption one day when consumption is to take place in the near future, than when consumption is to take place in the more distant future. This leads to time-inconsistent behaviour: A person will tend to consume more and save less than he or she would prefer from an *ex ante* perspective (Frederick *et al* 2002).

This may have consequences for the behaviour of unemployed workers, who face several intertemporal choices. First, a worker's choice of search intensity influences future incomes. Second, when deciding whether to accept a job or to continue searching, the alternative is to hope for a better job offer in the future. Hyperbolic discounting leads to lower search intensity and a greater tendency to accept bad job offers than the person would have preferred from a prior perspective.[8] This is discussed in Paserman (2002).

We will discuss the equilibrium effects of hyperbolic discounting in a search model of the labour market. Our conjecture is that too many low-quality jobs will flow into the market, offering wages that are too low relative to (from a prior perspective – here and below) socially optimal levels.[9]

An intriguing question is to what extent institutions that may help workers commit to efficient search behaviour, arise endogenously in the market. For instance, an employee may write a contract with his current employer on unemployment benefits and job search assistance in order to induce optimal search behaviour if unemployed.[10] Alternatively, a worker may take

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[7] Gromb and Scharfstein (2001) study a firm's choice between intrapreneurship and entrepreneurship (start-up), and find that multiple equilibria may arise due to informational asymmetries regarding managerial talent. Landier (2002) shows how the stigma of entrepreneurial failure also may give rise to multiple equilibria. In a recent paper, Fonseca et al (2001) studies the supply of entrepreneurs within a search theoretical framework. Their focus is on how the regulatory costs of starting a new firm may reduce the supply of entrepreneurs.

[8] The claim that the reservation wage of searching workers is too low from a prior perspective builds on the assumption that the worker is borrowing constrained.

[9] This is similar to the findings in Acemoglu and Shimer (2001), who show that if workers are risk averse and insurance markets are incomplete, too many low-quality firms will enter the market relative to the socially optimal level.

[10] This requires that the worker is initially employed. Furthermore, it may not work if the firm goes bankrupt.

out private insurance against unemployment, and in addition write a contract with a placement agency. The placement agency must then be able to commit not to renegotiate the contract and not collude with the insurance company.

Interestingly, whether intentional or not, labour market policies in many countries may serve as such a commitment device. Unemployment benefits tend to increase the reservation wages of unemployed workers. Public monitoring of the search activity of workers receiving unemployment, as observed for instance in Norway, reduce the propensity to decrease search efforts. As a result, individual behaviour and (through equilibrium effects) the composition of vacancies in the job market approach socially optimal levels.

References

Acemoglu, D. and Pischke, J.-S. (1998), "Why Do Firms Train? Theory and Evidence", *Quarterly Journal of Economics*, 113, 79-119.

Acemoglu, D. and Pischke, J.-S. (1999), "Beyond Becker: Training in Imperfect Labor Markets", *The Economic Journal*, 109, F112-F142.

Acemoglu, D. and Shimer, R. (1999a), "Efficient Unemployment Insurance", *Journal of Political Economy*, 107, 893-928.

Acemoglu, D. and R. Shimer (200). "Wage and Technology Dispersion". *Review of Economic Studies* 67, 585-607.

Aoki, M. (1990). "Toward an Economic Model of the Japanese firm". *Journal of Economic Literature* vol 28, 1-27.

Brokas, I, and Cartillo, J.D. (2003). *The Psychology of Economic Decisions*. Oxford University Press, Oxford, UK

Chang, C. and Wang, Y. (1995), "A Framework for Understanding Differences in Labor Turnover and Human Capital Investments", *Journal of Economic Behaviour and Organization*, 28, 91-105.

Diamond, P.A. (1982), "Wage Determination and Efficiency in Search Equilibrium", *Review of Economic Studies* 49, pp 217-227.

Fonseca, R., Lopez-Garcia, P., and P.A. Pissarides (2002), "Entrepreneurship, start-up costs and employment", *European Economic Review*, 45, 692-705.

Frederick, S., Loewenstein, G., and T O'Donoghue (2002), "Time Discounting and Time Preference: A Critical Review", *Journal of Economic Literature*, 40, 351-401.

Gromb, D., and D. Scharfstein (2001), "Entrepreneurial Activity in Equilibrium". Miemo, MIT.

Hamilton, B.H. (2000). "Does Entrepreneurship Pay? An Empirical Analysis of the Return to Self Employment". *Journal of Political Economy* vol 108, 604-631.

Hellman, Thomas (2001). "When do Employees Become Entrepreneurs?" Incentives, corporate strategy, and intellectual property rights. WP, Stanford University.

Holmstrom, B., and P. Milgrom. (1991). "Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design", *Journal of Law, Economics, and Organizations*, 7, 24-52.

Laffont, J.J. and Tirole, J (1993), *A Theory of Incentives in Procurement and Regulation*, MIT Press, Cambridge.

Landier, A (2002). "Entrepreneurship and the Stigma of Failure". Working paper, University of Chicago.

Lazear, E.P. (2000), "Performance Pay and Productivity", *American Economic Review* 90, 1346-1361.

Lazear, E.P, and Rosen, S. (1981), "Rank Order Tournaments as Optimum Labour Contracts", *Journal of Political Economy* 89, 841-64

Moen, E.R. (1997). "Competitive Search Equilibrium". *Journal of Political Economy* 1997, vol 105, No.2, 385-411.

Moen, E.R.(1999), "Education, Ranking, and Competition for Jobs", *Journal of Labor Economics* 17, 694-723.

Moen, E.R. and Rosen, Å. (2003). "Equilibrium Incentive Contracts". CEPR working paper no. 3790.

Moen, E. R., and Å Rosen (2004). "Does Poaching Distort Training?", forthcoming, *Review of Economic Studies.*

Moene, K.O. and Wallerstein, M. (1997), "Full Employment as a Worker Discipline Device", in Property Relations, Incentives and Welfare, ed. J. Roemer, MacMillan Press: London.

Morita, H (2001). "Choice of Technology and Labour Market Consequences". *Economic Journal* 111, 29-50.

Mortensen, D.T (1986), "Job Search and Labour Market Analysis". In O.C. Ashenfelter and R. Layard (eds),*Handbook of Labor Economics* Volume 2, Amsterdam, North-Holland 849-919.

Paserman, M.D. (2002). "Job search and hyperbolic discounting". Structural estimation and policy evaluation. Working paper, Hebrew University.

Pissarides, C.A. (2000). *Equilibrium Unemployment Theory*. MIT press, Cambridge, Massachusetts.

Saint-Paul, G. (1995), "The High Unemployment Trap", Quarterly Journal of Economics, 70, 527-550.

Salop S. C. (1979), "A Model of the Natural Rate of Unemployment?", *American Economic Review*, 69, 117-125.

Saxenian, A.L. (1994) *Regional advantage: culture and competition in Silicon Valley and Route 128*. Cambridge, Mass.: Harvard University Press.

Shapiro, C, and Stiglitz, J.E. (1984). "Equilibrium Unemployment as a Worker Discipline Device". *American Economic Review* vol 74, 433-444.

Stevens, M. (2001), "Should Firms be Required to Pay for Vocational Training?", *The Economic Journal* 111, 485-505.

Spulber, D.F. (1999). *Market microstructure : intermediaries and the theory of the firm.* Cambridge : Cambridge University Press, 1999

Spulber, D.F. (2002), "Market Microstructure and the Incentives to Invest", *Journal of Political Economy* 110, 352-381.

Weitzman, M. (1985). "The Simple Macroeconomics of Profit Sharing". *American Economic Review* 75, 937-53.