Markup Cyclicality and Input Factor Adjustments*

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This paper investigates the existence of markups and their cyclical behaviour at industry sector level. Markups are given as a price-cost relation that is estimated from a dynamic, structural model of the firm. The firms face costly adjustment of labour and potential financial constraints. The model is tested on a panel of firm- and plant-level data from Norwegian manufacturing industries. The results indicate a frequent presence of pro-cyclical markups. Labour adjustment costs are small and negligible. The results are related to the role played by unions in a setting with high union density.

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1. Introduction

Microeconomic foundations of modern macroeconomics imply that the price-cost margins of firms vary over the business cycle. Empirical evidence, available largely from US industry sector studies but increasingly from other countries, supports this. The variation in price-cost margins depends on the ability to adjust prices in relation to the development of marginal costs. Strategic price setting behaviour is one source of markup fluctuations. In imperfectly competitive markets this variation may go either way, pro-cyclical as shown by Green and Porter (1984), Domowitz, Hubbard and Petersen (1986, 1987) and Chirinko and Fazzari (1994), or counter-cyclical as indicated by Rotemberg and Saloner (1986), Borenstein and Shepard (1996) and summarised in Rotemberg and Woodford (1999). On the cost side, it may be reasonable to assume that marginal costs will increase in booms due to increased capacity utilization (Rotemberg and Woodford, 1999). Bils (1987), in his seminal paper based on US industry sector data, finds that prices tend to adjust more slowly than costs, and that markups are correspondingly counter-cyclical, in particular due to firms not lowering prices sufficiently during recessions. However, as indicated by the vast literature within the field, theoretical predictions as well as empirical evidence are inconclusive as to the directions of these markup fluctuations over the business cycle. Importantly, markup fluctuations may contribute to reinforcing or weakening the general business cycle fluctuation. In small, open economies, where booms and recessions often originate from external shocks, this feature of price-cost margins may be of particular importance for stabilisation policy.

The contribution of this paper is to analyse whether markup fluctuations are associated with costly adjustments of input factors. Slow adjustment of production factors may affect markups through firms' marginal costs. Galeotti and Schiantarelli (1998) use 2-digit industry-level data for USA and find evidence of capital adjustment costs together with counter-cyclical markups. Domowitz, Hubbard and Petersen (1986), using US data, analyse to what degree firms are hampered in adjusting labour and employment levels, thus affecting cyclicality of marginal costs. If the labour stock is costly to adjust, firms will at any point in time have to consider the size of current as well as future labour stocks. Fariñas and Huergo (2003) use Spanish data and estimate markups and labour adjustment costs, detecting positive and asymmetric adjustment costs, and pro-cyclical markup. Nationwide unions that are concerned with wages and employment levels, as in the Scandinavian countries (see Wallerstein et al., 1997), may contribute to dampening wage fluctuations through wages not being lowered in recessions while being moderated in booms. Of further relevance for Norway, Kahn (1998) shows that during recent years a recentralisation has taken place in wage determination. On the other hand, demand for employment stability may indicate high adjustment costs, potentially counteracting a wage-smoothing effect on markups.

In this paper we use micro data from Norwegian manufacturing industry sectors to investigate whether markup fluctuations and labour adjustment costs coexist. The period 1978–1991 is covered. The Norwegian economy is characterised as small and open, and with a high union density and coverage. An advantage of these data is that they also exist for relatively small firms and plants. Utilising micro-data for plants and firms means that we are using data at the level where decisions about production are taken. We believe that firm- and plant-level data give more reliable markup estimates.[1] Firstly, they allow us to correct for firm-specific non-observabilities, such as productivity differences between firms and effects of local wage bargaining. This is of importance, since production technology and scale economies are relevant for the price setting behaviour of firms. Aggregating up to industry level ignores these differences, and may thereby introduce biases into the estimation of the marginal costs and markups. Secondly, using plant- and firm-level data has the added advantage that the model is implemented at the level for which it is constructed and thereby

[1] Most of the papers investigating markup fluctuations use sector-level data, notable exceptions including Chirinko and Fazzari (1994, 2000), and Fariñas and Huergo (2003).

eliminates the notion of a representative firm. This is of significance if the cost elements of importance for markup cyclicality are firm specific and not industry sector specific. Such heterogeneity is captured using firm- or plant-level data. The markups are measured for different manufacturing industry sectors separately, which enables us to detect possible sectoral differences. The sector-wise markups are allowed to vary over the business cycle.

There are several advantages from using an approach where markups are estimated instead of taken as observable. First, it is not necessary to make assumptions concerning specific relationships between average and marginal costs, nor to proxy for marginal costs. Furthermore, the econometric model is based on an Euler equation for labour, making it unnecessary to parameterise the gross production function or the cost function of the firm. Another advantage of our study is that the economic model is based on the optimisation problem of the firm, and not a reduced form as in many studies. The dynamic modelling framework takes current as well as future production and labour demand into account. This way, we determine within the model whether or not adjustment costs are present when estimating the cyclicality of markups.

The next section describes the model. The empirical specification is derived in Section 3, and data are presented in Section 4. In Section 5 we report the results, while Section 6 includes some concluding remarks.

2. The Dynamic Optimisation Problem

Our approach is rather general, and we avoid using rather restrictive functional forms of the production function. Marginal costs cannot be directly observed. Instead, they are parameters estimated in an econometric model. The model includes fully flexible and quasi-fixed input factors. The objective of a firm indexed with subscript i is to maximise the present value $V_{i,t-1}$ of profits at the end of period $t-1$. The firm operates in an imperfectly competitive market.

However, no assumptions are made concerning specific kinds of output market imperfections. The reason is that several industries are considered, where the firms may operate in competitive or monopolistically competitive markets, or within oligopolistic market structures. Net output, employment, capital, investment and variable factors (and the corresponding prices) are denoted respectively as Y (p), L (w), K (p^I), I (p^I), Z (c). Then a firm's objective can be formally expressed as

$$V_{i,t-1} = E_{i,t-1} \sum_{s=0}^{\infty} \beta_{t+s} \left[p_{i,t+s}\left(Y_{i,t+s}\right) \cdot Y_{i,t+s} - w_{t+s} L_{i,t+s} - p_{t+s}^{I} I_{i,t+s} - c_{t+s} Z_{i,t+s} \right] \quad (1)$$

where $E_{i,t-1}$ denotes the conditional expectations operator as of time $t-1$, and $\beta_{t+s} = \prod_{\tau=0}^{s} \frac{1}{1+r_{t+\tau}}$ is the discount factor between time t and t+s with discount rate r_t. Contemporary variables are known to the firm with certainty, whereas future variables are stochastic. Net output of firm i is assumed to be given by $Y_{i,t} = F\left(K_{i,t}, L_{i,t}, Z_{i,t}\right) - G^L\left(L_{i,t}, L_{i,t-1}\right) - G^K(.)$.[2] This means both labour, L, and capital, K, are quasi-fixed, and therefore costly to adjust. For ease of exposition, we disregard potential cross-adjustment costs.[3] The dynamics of labour and capital adjustments are respectively $X_{i,t} = L_{i,t} - L_{i,t-1}$ and $I_{i,t} = K_{i,t} - (1-\delta)K_{i,t-1}$, where δ is the capital depreciation rate.

The first order condition for fully flexible input factors, $Z_{i,t}$, is given by

$$\frac{\partial Y_{i,t}}{\partial Z_{i,t}} = c_{i,t} \frac{\mu_{i,t}}{p_{i,t}} \quad (2)$$

[2] This formulation recognizes that we do not observe gross output, only output net of adjustment costs.
[3] This is a simplification in line with most of the empirical literature analysing the adjustment of capital and labour separately. Evidently, labour adjustment may affect capital adjustment and vice versa. However, in this dynamical setting, more will be lost in terms of clarity than gained in interpretation of firm behaviour by including interelatedness of adjustment costs in our model.

where $\mu_{i,t} = \dfrac{1}{1-\dfrac{1}{\varepsilon_{i,t}^{D}}}$ is the markup and $\varepsilon_{i,t}^{D} = -\dfrac{\partial Y_{i,t}}{\partial p_{i,t}}\dfrac{p_{i,t}}{Y_{i,t}}$ is the price elasticity of demand facing firm *i* in period *t*. Note that our measure of markup is related to the demand elasticity. In equilibrium, the markup level and its fluctuations can be explained by cost changes as well as the product market behaviour of the firm. The estimated markup will indicate whether an imperfectly competitive market is present.[4]

The first order condition for labour is

$$\frac{p_{i,t}}{\mu_{i,t}}\left(\frac{\partial F_{i,t}}{\partial L_{i,t}} - \frac{\partial G_{i,t}}{\partial L_{i,t}}\right) + E_t\left[\frac{1}{1+r_{t+1}}\frac{p_{i,t+1}}{\mu_{i,t+1}}\left(-\frac{\partial G_{i,t+1}}{\partial L_{i,t}}\right)\right] = w_t \tag{3}$$

According to equation (3), the present value of a marginal unit of labour should equal the wage w_{it}. The first term at the left hand side, which equals $\dfrac{\partial Y_{i,t}}{\partial L_{i,t}} = \dfrac{\partial F_{i,t}}{\partial L_{i,t}} - \dfrac{\partial G_{i,t}}{\partial L_{i,t}}$, represents increased revenue net of labour adjustment costs. Employment adjustments affect the following period as well. The last term in the square brackets, $\dfrac{\partial Y_{i,t+1}}{\partial L_{i,t}}\left(= -\dfrac{\partial G_{i,t+1}}{\partial L_{i,t}}\right)$, represents the cost of postponing employment adjustment.

The first order condition for capital is[5]

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[4] Our general formulation encompasses several different market settings and price games by a including number of firms in an industry sector and their conjectural variation. See, e.g., Domowitz, Hubbard and Petersen (1987).

[5] Here we have used $\dfrac{\partial Y_{i,t}}{\partial K_{i,t}} = \dfrac{\partial F_{i,t}}{\partial K_{i,t}} - \dfrac{\partial G_{i,t}}{\partial K_{i,t}}$, $\dfrac{\partial Y_{i,t+1}}{\partial K_{i,t}} = -\dfrac{\partial G_{i,t+1}}{\partial K_{i,t}}$, $\dfrac{\partial\left(p_{t+1}^{I} I_{i,t+1}\right)}{\partial I_{i,t+1}}\dfrac{\partial I_{i,t+1}}{\partial K_{i,t}} = p_{t+1}^{I}(1-\delta)$, and $\dfrac{\partial\left(p_{t}^{I} I_{i,t}\right)}{\partial I_{i,t}}\dfrac{\partial I_{i,t}}{\partial K_{i,t}} = p_{t}^{I}$.

$$\frac{p_{i,t}}{\mu_{i,t}}\left(\frac{\partial F_{i,t}}{\partial K_{i,t}}-\frac{\partial G_{i,t}}{\partial K_{i,t}}\right)+E_t\left[\frac{1}{1+r_{t+1}}\left(\frac{p_{i,t+1}}{\mu_{i,t+1}}\left(-\frac{\partial G_{i,t+1}}{\partial K_{i,t}}\right)+p^I_{t+1}(1-\delta)\right)\right]=p^I_t \qquad (4)$$

The equation states that along the optimal investment path, in any period *t*, the increase in the value of the firm resulting from one additional unit of capital equates benefits and costs over time: investment in one period affects the value of the firm this period and subsequent periods, and adjustment costs will affect the dynamic path of investments.

To arrive at an estimable expression that summarises the optimising behaviour of the firm, we need to specify the adjustment cost functions. The gross production function, F(.), can be maintained at a general level provided we make assumptions on the returns to scale elasticity of the net production function. The net production function is assumed to be homogeneous. At the outset, we use symmetric specifications of adjustment costs for labour and capital. A standard convex adjustment cost function for labour, GL(.), is written as $G^L=\frac{s^L}{2}\frac{X^2_{i,t}}{L_{i,t}}$, whereas a similar convex adjustment cost function of capital may be formulated as $G^K=\frac{s^K}{2}\frac{I^2_{i,t}}{K_{i,t}}$. Using these adjustment cost formulations, then from Euler's theorem the scale elasticity of the net product function, $Y_{i,t}$, is given by

$$\nu_{i,t}=\frac{\partial F_{i,t}}{\partial K_{i,t}}\frac{K_{i,t}}{Y_{i,t}}+\frac{\partial F_{i,t}}{\partial L_{i,t}}\frac{L_{i,t}}{Y_{i,t}}+\mu_{i,t}\frac{c_{i,t}}{p_{i,t}}\frac{Z_{i,t}}{Y_{i,t}}-\frac{s^K}{2}\cdot\left(\frac{I_{i,t}}{K_{i,t}}\right)^2\cdot\frac{K_{i,t}}{Y_{i,t}}-\frac{s^L}{2}\cdot\left(\frac{X_{i,t}}{L_{i,t}}\right)^2\cdot\frac{L_{i,t}}{Y_{i,t}} \qquad (5)$$

Rearranging (5) and solving for marginal product of labour results in

$$\frac{\partial F_{i,t}}{\partial L_{i,t}} = \tilde{\nu}_{i,t} \frac{Y_{i,t}}{L_{i,t}} - \mu_{i,t} \frac{c_{i,t}}{p_{i,t}} \frac{Z_{i,t}}{L_{i,t}} + \frac{s^L}{2} \cdot \left(\frac{X_{i,t}}{L_{i,t}} \right)^2 \tag{6}$$

where $\tilde{\nu}_{i,t} \equiv \nu_{i,t} - \left[\frac{\partial F_{i,t}}{\partial K_{i,t}} - \frac{s^K}{2} \cdot \left(\frac{I_{i,t}}{K_{i,t}} \right)^2 \right] \cdot \frac{K_{i,t}}{Y_{i,t}}$. By using this formulation, we may keep a rather general form of the gross production function, $F(.)$. Furthermore, the expression for $\frac{\partial F}{\partial L}$ consists of only observables. Capital adjustment and its adjustment costs are implicitly included in the first order condition for labour through $\frac{\partial F}{\partial L}$ and the definition of $\tilde{\nu}_{i,t}$. Reliable data on capital are hard to acquire, and empirically the functional form and magnitude of capital adjustment costs are unsettled.[6] It is therefore convenient to use this form, where different capital adjustment cost levels can be taken care of by changes of variables included in the square bracket in the expression for $\tilde{\nu}_{i,t}$. A value $\tilde{\nu}_{i,t}$ = 1 corresponds to a given magnitude of capital adjustment costs. If, for example s^K increases, this will affect $\tilde{\nu}_{i,t}$. Similarly, a different functional form of adjustment costs might also change $\tilde{\nu}_{i,t}$. Thus, changes in $\tilde{\nu}_{i,t}$ away from its baseline value of 1 may be interpreted as sensitivity in the estimates to different levels of capital adjustment costs.

We may interpret $\tilde{\nu}_{i,t}$ as short-term returns to scale, while $\nu_{i,t}$ may be interpreted as long-term returns. In the model here, this interpretation is consistent with the common assumption that capital is less flexible than labour, and in general predetermined through sunk investments before prices are set. This, however, does not imply that labour adjustments are unaffected by capital adjustments. Instead, capital adjustment costs affect adjustment of

[6] Note that, as long as labour and capital adjustment costs are separable, we could have used a more general form of capital adjustment costs without altering (6). Empirical evidence indicates that adjustment costs of capital are non-convex and irreversible. See for instance Doms and Dunne (1998), Cooper, Haltiwanger and Power (1999), Abel and Eberly (2002), and Nilsen and Schiantarelli (2003).

labour and other factors through assumptions on returns to scale. This implies that for a given $\tilde{\nu}_{i,t}$, demand shocks are reflected in prices and in the use of flexible factors $Z_{i,t}$, rather than in immediate adjustment of capital.[7] Finally, note also that as long as capital adjustment costs are additively separable from labour, as in the chosen model formulation, first-order conditions for labour are unaffected.

Now, assume that the decision-makers have rational expectations. We then replace the expectation operator with white noise expectation errors, which are uncorrelated with any information at time t. Using equations (3) and (6), normalising with the value of capital, $p_t^I K_{i,t}$, after rearranging we obtain the following equation which serves as the basis for our empirical specification

$$
\begin{aligned}
\frac{p_{i,t}Y_{i,t}}{p_t^I K_{i,t}} = {} & \frac{\mu_{i,t}}{\tilde{\nu}_{i,t}}\left(\frac{w_{i,t}L_{i,t}}{p_t^I K_{i,t}} + \frac{c_{i,t}Z_{i,t}}{p_t^I K_{i,t}}\right) \\
& + \frac{s}{\tilde{\nu}_{i,t}}\frac{p_{i,t}L_{i,t}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t}}{L_{i,t}}\right)\cdot\frac{X_{i,t+1}}{L_{i,t+1}} \\
& - \frac{\mu_{i,t}}{\mu_{i,t+1}}\frac{s}{\tilde{\nu}_{i,t}}\frac{1}{1+i_t}\frac{p_{i,t+1}L_{i,t+1}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t+1}}{L_{i,t+1}}\right)\cdot\frac{X_{i,t+1}}{L_{i,t+1}} \\
& + e_{i,t+1}
\end{aligned}
\qquad (7)
$$

A final remark about the prices should be made. Firm-specific prices cannot be directly observed, which is a reason for not modelling price games. As already mentioned, the underlying assumption is that competition may vary over the business cycle and among sectors. The parameterisation of the markup will give room for these types of variation.

[7] We abstract from the choice of hours worked, indicating that such adjustment costs are of less magnitude. In the manufacturing sectors to be investigated, most workers are full-time workers and hours worked mostly follow contractual hours contained in the agreements between firms and unions. As a result, employment changes capture well the fluctuations of the labour input.

3. Empirical Specification

The cyclical fluctuations in markups due to cyclical variations in demand and marginal costs, are represented by parameterising $\mu_{i,t}$ as

$$\mu_{i,t} = \mu_{j,t} = \mu_j^0 + \mu_j^1 \Psi_{j,t} \tag{8}$$

where subscript j denotes industry. Thus, we assume that all firms within a sector have the same markup. According to (8), the markup term consists of a constant term, μ_j^0, which is insensitive to demand fluctuations,[8] and a variable term, μ_j^1. The variation is related to changes in sectoral gross domestic products, $\Psi_{j,t}$, as measured relative to the four surrounding years. The $\Psi_{j,t}$ variable is expressed as[9]

$$\Psi_{j,t} = \ln(GDP_{j,t}) - \frac{1}{4}\left(\ln(GDP_{j,t-2}) + \ln(GDP_{j,t-1}) + \ln(GDP_{j,t+1}) + \ln(GDP_{j,t+2})\right) \tag{9}$$

The variable $\Psi_{j,t}$ picks up the degree to which demand each year in the sector j to which a plant i belongs is higher or lower than the general trend. We will use a Taylor approximation of first order for the term $\dfrac{\mu_{i,t}}{\mu_{i,t+1}}$ in (7).

The final model to be estimated is derived by substituting in (7) the expressions (8)–(9) for $\mu_{i,t}$, and is presented with unrestricted parameters π_k, k = 1–4, which are based on the

[8] A constant term equal to unity does not necessarily indicate perfect competition, due to lack of normalization over the industry sectors. However, variations indicate differences in degree of competition.
[9] The five-year centered moving average is also used in other related studies. See Bils (1987) and Galeotti and Schiantarelli (1998).

non-linear combinations of the deep parameters $\frac{\mu^0}{\tilde{\nu}}$, $\frac{\mu^1}{\tilde{\nu}}$, $\frac{s}{\tilde{\nu}}$ and $\frac{\mu^0 s}{\mu^1 \tilde{\nu}}$ respectively (see also Appendix A)

$$\begin{aligned}
\frac{p_{i,t} Y_{i,t}}{p_t^I K_{i,t}} &= \pi_1 \cdot \left(\frac{w_{i,t} L_{i,t}}{p_t^I K_{i,t}} + \frac{c_{i,t} Z_{i,t}}{p_t^I K_{i,t}} \right) \\
&+ \pi_2 \cdot \left(\frac{w_{i,t} L_{i,t}}{p_t^I K_{i,t}} + \frac{c_{i,t} Z_{i,t}}{p_t^I K_{i,t}} \right) \cdot \Psi_t \\
&+ \pi_3 \cdot \left(\frac{p_{i,t} L_{i,t}}{p_t^I K_{i,t}} \left(1 - \frac{X_{i,t}}{L_{i,t}} \right) \cdot \frac{X_{i,t}}{L_{i,t}} - \frac{1}{1 + r_{t+1}} \frac{p_{i,t+1} L_{i,t+1}}{p_t^I K_{i,t}} \left(1 - \frac{X_{i,t+1}}{L_{i,t+1}} \right) \cdot \frac{X_{i,t+1}}{L_{i,t+1}} \right) \\
&+ \pi_4 \cdot \frac{1}{1 + r_{t+1}} \frac{p_{i,t+1} L_{i,t+1}}{p_t^I K_{i,t}} \left(1 - \frac{X_{i,t+1}}{L_{i,t+1}} \right) \cdot \frac{X_{i,t+1}}{L_{i,t+1}} \cdot \left(\Psi_{t+1} - \Psi_t \right) \\
&+ f_i + \gamma_t + e_{i,t+1}
\end{aligned} \tag{10}$$

When estimating (10) we have included a firm-specific fixed effect, f_i. The fixed firm effect can be interpreted as accounting for firm-specific characteristics that are constant over the sample period. We have also included time dummies, γ_t, to represent the effect of macro shocks. The estimation is carried through separately for each sector, since we want to allow for sectoral differences in the parameters.

We assume that the decision-makers have rational expectations, i.e., the errors they make in forecasting are uncorrelated with the information available when the forecasts are made. This rational expectations hypothesis suggests orthogonality conditions that can be used in a generalised method of moments (GMM) as outlined in Hansen (1982).[10] Variables dated t and earlier which are correlated with the variables in the regression, are valid instruments given that the error term, $e_{i,t+1}$, is serially uncorrelated. The firm-fixed effects are removed by estimating the model in first-differences and consequently, a first-order serial correlation is introduced. To test for the serial correlation, we apply the first-order and

[10] The unconstrained GMM coefficients are estimated using the GMM procedure written in STATA by Roodman (2005). This procedure has finite-sample corrections for the two-step covariance matrix developed by Windmeijer (2005).

second-order autocorrelation tests, denoted in the tables as AR(1) and AR(2) tests. Further testing for the validity of the instruments is done by the *Sargan/Hansen* test.[11] In our estimation, we have used the following variables in levels as instruments, $\frac{w_{i\tau}L_{i\tau}+c_{i\tau}Z_{i\tau}}{p^I_\tau K_{i\tau}}, \frac{w_{i\tau}L_{i\tau}+c_{i\tau}Z_{i\tau}}{P^I_\tau K_{i\tau}}\cdot\psi_{\mathrm{j},\tau}$, $L_{i\tau}$, all at dates $\tau = t-2$ and earlier, since $\tau = t-1$ is valid only when there is no serial correlation in the error terms.

The GMM estimates of the model give unrestricted estimates of the unrestricted parameters, π_k, $k = 1$–4, while we are interested in the deep parameters, μ^0, μ^1, $\tilde{\nu}$, and s. To find these latter parameters from the GMM estimates, we use a minimum distance estimation method.[12] Since a negative s parameter in the adjustment function is hard to interpret and inconsistent with the model, we restrict it to be non-negative by assuming $s = \exp(\eta)$ and allowing η to be computed without restrictions when doing the minimum distance estimation.

4. Data

The empirical work is based on a large set of unbalanced annual data of Norwegian plants and firms within manufacturing industries for the period 1978–1991, collected by Statistics Norway. Income statement and balance sheet information are provided from Statistics of Accounts for all firms with more than 50 employees during the period 1978–1990. For all firms included in Statistics Norway's Statistics of Accounts, plant-level information about production, production costs, investment and capital stock is available from the Manufacturing Statistics. The micro-level data are matched with information about the

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[11] See Arellano and Bond (1991) for a complete discussion of both the auto-correlation tests and the overidentification test.
[12] The proof of the consistency and asymptotic normality of the minimum distance estimator can be found in Appendix 3A, Hsiao (1986).

sectoral gross domestic product at sector level. The industry sector values are collected from National Accounts. The empirical analysis is carried out at the plant level.[13]

We investigate plants where the changes in the number of employees are of reasonable magnitude. Observations with employment levels 3 times larger than or 1/3 less than that of the previous year are excluded. Furthermore, to make the sample as homogeneous as possible, we include only plants with more than 5 and fewer than 500 employees, whereas firm size is limited to 1500 employees. Lastly, we exclude observations where the calculated annual man-hours worked per employee are outside the interval [400, 2500].[14]

[Table 1 about here]

The descriptive statistics are reported in Table 1. Means are calculated over all observations and for 1985. We see that the sales/capital ratio, pY/p^IK, as well as the costs/capital ratio, $(wL+cZ)/p^IK$, vary among the industries. Comparing the differences between the sales/capital ratio and the costs/capital ratio, we find that these differences are approximately 0.1, which indicates the presence of a markup and possibly some degree of market power. The average plant size in the sample is over 100 employees in most industries which, in a Norwegian context, implies that we are dealing with relatively large plants. We note from Table 1 that there are several observations with zero adjustments, which might indicate non-convex adjustments costs. On the other hand, frequent adjustments around zero are consistent with convex adjustments costs. This leaves a rather mixed picture of the exact form of adjustment costs.

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[13] See Appendix B for details on variable definitions and construction.
[14] The upper bound of 2500 amounts to 1.5 times standard working hours per year. We assume that average working hours greater than 2500 are due to reporting or measurement errors.

5. Results

Estimation results are reported in Table 2. The unrestricted parameter estimates of the Euler equation used for calculating the deep parameters are presented in the upper panel. They are based on one-step first-differenced estimates of GMM.[15] In the lower panel of Table 2, we report restricted estimates revealed by the minimum distance procedure. The test statistic is the value function of the minimum distance procedure, asymptotically distributed as χ^2 with one degree of freedom (equal to the number of restrictions). The non-linear common factor restriction $\pi_4 = \frac{\pi_2 \cdot \pi_3}{\pi_1}$ is imposed on the unrestricted parameter estimates reported in the upper panel ($\pi_1, \pi_2, \pi_3,$ and π_4), to get the restricted estimates reported in the lower panel. Thus the test statistic is a test of the validity of the common factor (*ComFac*) restriction. It is immediately observed that the *ComFac* test indicates that the restriction is rejected in several sectors. Therefore, we have also tested a model where adjustment costs are excluded. Main conclusions about base markup and cyclical variation remain. We return to this issue below when discussing the sign and economical significance of the restricted results.

We interpret the base markup, the non-variable term μ^0, as the proportion of the markup which is insensitive to demand fluctuations, where at the outset we expect $\mu^0 \approx 1$. The cyclical part of the markup, μ^1, may be positive or negative, indicating pro- and counter-cyclical markup fluctuations respectively. To interpret its size and magnitude, we assume that we find $\mu^1 = 0.5$. This implies that a relative change in the (detrended) GDP of 6 per cent increases the markup by 0.03, for instance from 1.00 to 1.03. With the non-negativity restriction on labour adjustment costs, there is an adjustment cost parameter $s \geq 0$. Initially, we assume constant unit elasticity of scale. This assumption is supported by the findings in

[15] We return later to extensions with the two-step first-differenced GMM estimator, including a system estimator.

Klette (1999) that increasing returns to scale are not a widespread phenomenon in Norwegian manufacturing industries.

[Table 2 about here]

In four industry sectors we find the invariant markup term, μ^0, to be significantly above unity. In the remaining three sectors (Food, Chemicals, Metal products) it is not significantly different from unity. An estimate of $\mu^0 \geq 1$ is consistent with the descriptive statistics in Table 1, and also with other international studies using an Euler equation approach on panel data (see for instance Whited, 1992 and Hubbard et al., 1995). It is, however, not trivial to draw inferences from these observations to the existence of market power. Even for industries with a fixed markup term not significantly different from unity, we cannot rule out that market power prevails. The main reason is that we have not normalised the markups over industry sectors with a base value corresponding to perfect competition. Then, fluctuations in the markup may indicate periods where market power is effective, while potential for reaping these benefits is not continuously present. In another study, using larger panel data sets from Norwegian manufacturing industries, Klette (1999) finds μ^0 greater than unity, indicating moderate but statistically significant market power.

Our estimates of the cyclical markup term, μ^1, indicate a statistically significant pro-cyclical markup in six of the industries, while there is a statistically significant counter-cyclical markup in one industry sector (Textiles and clothing). However, coefficient estimates indicate a relatively moderate variation around the invariant markup term. The general tendency of pro-cyclical markups corresponds to the findings of Domowitz, Hubbard and Petersen (1986, 1987), Chirinko and Fazzari (1994) and Bottasso, Galeotti and Sembenelli (1999). It is hard to relate the estimated cyclicities to industry specific factors. Generally one would try to explain differences among sectors by degree of competition (e.g., as measured by a Herfindahl index), by degree of sheltering from foreign competition, whether firms in the sector are basically import or export competing, or according to type of production (consumption goods, durables etc.). The model here does not incorporate proxies for industry sector competitiveness, and thereby we are unable to conclude further on firms' potential for strategic price-setting behaviour. The problem is, as has been pointed out by others (see for example Klette, 1999), that even at sector levels as used here, there will be too much heterogeneity to perform adequate analyses of these phenomena and underlying explanations. Market power, for example, may differ more within a sector than across average firms in different industries.[16] Our estimates are based on the assumption that the behaviour of all firms within a sector is identical, which is a limiting assumption due to data availability. This might introduce a measurement error bias, which is in general a problem with sector-level data representing firms competing in imperfectly competitive markets. See Klette and Griliches (1996) for a more detailed analysis. Time-invariant variations will be picked up by the fixed effect factor. Thus, we refrain from relating the observed variations to industry specific factors, other than adjustment of labour. When it comes to cost variations and potential union power, we note that the relevant union branches are industry sector specific, covering to a large degree the sectors analysed here.[17]

The employment adjustment costs parameter, *s*, is statistically different from zero in two sectors, 'Textiles and clothing' and 'Chemicals'. However, the *ComFac* test is rejected in all sectors but 'Food', 'Chemicals' and (borderline) 'Metal products'. Thus, only one sector, 'Chemicals', seem to have significant pro-cyclical variation in markup and presence of adjustment costs. In this sector, the cost factor is also of some magnitude. Using the estimate of s = 40 in the formula for adjustment costs of labour, G^L, and assuming a labour cost adjustment of 5% of the work force, this will correspond to a production loss of 5%. In

[16] See Klette (1999), p. 470, for a more thorough discussion of this in industry sector studies.
[17] The main unions were part of the central union, LO. Much of wage negotiation takes place at industry sector level, though with a tendency for recentralisation during the relevant period (Kahn, 1998). Later, after the period covered by data here, several of the industry union branches have merged.

‘Chemicals’, rather specialised labour is demanded, and firms are often located in areas with limited industry sector diversity. Union density is relatively high, and the resulting union strength may contribute to smoothening wage adjustments over the business cycle, in particular by fighting wage reductions in downturns. Resistance to employment adjustments, to be paid for by some wage rigidity over the business cycle, may be commensurable with union objectives, and expectedly observed where union density and tariff coverage is high. Finding that labour is costly to acquire is therefore not unreasonable.

The *ComFac* test indicates acceptance of the model also in ‘Food’ and, at 10% level of significance, in ‘Metal products’. In these sectors, which both have pro-cyclical markup, adjustment costs are not significantly different from zero. In these two sectors, labour adjustments run smoothly, and wages seem to be moderated over the business cycle as compared with prices. This may be due to union policy of preferring small variations in wages, combined with a labour market policy where firms may lay off workers during downturns on a temporary basis, thus having reserve labour at hand. For the remaining sectors with pro-cyclical markup, ‘Wood products’, ‘Paper’, and ‘Mineral and Metals’, the *ComFac* test rejects the restriction, and similarly in ‘Textiles and clothing’, which is the only sector where markup is counter-cyclical. Using a more extensive set of instruments where we also include $\frac{p_{i,t-2}Y_{i,t-2}}{p^I_{t-2}K_{i,t-2}}$, the *ComFac* test still rejects the null hypothesis of a common factor for this sector.[18] Thus, we cannot conclude clearly on the coexistence of counter-cyclical markups and adjustments costs. On the other hand, when testing the model without labour adjustment costs, i.e., setting $s^L = 0$, for this sector the significant counter-cyclical markup remains. A possible explanation of the latter then is that additional labour is available at high wage costs in upturns, whereas wages are reduced relatively more than prices in downturns.

[18] The results (coefficients and st. errors) are 1.042 (0.010), –0.209 (0.018), and 5.902 (1.071) (μ^0, μ^0, and s respectively).

The relatively low union density in this sector, see Table 3, may account for a limited role of wage smoothening over the business cycle.

[Table 3 about here]

We have investigated how sensitive the markup fluctuations may be to the inclusion of adjustment costs. By disregarding adjustment costs, the coefficients may be interpreted directly from the unrestricted estimates. Testing the model with $s^L = 0$, and comparing to the unrestricted estimates in Table 2 (upper panel) the invariant markup terms, μ^0, remain almost unaltered. For the cyclical markup term, μ^1, all signs are unaltered, and apart from one sector ('Paper'), the magnitude of coefficients and their level of significance change only marginally. Thus, differences between a restricted and unrestricted model seem not to be economically significant when it comes to the interpretation of markup behaviour.

The pro-cyclical markup is consistent with wage smoothening over the business cycle. We have furthermore found little indication of significant labour adjustment costs. It should be noted, however, that an insignificant adjustment costs parameter may only be used to reject the symmetric and convex adjustment costs structure, not to exclude the existence of labour adjustment costs in general. We have experimented with different formulations, including asymmetric adjustment costs, without obtaining sharper results, nor does the introduction of a zero cost interval dramatically change the result that labour adjustment costs play a negligible role. Although somewhat surprising, the results are not unreasonable. We note that other studies also tend to find relatively small adjustment costs for labour (see for instance the discussion by Hamermesh and Pfann, 1996).[19] With the weak tendency for pro-cyclical markup fluctuations we have found here, according to our model, small and insignificant labour adjustment costs, as found, are not unexpected. The results indicate some market

[19] Fariñas and Huergo (2003) find significant labour adjustment costs for Spain. Note, however, that the Spanish labour market is characterised by strong employment protection (OECD 1999), expectedly giving rise to higher adjustment costs.

power on the output side. On the other side, relatively strong unions, with densities above 50%, contribute potentially to flexibility in adjusting input factors (see Salvanes (1997) for a discussion of flexibility of the Norwegian labour market).

We have, without reporting the results, also estimated the two-step first-differenced estimates of GMM using the same set of instruments as the ones reported in Table 2. The results are of the same magnitude. The labour adjustment cost parameter *s* is significant only in ‘Chemicals’, which is the only sector where the *ComFac* test is still not rejected. We have also experimented with the one-step Arellano–Bover system estimator (Arellano and Bover, 1995). Given the limited number of firms in some of the sectors, the number of instruments gets too large relative to the number of observations, and we have therefore not reported results from there either.[20]

As another test of robustness, we relax the assumption of constant returns to scale when estimating the deep parameters by the minimum distance method. However, since the returns to scale parameter $\tilde{\nu}$ is interacted with the other parameters, computational difficulties arise.[21] Therefore, instead we impose a value of $\tilde{\nu}$ = 0.90.[22] As expected, we find that the estimated deep parameters are getting proportionally smaller compared with the results presented in Table 2. Levels of significance remain the same. Relaxing the assumption of constant returns to scale does not affect the revealed cyclical behaviour of markup.

A further extension of the model might be to consider financial constraints, either as dividend constraints or as debt constraints. A dividend restriction prevents the firm from raising external funds by issuing shares to meet the owners' return claims. The non-negative

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[20] Still, we find it somewhat comforting that the magnitude of the unrestricted coefficients, especially π_1 and π_2, are of the same order as those reported in Table 2.

[21] From equation (7), we see that the scale elasticity $\tilde{\nu}$ occurs in the denominator in all terms on the right hand side. We are therefore unable to identify it. It can be considered a scaling parameter.

[22] Klette (1999) finds that in four out of fourteen Norwegian manufacturing sectors, constant returns to scale do not prevail. Here, returns to scale are in the range 0.89–0.96.

dividend restriction can loosely be interpreted as a premium on external funding. Borrowing restrictions may be formulated either as an absolute debt limit or, with interest payments increasing, in a variable which is correlated with the likelihood of facing borrowing constraints (see for instance Bond and Meghir, 1994, Chirinko and Schaller, 1995, and for a recent overview Bond and van Reenen, 2007). We have tested for both ways of representing financial frictions. Neither of them had any effect on the dynamic optimisation, and no binding financial constraints were detected.

Lastly, to shed more light on a potential explanation for the relatively strong evidence of pro-cyclicality, we identify a connection between pro-cyclicality and the degree of union density. Bratsberg and Ragan (2002) (see also Wunnava and Honney, 1991), use US data to derive a clear counter-cyclical relationship with the union premium. An explanation for this relationship is that unions use their bargaining power to set wages above opportunity wage but such that wages are more rigid over the business cycle than in less unionised sectors. This can be shown to follow from an optimising behaviour of unions (McDonald and Solow, 1985). If union density is an indication of union power (Askildsen and Nilsen, 2002) this theory would predict a positive relationship between union density and degree of markup cyclicality. By investigating the correlation between the μ^1 reported in Table 2, and the union densities reported in Table 3, we find strongly significant (p-value = 0.000) correlations with size effects varying from 0.30 to 0.50, depending on whether we weight sectors according to number of firms, observations, average firm employment, or number of workers. This exercise does not provide any causal relationship between the estimated degree of cyclicity and union density, but results are in accordance with theoretical predictions and available evidence from other empirical studies on related issues. In the Scandinavian model, characterised with strong, nationwide unions, a possible explanation is related to unions being concerned with macroeconomic consequences of wage setting. This is expected to result in flatter wage setting behaviour over the business cycle.

6. Concluding Remarks

We have derived a relatively robust tendency for pro-cyclical markup fluctuations over the business cycle for a panel of Norwegian manufacturing firms. We only estimate counter-cyclical markups in one sector. The results are in line with the firm-level studies by Chirinko and Fazzari (2000) and Fariñas and Huergo (2003).

There is little evidence of markup cyclicality being associated with frictions in the labour market. The results may be interpreted as indications that there is some tendency for wages to be smoothed relatively more than prices over the business cycle. This may be due to the role played by unions, which in most sectors have a high proportion of workers as members. Some market power prevails in the final goods market.

We have used a structural approach to estimate markups. The markups and their cyclicities are measured on a sample of medium-sized industry sector firms. The analyses are performed at industry sector level. An advantage of the chosen method is that we are then able to identify industry sector-specific properties that the theoretical model shows impact on markups and adjustment costs.

In total, we find little evidence of the simultaneous occurrence of labour market inflexibilities and markup fluctuations. In further studies on markup cyclicity, more emphasis should be placed on price setting behaviour and price games. Such studies would require much narrower industry groups to define a relevant product market.

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Appendix A. The estimated equation

The estimated equation to be tested stems from using equations (7) and (8) and a Taylor expansion of $\frac{\mu_t}{\mu_{t+1}}$. Putting all this together, we get the following specification

$$
\begin{aligned}
\frac{p_{i,t}Y_{i,t}}{p_t^I K_{i,t}} = & \frac{\mu^0}{\tilde{\nu}_{i,t}}\left(\frac{w_{i,t}L_{i,t}}{p_t^I K_{i,t}} + \frac{c_{i,t}Z_{i,t}}{p_t^I K_{i,t}}\right) \\
& + \frac{\mu^1}{\tilde{\nu}_{i,t}}\left(\frac{w_{i,t}L_{i,t}}{p_t^I K_{i,t}} + \frac{c_{i,t}Z_{i,t}}{p_t^I K_{i,t}}\right)\cdot \Psi_t \\
& + \frac{s}{\tilde{\nu}_{i,t}}\left(\frac{p_{i,t}L_{i,t}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t}}{L_{i,t}}\right)\cdot\frac{X_{i,t}}{L_{i,t}} - \frac{1}{1+r_{t+1}}\frac{p_{i,t+1}L_{i,t+1}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t+1}}{L_{i,t+1}}\right)\cdot\frac{X_{i,t+1}}{L_{i,t+1}}\right) \\
& + \frac{\mu^1}{\mu^0}\frac{s}{\tilde{\nu}_{i,t}}\frac{1}{1+r_{t+1}}\frac{p_{i,t+1}L_{i,t+1}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t+1}}{L_{i,t+1}}\right)\cdot\frac{X_{i,t+1}}{L_{i,t+1}}\cdot\left(\Psi_{t+1}-\Psi_t\right) \\
& + f_i + \gamma_t + e_{i,t+1}
\end{aligned}
$$

or

$$
\begin{aligned}
\frac{p_{i,t}Y_{i,t}}{p_t^I K_{i,t}} = & \pi_1 \cdot \left(\frac{w_{i,t}L_{i,t}}{p_t^I K_{i,t}} + \frac{c_{i,t}Z_{i,t}}{p_t^I K_{i,t}}\right) \\
& + \pi_2 \cdot \left(\frac{w_{i,t}L_{i,t}}{p_t^I K_{i,t}} + \frac{c_{i,t}Z_{i,t}}{p_t^I K_{i,t}}\right)\cdot \Psi_t \\
& + \pi_3 \cdot \left(\frac{p_{i,t}L_{i,t}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t}}{L_{i,t}}\right)\cdot\frac{X_{i,t}}{L_{i,t}} - \frac{1}{1+r_{t+1}}\frac{p_{i,t+1}L_{i,t+1}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t+1}}{L_{i,t+1}}\right)\cdot\frac{X_{i,t+1}}{L_{i,t+1}}\right) \\
& + \pi_4 \cdot \frac{1}{1+r_{t+1}}\frac{p_{i,t+1}L_{i,t+1}}{p_t^I K_{i,t}}\left(1-\frac{X_{i,t+1}}{L_{i,t+1}}\right)\cdot\frac{X_{i,t+1}}{L_{i,t+1}}\cdot\left(\Psi_{t+1}-\Psi_t\right) \\
& + f_i + \gamma_t + e_{i,t+1}
\end{aligned}
$$

subject to the non-linear (common factor restriction) $\pi_4 = \frac{\pi_2 \cdot \pi_3}{\pi_1}$, and assuming $\tilde{\nu} = 1$.

Appendix B. Data[23]

Firms in which the central or local governments own more than 50 per cent of the equity have been excluded from the sample, as well as observations that are reported as "copied from previous year". This actually means missing data. We also excluded observations from auxiliary (non-production) plants as well as plants where part-time employees count for more than 25 per cent of the work force. Since the capital stock is used as the denominator in most of the variables used in the regression analysis, we make an attempt to isolate plants whose capital stock has a negligible role in production. Observations where the calculated replacement value of equipment and buildings together was less than NOK 200,000 (1980 prices) are deleted.[24] To avoid measurement errors of production, observations with non-positive production levels are also deleted. The remaining data set was trimmed to remove outliers. Observations with ratios outside of five times the inter-quartile range above or below the sector specific median were excluded.[25]

Finally, we included only series with at least six consecutive observations. Due to leading and lagging when constructing the explanatory variables, we loose two cross-sections. This leaves us with series of at least four consecutive observations.

Replacement value of capital stock ($p^I K_t$): The replacement value of capital is calculated separately for equipment and buildings using the perpetual inventory formula. Depreciation rates are taken from the Norwegian National Accounts (0.06 and 0.02 for equipment and buildings, respectively). The price indices for investment are also taken from the Norwegian National Accounts. When calculating the replacement value of capital, we use as a benchmark the oldest reported fire insurance value larger than or equal to NOK 200,000, measured in 1980 prices. From these initial values, we calculate the replacement value backwards and forwards, using the investment figures.[26] Finally we add together the two categories of capital. Real investment at time t in capital of type k equals purchases minus sales of fixed capital. Investments in equipment include machinery, office furniture, fittings and fixtures, and other transport equipment, excluding cars and trucks. The measure of buildings includes buildings used for production, offices and inventory storage.

Output ($p_t Y_t$): Gross production plus subsidies and minus taxes.

Variable costs ($w_t L_t + c_t Z_t$): Wage expenses and inputs.

Employees (L_t): Number of employees. The change in the labour stock is defined as $X_{it} = L_{it} - L_{it-1}$.

Price indices (p_t): Price indices for the industry sectors' gross output collected from National Accounts.

Sectoral Gross Domestic Product (GDP_t): The industry sector values are collected from National Accounts. The GDP_t values are annual. For sectors where the National Accounts give information at a less aggregated level than our sector specification, we have used the more detailed information.

[23] See also Halvorsen et al. (1991) for further details.
[24] Approximately £20,000.
[25] We used ratios for output and variable costs.
[26] If the replacement value of capital became negative, it was set equal to zero. When calculating the capital stock forward it may happen that the replacement value becomes negative because of large sales of capital goods. When calculating it backwards, the replacement value becomes negative if the net purchase of fixed capital is larger than the replacement value in year $t+1$.

Table 1. Summary statistics

Sectors (ISIC)	Food (311)	Textiles and Clothing (321-324)	Wood Products (331-332)	Paper (341)	Chemicals (351-356)	Minerals and Metals (36, 37)	Metal products (381-382)
Mean values of total sample							
pY/p^IK	2.297	1.384	1.496	0.950	1.393	1.185	1.588
$(wL+cZ)/p^IK$	2.192	1.301	1.364	0.875	1.222	1.058	1.492
L_{it}	73	88	81	122	88	119	102
$\Delta L_{it}/L_{it}$	-0.021	-0.062	-0.019	-0.031	-0.040	-0.026	-0.026
Shares							
$\Delta L_{it}/L_{it} < -0.05$	0.316	0.428	0.296	0.289	0.328	0.313	0.323
$-0.05 <= \Delta L_{it}/L_{it} <= 0.05$	0.456	0.426	0.443	0.517	0.464	0.457	0.432
$0.05 < \Delta L_{it}/L_{it}$	0.229	0.146	0.261	0.193	0.208	0.230	0.245
$\Delta L_{it}/L_{it} = 0$	0.188	0.088	0.131	0.121	0.115	0.093	0.091
Nbr. of observations	1508	376	747	429	591	569	1071
Nbr. of firms	305	71	128	65	106	94	186
Mean values in 1985							
pY/p^IK	2.410	1.520	1.576	0.999	1.454	1.246	1.703
$(wL+cZ)/p^IK$	2.301	1.422	1.443	0.929	1.297	1.091	1.587
L_{it}	75	83	79	111	91	121	103
$\Delta L_{it}/L_{it}$	-0.032	-0.003	0.014	-0.018	-0.018	0.001	-0.010
Shares							
$\Delta L_{it}/L_{it} < -0.05$	0.313	0.256	0.294	0.333	0.159	0.203	0.233
$-0.05 <= \Delta L_{it}/L_{it} <= 0.05$	0.492	0.512	0.353	0.463	0.540	0.563	0.467
$0.05 < \Delta L_{it}/L_{it}$	0.195	0.233	0.353	0.204	0.302	0.234	0.300
$\Delta L_{it}/L_{it} = 0$	0.203	0.140	0.094	0.074	0.143	0.203	0.125
Nbr. of observations/firms	128	43	85	54	63	64	120

Table 2. Euler Equation Estimates

Sector (ISIC)	Food (311)	Textiles and Clothing (321-324)	Wood Products (331-332)	Paper (341)	Chemicals (351-356)	Minerals and Metals (36, 37)	Metal products (381-382)
Unrestriced estimates							
π_1 (μ^0)	0.995	1.025	1.167	1.156	0.931	1.088	1.001
	(0.058)	(0.034)	(0.055)	(0.071)	(0.151)	(0.055)	(0.069)
π_2 (μ^1)	0.034	-0.138	0.259	0.482	0.261	0.043	0.188
	(0.065)	(0.059)	(0.190)	(0.229)	(0.113)	(0.061)	(0.106)
π_3 (s)	8.341	5.206	-10.749	-24.074	41.035	5.729	7.064
	(24.667)	(4.552)	(16.163)	(13.375)	(36.772)	(20.248)	(10.617)
π_4 ($s*\mu^1/\mu^0$)	138.224	-84.153	-226.706	-259.040	371.237	368.159	113.034
	(536.556)	(63.282)	(273.231)	(183.077)	(1119.614)	(415.900)	(194.394)
AR(1)-test	-3.25	-3.31	-2.90	-2.80	-1.95	-3.94	-3.24
p-value	0.00	0.00	0.00	0.01	0.05	0.00	0.00
AR(2)-test	-1.82	0.69	-0.72	-0.88	-0.80	-1.01	-0.62
p-value	0.07	0.49	0.47	0.38	0.43	0.31	0.54
Sargan	10.90	24.51	28.70	15.02	32.80	30.78	27.24
p-value	0.82	0.55	0.33	0.52	0.17	0.24	0.40
Restriced estimates							
μ^0	0.996	1.032	1.151	1.069	0.963	1.065	1.014
	(0.018)	(0.011)	(0.017)	(0.022)	(0.036)	(0.017)	(0.021)
μ^1	0.041	-0.172	0.393	0.474	0.261	0.066	0.182
	(0.018)	(0.017)	(0.047)	(0.071)	(0.036)	(0.019)	(0.034)
s	9.067	3.837	0.000	0.000	42.486	0.000	4.288
	(7.749)	(1.402)	(5.111)	(3.638)	(11.531)	(2.635)	(2.993)
ComFac	0.66	17.44	11.24	101.07	1.04	24.15	3.33
p-value	0.42	0.00	0.00	0.00	0.31	0.00	0.07
# obs.	1508	376	747	429	591	569	1072
# firms	305	71	128	65	106	94	186

Notes: One-step First-Difference Estimates of Euler Equation
See Appendix A for a presentation of the estimated model.
See main text for explanation of the instruments.
All standard errors in parentheses are robust to heteroskedasticity.
AR(1) is a test of first-order serial correlation, AR(2) a test of second order serial correlation.
Sargan is the Sargan/Hansen test of overidentification restrictions.
ComFac is a test of the validity of the common factor restriction imposed to get the restricted estimates from the unrestricted ones.

Table 3. Union densities in percentage

Sectors (ISIC)	Food (311)	Textiles and Clothing (321-324)	Wood Products (331-332)	Paper (341)	Chemicals (351-356)	Minerals and Metals (36, 37)	Metal products (381-382)
	53	49	50	82	63	78	61

Notes: The numbers are measured in 1995 and based on census data as part of the project "Medvirkning, læring og belønning i det nye arbeidslivet" (eng. Participation, learning and rewards in the new labour market")
Source: Institute for Labour and Social Research (FAFO).