Firm Size and Employment Determination in Dutch Manufacturing Industries

Marcel H. C. Lever

ABSTRACT. This paper examines whether the determination of employment differs between large and small firms. An employment equation is estimated on panel data of 67 (35) three-digit industries in Dutch manufacturing (1974–1986). The conclusions are as follows. Firstly, employment adjustment appears to be faster in small firms than in large ones. Secondly, the elasticity of factor substitution and the real wage elasticity at constant output are nearly the same for large and small firms. Thirdly, the estimated output elasticities suggest constant returns to scale in large firms and increasing returns in small ones. Finally, the number of working hours has less impact on employment in small firms than in large ones.

1. Introduction

Hamermesh (1993) presents an extensive survey of over 100 empirical studies on labour demand. None of these studies investigates labour demand in relation to firm size. Apparently, the subject has nearly been neglected so far; exceptions include Van Leeuwen and Schim van der Loeff (1990), Nguyen and Reznek (1991, 1993) and Huigen *et al.* (1994). This is somewhat surprising as the role of small firms in the manufacturing industry is steadily increasing. The increased importance of small firms has to do with changes both in the production technology and in consumer demand. The emergence of computer-based technologies in the areas of production, administration and information have decreased the role of economies of scale. The increased standard of living and greater individualism of consumers have led to fragmented markets and shorter product life cycles; see also Thurik (1993). Although large firms (with 50 or more employees) still provide most of the jobs, the share of small firms (with 10 to 50 employees) in manufacturing employment in the Netherlands has increased from 15.4 percent in 1974 to 21.3 percent in 1991. Similar developments for other countries are reported by Carlsson (1989), Sato (1989), Storey and Johnson (1990), Loveman and Sengenberger (1991) and Acs and Audretsch (1993). There are good reasons to suppose that the determination of employment differs between large and small firms due to differences in production technology or in organization structure. Therefore, it is interesting to investigate whether the elasticities of employment of large and small firms are the same or not. Knowledge of these elasticities is important for considering policies to increase employment, such as wage moderation and reduction of working time.

The purpose of this paper is to investigate whether there are any differences in employment determination between large and small firms. This is accomplished by comparing the elasticities of employment to real wages, output and working hours, the elasticity of factor substitution and the speed of employment adjustment for small and large firms in the manufacturing sector in the Netherlands. To obtain the elasticities, a marginal productivity condition is derived for a profit-maximizing firm with a CES production technology. The resulting employment equation is estimated on panel data for 67 three-digit industries in the Dutch manufacturing sector. The data are annual observations from 1974 up to and including 1986. Moreover, the equation is estimated separately for large and small firms in 35 of these sectors.

The rest of this paper is organized as follows. The employment equation is derived in Section 2. Section 3 discusses the data and the estimation procedure. The estimation results are reported in

Final version accepted on August 18, 1995

EIM Small Business Research and Consultancy,
P.O. Box 7001,
NL-2701 AA Zoetermeer,
the Netherlands

Small Business Economics **8**: 389–396, 1996.

Section 4. Section 5 summarizes the results and provides one suggestion for further research.

2. Model

This section presents the derivation of the employment equation. The derivation starts from assuming that the firm sets the employment level such that profits are maximized. Another assumption is that the production technology can be described by a CES production function which is modified by introducing the distinction between workers and hours. At the end of the section the role of unfilled vacancies is discussed.

Let the production technology be represented by a constant-returns-to-scale production function of the CES type,

$$Y_i = [A_i(1+\alpha)^{\rho t}K_i^{\rho} + B_i(1+\beta)^{\rho t}L_i^{\rho}]^{1/\rho},\quad 0 \neq \rho < 1,\quad A_i, B_i > 0,\quad \alpha, \beta \geq 0, \tag{1}$$

where Y_i, K_i and L_i denote value-added output, capital services and labour services of a representative firm in industry i, respectively. Capital-augmenting and labour-augmenting technical progress are captured by $(1+\alpha)^t$ and $(1+\beta)^t$, respectively, where t is a time index. The parameter ρ is related to the elasticity of factor substitution by $\sigma = 1/(1-\rho) \geq 0$. The amount of labour services depends not only on the number of workers (N_i), but also on the number of hours worked per worker per year (H_i). It seems reasonable to assume that the amount of labour services is proportional to the number of workers. The number of working hours has a positive, but perhaps less than proportional, impact as productivity may decrease if workers become tired. Therefore, the amount of labour services is modelled as a flexible function of the number of working hours

$$L_i = N_i H_i^{\gamma},\quad 0 \leq \gamma \leq 1. \tag{2}$$

If $\gamma = 0$, the amount of labour services depends on the number of workers only; if $\gamma = 1$, the amount of labour services is proportional to the total number of hours worked. Substituting (2) in (1) gives the production function

$$Y_i = [A_i(1+\alpha)^{\rho t}K_i^{\rho} + B_i(1+\beta)^{\rho t}N_i^{\rho}H_i^{\gamma\rho}]^{1/\rho},\quad 0 \neq \rho < 1,\quad A_i, B_i > 0,\quad \alpha, \beta \geq 0. \tag{3}$$

The firm is assumed to maximize its short-run profits taking the wage rate and the number of working hours as stipulated by contract. The firm faces a constant-elasticity demand curve for its products. Let $\eta_i > 1$ denote the absolute elasticity of demand. If $\eta_i \to \infty$, perfect competition prevails; if η is finite, the firm has monopoly power in the product market. The amount of capital services, which is assumed to be proportional to the capital stock, is assumed to be predetermined. The firm's maximization problem is

$$\max_{N_i} \Pi_i(W_i, N_i) = P_i Y_i - W_i N_i \tag{4}$$
$$\text{s.t.}\quad Y_i = [A_i(1+\alpha)^{\rho t}K_i^{\rho} + B_i(1+\beta)^{\rho t}N_i^{\rho}H_i^{\gamma\rho}]^{1/\rho},$$

where Π_i denotes profits, P_i the price level and W_i the yearly wage rate. As first-order condition one obtains the marginal productivity condition (taking logarithms)

$$\ln P_i + \ln\left[1 - \frac{1}{\eta_i}\right] + \ln[A_i(1+\alpha)^{\rho t}K_i^{\rho} + B_i(1+\beta)^{\rho t}N_i^{\rho}H_i^{\gamma\rho}]^{\frac{1-\rho}{\rho}} + \ln B_i + \rho t\ln(1+\beta) + (\rho-1)\ln N_i + \gamma\rho\ln H_i - \ln(W_i) = 0. \tag{5}$$

Combining the marginal productivity condition with the production function gives the labour demand equation (lower case letters denote natural logarithms, unless otherwise stated)

$$\eta_i = \sigma\left[b_i - \frac{1}{\eta_i}\right] - \beta(1-\sigma)t - \sigma(w_i - p_i) + y_i - \gamma(1-\sigma)h_i,\quad \beta, \sigma \geq 0,\ 0 \leq \gamma \leq 1, \tag{6}$$

where $\ln(1+\beta)$ and $\ln(1-1/\eta_i)$ are approximated by β and $-1/\eta_i$, respectively, and where b_i denotes $\ln B_i$. The industry-specific constants can be eliminated by taking first differences. In the empirical work a lagged dependent variable is necessary to capture adjustment lags; see Nickell (1986). After including an error term and a subscript t to denote the time period, this results in

$$\Delta n_{i,t} = \gamma_0 + \gamma_1\Delta n_{i,t-1} + \gamma_2\Delta(w-p)_{i,t} + \gamma_3\Delta y_{i,t} + \gamma_4\Delta h_{i,t} + \Delta\varepsilon_{i,t}, \tag{7}$$
$$\gamma_0 = -(1-\gamma_1)\beta(1-\sigma) < (>)\ 0$$
$$\text{iff}\quad \sigma < (>)\ 1,\ 0 \leq \gamma_1 < 1,\ \gamma_2 = -(1-\gamma_1)\sigma < 0,$$
$$0 < \gamma_3 = (1-\gamma_1) \leq 1,$$
$$\gamma_4 = -(1-\gamma_1)\gamma(1-\sigma) < (>)\ 0\quad \text{iff}\quad \sigma < (>)\ 1,$$
$$E\varepsilon_{i,t} = E\varepsilon_{i,t}\varepsilon_{i,s} = 0\quad \text{for}\quad t \neq s.$$

As there may be unfilled vacancies, labour demand may differ from employment. Unfortunately, vacancy data are not available for three-digit industries. Therefore, labour demand is assumed to be equal to employment.

After estimating Equation (7), the long-run employment elasticities and the speed of employment adjustment can be obtained. The speed of employment adjustment follows from $1 - \gamma_1$. There are four elasticities which are of interest. Firstly, the elasticity of factor substitution $\sigma = -\gamma_2/(1 - \gamma_1)$. Secondly, the real wage elasticity at constant output. This elasticity is defined as $\eta_N = -(1 - s_N)\sigma$, where s_N denotes the share of labour in value added; see Allen (1938, pp. 372–374) or Hamermesh (1993, p. 24). Thirdly, the output or scale elasticity $\eta_Y = \gamma_3/(1 - \gamma_1)$. The restriction $\gamma_3 = 1 - \gamma_1$ is not imposed during estimation to allow for increasing or decreasing returns to scale. Fourthly, the elasticity of employment with respect to working hours is $\eta_H = \gamma_4/(1 - \gamma_1)$. Besides, two underlying parameters can be obtained, namely the rate of labour-augmenting technical progress, $\beta = -\gamma_0/(1 - \gamma_1 + \gamma_2)$, and the elasticity of labour services with respect to working hours, $\gamma = -\gamma_4/(1 - \gamma_1 + \gamma_2)$, respectively. As the elasticities are twice continuously differentiable functions (denoted by g) of the parameter estimates (denoted by γ_i and γ_j), the standard errors of the elasticities can be computed using

$$\operatorname{var} g(\gamma_i, \gamma_j) = \left(\frac{\partial g}{\partial \gamma_i}\right)^2 \operatorname{var}(\gamma_i) + \left(\frac{\partial g}{\partial \gamma_j}\right)^2 \operatorname{var}(\gamma_j) + 2\frac{\partial g}{\partial \gamma_i}\frac{\partial g}{\partial \gamma_j}\operatorname{cov}(\gamma_i, \gamma_j); \tag{8}$$

see Theil (1971, p. 374).

3. Data and estimation procedure

The data are aggregate, annual observations for 67 three-digit industries in Dutch manufacturing from 1974 up to and including 1986. The sectoral division of the manufacturing industry is according to the SBI 1974 classification system. This classification system was developed by the Netherlands Central Bureau of Statistics (CBS). For a subsample of 35 sectors separate observations for large and small firms are available. The industries which are included in the (sub)sample are listed in Appendix I.

Most of the data are taken from the so-called DUMA (DUtch MAnufacturing) set. This data set contains 39 variables including sales, material costs, labour costs, domestic and foreign sales prices, material price and employment. The data set covers about 90 percent of all firms with ten or more employees in the manufacturing industry. The data set is mainly based on three sources: the Production Statistics Manufacturing Industry, the Statistics on Fixed Capital Formation in Industry and the Monthly Bulletins of Price Statistics. All these statistics are collected by CBS. A more detailed description of the DUMA set is provided by Bakker and Prince (1990).

Series for employment, real wages and output (value added) are required. Employment data are readily available. Real wages are obtained in two steps. Firstly, nominal wages are computed by dividing labour costs by employment. Secondly, real wages are obtained by deflating nominal wages by a value-added price index. The computation of a value-added price index is less straightforward. Firstly, a sales price index p_s is computed as a weighted average of the domestic sales price p_d and the foreign sales price p_f,

$$p_s = sp_d + (1 - s)p_f, \tag{9}$$

where s is the share of domestic sales in total sales. Then the value-added price index p is defined implicitly by

$$p_s = mp_m + (1 - m)p, \tag{10}$$

where m is the share of material costs in total sales. Rearranging and substituting for the sales price gives the value-added price index

$$p = \frac{1}{1 - m}[sp_d + (1 - s)p_f - mp_m]. \tag{11}$$

This method to construct a value-added price index is similar to the one described by Nickell and Kong (1992). A quantity index of value added is obtained by deflating sales minus material costs by the value-added price index.

The actual number of hours worked per worker per year are taken from another EIM data set. The actual number of hours worked are computed by correcting the contractual number of hours worked for vacation, holidays, overtime, sick leave, idle days, reduction of working hours, strikes, etc. These data are available for 11 two-digit industrial sectors. The boundary between small and large firms for working hours is drawn at 100 employees, whereas the one for the other variables is drawn at 50 employees. For firms with 10 up to 50 employees the data on working hours for firms with 10 up to 100 employees are used; for firms with 50 or more employees a weighted average of the data on working hours for firms with 10 up to 100 employees and of those with 100 or more employees are used. The construction of the actual number of hours worked is described in Bol *et al.* (1982).

The employment equation is estimated by the "generalized method of moments" (GMM); see Arellano and Bond (1991). As the explanatory variables may be endogenous, there may be correlation between the explanatory variables and the disturbances. Therefore, estimates obtained by ordinary least-squares (OLS) and fixed effects are inconsistent. By using instrumental variables, GMM produces consistent estimates.

Instruments must be selected in such a way that they are correlated with the explanatory variables yet not correlated with the disturbances in the model in first differences, while the number of instruments must be higher than the number of regressors. For endogenous variables (eventually including a lagged dependent variable) only those dating back from two previous or earlier periods may be used as instruments, while all variables may be used as instruments for strictly exogenous variables. This matrix of instruments is nonetheless only suitable in the event of compliance with the hypothesis that no serial correlation exists. In the event of e.g., first-order serial correlation (i.e., correlation between $\varepsilon_{i,t}$ and $\varepsilon_{i,t-1}$), the use of endogenous variables is restricted to variables dating back from three previous or earlier periods. Otherwise, correlation will emerge between instruments and disturbances in first differences. The selection of instruments thus depends on hypotheses with respect to the disturbances. In view of the above, the hypothesis that no serial correlation exists will be tested.

In the reported regressions all the explanatory variables are instrumented. This can be motivated as follows. Nominal wages may be assumed to be predetermined. As the output price may be endogenous, it seems appropriate to assume that real wages are endogenous as well. That output is endogenous is evident. Contractual working hours may be assumed to be predetermined. As actual working hours include overtime, it is better to assume that working hours are endogenous as well. As one observation is lost by taking first differences and two observations are used as instruments, the observations for 1977 up to and including 1986 are available for estimation.

4. Empirical results

The parameter estimates for employment Equation (7) are reported in Table I. The estimates in column 1 are based on 67 industries. Column 2 provides the estimates for those 35 sectors for which separate data on large and small firms are available. The estimates for large and small firms separately are reported in columns 3 and 4, respectively. The constant term (γ_0) is significantly negative in all cases. As the elasticity of substitution σ is below unity (see Table II), the negative sign is in line with the theoretical model. The impact of lagged employment (γ_1) is between zero and unity, as required. The negative impact of real wages (γ_2) and the positive one of output (γ_3) are in line with the model as well. The impact of working hours is negative and, except for small firms, significant. As before, the sign is as expected, because σ is below unity. The test statistics indicate that there is no second-order serial correlation; the Sargan test statistic for the 67 sectors is below the critical value (67.5), indicating that the instruments are valid. The Sargan test statistic cannot be computed consistently for the other subsamples, as the number of instruments exceeds the number of cross-sections.

The implied long-run elasticities and their standard errors are reported in Table II. The elasticity of substitution between capital and labour is somewhat below unity, but not significantly. This means that the estimated production function is close to the Cobb-Douglas specification. The elasticity of substitution is somewhat higher than the one Hamermesh (1993) obtains in his survey of empirical studies on labour demand. He reports that the simple average of the estimates of σ in his survey is 0.75. The share of labour in value added in 1986 ($s_N = \Sigma W_i N_i / \Sigma P_i Y_i$) in the sample is around 0.70, which is more or less standard in developed economies; see Hamermesh

TABLE I
Parameter estimates of employment Equation (7) for 67 (35) industries in Dutch manufacturing (1977–1986)[a, b, c]

Parameter	67 Industries	35 Industries	Large firms, 35 industries	Small firms, 35 industries
γ_0	−0.617	−1.115	−1.281	−1.159
Δt (× 100) (trend)	(0.064)	(0.196)	(0.287)	(0.212)
γ_1	0.559	0.414	0.335	0.153
$\Delta n_{i,t-1}$ (lagged employment)	(0.020)	(0.048)	(0.054)	(0.045)
γ_2	−0.426	−0.510	−0.550	−0.679
$\Delta(w-p)_{i,t}$ (real wage rate)	(0.017)	(0.061)	(0.077)	(0.072)
γ_3	0.411	0.584	0.673	0.716
$\Delta y_{i,t}$ (output)	(0.020)	(0.051)	(0.063)	(0.039)
γ_4	−0.382	−0.558	−0.505	−0.113
$\Delta h_{i,t}$ (working hours)	(0.052	(0.176)	(0.212)	(0.174)
Sargan instrument test, $\chi^2(n)$	59.51 (50)			
2nd order correlation, $N(0, 1)$	−0.91	−0.02	−0.79	−0.47

[a] Dependent variable: $\Delta n_{i,t}$ (employment).
[b] Standard errors are given in parentheses.
[c] The equation is estimated in first differences by DPD. Instruments include a constant, $\Delta n_{i,t-2}$ up to and including $\Delta n_{i,t-7}$, $\Delta(w-p)_{i,t-2}$, $\Delta(w-p)_{i,t-3}$, $\Delta h_{i,t-2}$, $\Delta h_{i,t-3}$.

TABLE II
Estimates of long-run employment elasticities in 67 (35) industries in Dutch manufacturing (1977–1986)[a]

Elasticity	67 industries	35 industries	Large firms, 35 industries	Small firms, 35 industries
Elasticity of factor substitution $\sigma = -\gamma_2/(1-\gamma_1)$	0.966	0.871	0.828	0.802
	(0.078)	(0.141)	(0.144)	(0.115)
Share of labour in value added in 1986 s_N	0.692	0.729	0.733	0.718
Real wage elasticity with constant output $\eta_N = -(1-s_N)\sigma$	−0.297	−0.236	−0.221	−0.226
	(0.024)	(0.038)	(0.039)	(0.032)
Output elasticity $\eta_Y = \gamma_3/(1-\gamma_1)$	0.931	0.996	1.013	0.846
	(0.079)	(0.120)	(0.135)	(0.079)
Elasticity of working hours $\eta_H = \gamma_4/(1-\gamma_1)$	−0.866	−0.953	−0.759	−0.133
	(0.108)	(0.307)	(0.313)	(0.204)

[a] Standard errors are given in parentheses.

(1993, p. 92). The real wage elasticity at constant output in the 67 industries is around −0.30. This corresponds exactly to the average elasticity Hamermesh (1993) obtains in his survey. The long-run output elasticities are close to and insignificantly different from unity, as supposed in the theoretical model. The elasticity of working hours is between 0 and −1 in all cases.[1]

The results for the subset of 35 sectors are largely in line with those for all 67 sectors; compare columns 1 and 2. Employment determination for the 35 manufacturing sectors as a whole is nearly the same as that for large firms only; compare columns 2 and 3. This result is not quite surprising as the employment share of large firms in these 35 manufacturing sectors is 77 percent on average in the period 1974–1986.

More interesting are the similarities and differences between the estimates for large and small firms; compare columns 3 and 4. Firstly, employment adjustment appears to be faster in small firms than in large ones. Assuming that the adjustment process during the annual observations is smooth, the estimates imply that half of the employment adjustment takes 4.4 months in small firms and 7.6 months in large ones.[2] Secondly, the elasticity of factor substitution and the real wage elasticity at constant output are nearly the same for large and small firms. Thirdly, the output or scale elasticity for small firms is estimated at 0.85, although it is just insignificantly different from unity, whereas that for large firms is quite close to unity. The estimates suggest that small firms experienced increasing returns to scale during the late seventies and early eighties and that large firms experienced constant returns to scale. Finally, the elasticity of working hours is relatively high and significant for large firms, whereas it is (in absolute terms) low and insignificant in small ones. This corresponds to the intuition that redistribution of work after a reduction of working hours is more difficult in small firms than in large ones.

The finding that employment adjustment is faster in small firms than in large ones is not corroborated by Van Leeuwen and Schim van der Loeff (1990). Using a panel of individual firms in Dutch manufacturing for which observations are available for all years (1978–1986), they find that employment adjustment is faster in large firms than in small ones. The findings can be reconciled by arguing that employment adjustment is faster in small firms than in large ones if the impact of entry and exit of firms is included (as in this study) and is slower if the impact of entry and exit is excluded (as in the study by Van Leeuwen and Schim van der Loeff).

The finding that the elasticity of factor substitution is nearly the same for large and small firms is consistent with earlier results obtained by Nguyen and Reznek (1993) for individual US manufacturing establishments and by Huigen *et al.* (1994) for individual Dutch manufacturing firms. Van Leeuwen and Schim van der Loeff (1990) find that the elasticity of factor substitution increases from 0.527 for firms with 10 up to and including 50 employees to 0.842 for firms with more than 500 employees.

The findings of both increasing returns to scale in small firms and constant returns to scale in large ones correspond to those of Nguyen and Reznek (1991). They find constant returns to scale for large establishments and increasing returns for small establishments during the recession year 1982. For 1977 the authors find that both large and small firms operate on the horizontal part of the average cost curve corresponding to constant returns to scale. Their interpretation of this result is that large establishments can adjust their scale of operations and still maintain constant returns to scale in response to a decrease in the demand for their products during a recession, whereas small establishments experience increasing returns because they can only minimize short-run average costs on the declining portion of the industry long-run average cost curve. Van Leeuwen and Schim van der Loeff (1990) find that the output elasticity decreases from 0.626 for firms with 10 up to and including 50 employees to 0.416 for firms with more than 500 employees. Curiously, the output elasticity for all firms with 10 or more employees is much higher, namely 0.826. This estimate is more closely to the results reported in this paper.

The implied estimates of the rate of labour-augmenting technical progress, β, and the elasticity of labour services with respect to working hours, γ, are not reported. The estimates of these parameters are outside the reasonable intervals [0.03, 0.06] and [0, 1], respectively. The corresponding standard errors appear to be quite large, however, so the estimates are not significantly outside the presumed intervals.

5. Concluding remarks

The purpose of this paper is to investigate whether the determination of employment differs between large and small firms. Therefore, an employment equation is estimated on panel data for 67 industries in Dutch manufacturing for the years 1974 up to and including 1986. Moreover, the equation is estimated separately for large and small firms in 35 of these industries. Knowledge of employment determination is important to assess the effectiveness of policies to enhance employment, such as moderation of real wages or a reduction of working time.

The estimates imply that the elasticity of factor substitution is somewhat below unity. The share of labour in value added is around 0.70, which is more or less standard in developed economies. The real wage elasticity at constant output is around –0.30, which corresponds to earlier results obtained for other countries. The output elasticity is close to unity, which corresponds to constant returns to scale. The elasticity of working hours, finally, is around –0.87.

Comparing the results for large and small firms reveals that the adjustment of employment is somewhat faster in small firms than in large ones. The elasticity of factor substitution and the real wage elasticity at constant output appear to be strikingly similar. The estimated output elasticities suggest constant returns to scale in large firms and increasing returns in small ones. The elasticity of working hours is significant for large firms, but low and insignificant for small ones.

Further research should dig deeper into the causes of different rates of employment adjustment between large and small firms. One explanation for this result is that adjustment costs are less steep in small firms than in large ones. An alternative explanation is that the adjustment of employment in small firms is not accomplished within the firms themselves, but results from higher rates of entry and exit of small firms. As advocated by Hamermesh (1993, p. 162), given the immense number of studies on the determinants of employment in existing firms, some redirection of effort is required toward the determinants of employment which results through entry and exit of firms. For further research with respect to (asymmetry in) employment adjustment, quarterly or monthly data are required.

Acknowledgements

A. R. Thurik and A. J. M. Kleijweg provided helpful comments on a previous draft.

Notes

[1] To check the robustness of the results I estimated a log-linear employment equation on National Accounts data of 18 sectors in the Dutch market sector (1963–1990). The equation does not include working hours. This is not too serious, as wages and employment are measured in labour years. The estimates imply that the elasticity of factor substitution is 0.611 (s.e. 0.139), the real wage elasticity at constant output is –0.173 (s.e. 0.039), the output elasticity is 1.012 (s.e. 0.060) and the rate of labour-augmenting technical progress is 3.23 (s.e. 2.33) percent. The share of labour in value added between 1967 and 1990 (weighted over industries, unweighted over time) is 71.6 percent.

[2] In order to investigate whether there are asymmetries in the employment adjustment process, the employment equation is also estimated with separate parameters for periods with either more or less than average output growth. For the sample of 67 industries employment adjustment appears to be slower during downturns than during upturns. For the subsample of 35 industries and both for large and small firms in these industries the adjustment of employment appears to be a bit slower during upturns than during downturns. In none of these cases the difference in speed of adjustment between upturns and downturns is significant, however.

Appendix

The 67 three-digit industries, or combinations thereof, which are included in the data set are listed below. For 35 industries separate observations for large and small firms are available. These industries are indicated by an asterisk. Combinations of three-digit industries are indicated by a + sign.

SBI-code	Description
20.1*	Slaughtering and meat processing industry
20.4	Flour mills, groats and rice husking mills, etc.
20.7	Canning, preserving and processing of fruits and vegetables
20.8*	Manufacture of bread, rusks, pastries, cakes and biscuits
20.9*	Manufacture of cocoa, chocolate and confectionery
21.2*	Manufacture of compounded animal stock feeds
21.3*	Manufacture of other food products
21.4	Alcohol manufacturing and distilleries
21.5	Breweries and malt houses
21.6	Non-alcoholic beverages
22.1	Wool industry
+22.2	Cotton industry
22.3	Knitting and hosiery industry
22.5	Manufacture of carpets and rugs
23.1	Manufacture of ready-made clothing
+23.2	Contract manufacture of ready-made clothing
24.1	Leather industry
24.2	Leatherware industry (excl. clothing)
24.3	Footwear industry
25.3	Carpenting, parqueting industry
25.4	Manufacture of wooden containers
25.5	Manufacture of other wooden articles
25.7	Furniture industry (excl. metal furniture)
26.1	Paper and cardboard industry
26.2*	Paperware industry
26.3*	Corrugated cardboard and cardboard industry
27.1*	Printing industry
27.2*	Publishing industry
27.3*	Book binding industry
29.1	Manufacture of fertilizers
29.2	Manufacture of plastics
29.3	Manufacture of dye-stuffs and pigments
29.4	Other chemical basic industry
+30.0	Manufacture of artificial and synthetic yarns and fibres

Appendix *(Continued).*

SBI-code	Description
29.5*	Manufacture of paint, lacquer, varnish and printing ink
29.6*	Manufacture of pharmaceutical and antiseptic dressings
29.7*	Manufacture of soap; other washing and cleaning materials, perfumes and cosmetics
29.8	Manufacture of chemical detergents, etc.
29.9*	Manufacture of other chemical products
31.1	Rubber-processing industry
31.3	Plastic-processing industry
32.1	Manufacture of brick and tiles
+32.2	Manufacture of earthenware
32.3	Manufacture of sand-lime bricks
32.5*	Manufacture of concrete and cement products
33.1	Iron and steel industry
+33.2	Manufacture of steel tubes
+33.4	Non-ferrous metal industry
33.3*	Wire-drawing and cold-rolling industry
34.0*	Foundries
34.1*	Iron works, crushing and pressing industry
34.2*	Manufacture of screws, mass products from lathes and springs
34.3*	Construction of tanks, reservoirs and pipelines
34.4*	Other metal construction
34.5*	Manufacture of metal furniture
34.6*	Metal-packing industry
+34.8*	Manufacture of other metal products
34.7*	Manufacture of heating and cooking apparatus (excl. electric)
34.9	Forges, surface treatment
35.1*	Manufacture of agricultural machinery
35.2*	Manufacture of metal-working machinery
35.3*	Manufacture of machinery for food-processing, chemical and related industries
35.4*	Lifting and other transport equipment for mining, construction, building-materials and metallurgic industries
35.5	Manufacture of cog-wheels, bearings and other driving gear
35.6*	Manufacture of machinery and other equipment for industries n.e.s.
35.7*	Manufacture of steamboilers, engines and turbines
35.8	Manufacture of office machinery
35.9*	Manufacture of other machinery and apparatus
36	Electrotechnical industry
37.1*	Manufacture and assembly of automobiles
+37.3*	Manufacture of car parts
+37.7*	Aircraft-construction and repair industry
37.2*	Manufacture of coach work and trailers
37.4	Shipbuilding and ship repair industries
37.6*	Manufacture of bicycles and motorcycles
37.9*	Manufacture of other transport equipment

References

Acs, Z. J. and D. B. Audretsch, 1993, 'Conclusions', in Z. J. Acs and D. B. Audretsch (eds.), *Small Firms and Entrepreneurship: An East-West Perspective*, Cambridge: Cambridge University Press, pp. 227–231.

Allen, R. G. D., 1938, *Mathematical Analysis for Economists*, London: Macmillan.

Arellano, M. and S. Bond, 1991, 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations', *Review of Economic Studies* **58**, 277–297.

Bakker, K. and Y. M. Prince, 1990, 'Data Set of Dutch Manufacturing per Third Digit Industry, 1974–1986', *Fundamental Research Note* 90.01, Zoetermeer: EIM.

Bol, A., A. Nijsen, G. Regter and F. van Rossum, 1982, 'Werkgelegenheid en Arbeidsvolume in het Midden- en Kleinbedrijf, 1960–1980: Een Analyse over de Bijdrage van het MKB in de Totale Werkgelegenheid' (Employment in Small and Medium-Sized Enterprises, 1960–1980: An Analysis of the Contribution of SME in Total Employment), Zoetermeer: EIM.

Carlsson, B., 1989, 'The Evolution of Manufacturing Technology and Its Impact on Industrial Structure: An International Study', *Small Business Economics* **1**, 21–37.

Hamermesh, D.S., 1993, *Labor Demand*, Princeton: Princeton University Press.

Huigen, R. D., A. J. M. Kleijweg, G. van Leeuwen and C. Zeelenberg, 1994, 'A Micro-Econometric Analysis of Interrelated Factor Demand', *Research Report* 9403/E, Zoetermeer: EIM.

Leeuwen, G. van and S. Schim van der Loeff, 1990, 'Employment Equations for Dutch Manufacturing Estimated from Panel Data 1978–1986', Voorburg: CBS.

Loveman, G. and W. Sengenberger, 1991, 'The Re-emergence of Small-Scale Production: An International Comparison', *Small Business Economics* **3**, 1–37.

Nguyen, S. V. and A. P. Reznek, 1991, 'Returns to Scale in Small and Large U.S. Manufacturing Establishments', *Small Business Economics* **3**, 197–214.

Nguyen, S. V. and A. P. Reznek, 1993, 'Factor Substitution in Small and Large U.S. Manufacturing Establishments: 1977–82', *Small Business Economics* **5**, 37–54.

Nickell, S. J., 1986, 'Dynamic Models of Labour Demand', in O. Ashenfelter and R. Layard (eds.), *Handbook of Labor Economics* 1, Amsterdam: North-Holland, pp. 473–522.

Nickell, S. J. and P. Kong, 1992, 'An Investigation into the Power of Insiders in Wage Determination', *European Economic Review* **36**, 1573–1599.

Sato, Y., 1989, 'Small Business in Japan: A Historical Perspective', *Small Business Economics* **1**, 121–128.

Storey, D. J. and S. G. Johnson, 1990, 'A Review of Small Business Employment: Data Bases in the United Kingdom', *Small Business Economics* **2**, 279–299.

Theil, H., 1971, *Principles of Econometrics*, New York: John Wiley and Sons.

Thurik, A. R., 1993, 'Recent Developments in the Firm-Size Distribution and Economics of Scale in Dutch Manufacturing', in Z. J. Acs and D. B. Audretsch (eds.), *Small Firms and Entrepreneurship: An East-West Perspective*, Cambridge: Cambridge University Press, pp. 78–109.