DEPARTMENT OF ECONOMICS

Working Paper

A NOTE ON THE ESTIMATION OF
MARKUP PRICING IN MANUFACTURING

Svend Hylleberg
Rikke Willemoes Jørgensen

Working Paper No. 1998-6
Centre for Non-linear Modelling in Economics

ISSN 1396-2426

UNIVERSITY OF AARHUS • DENMARK

CENTRE FOR NON-LINEAR MODELLING IN ECONOMICS

DEPARTMENT OF ECONOMICS - UNIVERSITY OF AARHUS - DK - 8000 AARHUS C - DENMARK
☎ +45 89 42 11 33 - TELEFAX +45 86 13 63 34

WORKING PAPER

A NOTE ON THE ESTIMATION OF MARKUP PRICING IN MANUFACTURING

Svend Hylleberg
Rikke Willemoes Jørgensen

Working Paper No. 1998-6

DEPARTMENT OF ECONOMICS

SCHOOL OF ECONOMICS AND MANAGEMENT - UNIVERSITY OF AARHUS - BUILDING 350
8000 AARHUS C - DENMARK ☎ +45 89 42 11 33 - TELEFAX +45 86 13 63 34

A Note on the Estimation of Markup Pricing in Manufacturing

Svend Hylleberg and Rikke Willemoes Jørgensen
Centre for Non Linear Modelling in Economics,
Department of Economics,
University of Aarhus,
Dk-8000 Aarhus C Denmark

Revised August 21, 1998

Abstract

Earlier results on estimating markup ratios as indicators of competitive pressure are discussed and it is shown that the estimation method suggested by Roeger (1995) suffers from problems similar to an earlier method suggested by Hall (1988). It is also shown that the estimating equations applied are prone to autocorrelation and heteroskedasticity and that a proper treatment of these problems may imply the the use of instrumental variables and use of a sandwich estimator The results obtained for Belgium, Canada, Denmark and the UK indicate that the relations between the markups and the scale factors are smaller than those reported in the litterature. JEL Classification C20, D49. Keywords: Competition, markup ratios, returns to scale, estimation.

1 Introduction

Perfect[1] competition is an assumption of many economic theories. Under perfect competition the firms produce to a point where their marginal cost

[1]Acknowledgments: The authors want to thank two anonymous referees, seminar participants at the CNLME workshop in Kokkedal, November 1997, participants in Nationaløkonomisk Forenings 125 Anniversary Meeting, Jan-

is equal to the market price and the purchasers set their marginal rates of substitution between commodities equal to the corresponding marginal rates of transformation. Perfect competition is, however, the exception rather than the rule. In case of a downward sloping demand schedule for the product a monopolist or oligopolist produces at a point where price exceeds the marginal cost. Recently, the interest in getting some broad information on the competitive situation in different sectors of the economy has increased.

In the industrial organization literature there exist several measures such as concentration ratios, profit ratios etc. A common feature among these measures is that they are static and backward looking. Under certain assumptions on the price expectation formation of firms the markup ratio, defined as the relation between price and marginal cost, may be shown to give a more forward looking and dynamic measure of the degree of competition in a given sector. Markup ratios have been estimated by Hall (1988), Roeger (1995), Martins, Scarpetta, and Pilat (1996 a, b), DØRS[2] (1995), Finansministeriet[3] (1995) among others. The estimation of the markup ratios suggested by Hall (1988) is based on a model for the Solow residual. The estimation procedure has been criticized and the results deemed somewhat dubious mostly because the estimation procedure requires use of instrumental variables which are difficult or impossible to find in the context. In Roeger (1995) an alternative method of estimation is proposed founded on both the Solow residuals and the dual Solow residuals. The estimation suggested by Roeger is used by Martins et al. (1996a, b), DØRS (1995) and Finansministeriet (1995) and the estimates of the markup ratio obtained are indeed much lower than the estimates obtained by Hall.

Below it will be argued that the estimation method suggested by Roeger (1995) is open for similar lines of criticism as the Hall method. It is argued that the regressors in the estimation equations of Roeger are not uncorrelated with the errors and that the errors may be both autocorrelated and heteroskedastic. We will suggest to reformulating the regression equation and allow for both autocorrelation and heteroskedasticity in order to obtain

uary 1998 and seminar participants at UCSD in April 1998 for constructive comments. Financial support from the Danish Social Science Research Council and the Research Foundation of the University of Aarhus is gratefully acknowledged. The computations were done using PC Give 9, see Hendry and Doornik (1996) and EViews version 2.0, 1997.

[2]The Danish Council of Economic Advisors.

[3]The Danish Ministry of Finance.

more reliable estimates of the relation between the markup ratio and an index of the return to scale. The estimate of this ratio will provide us with bounds on the markup ratio as shown by Martins et al. (1996a). It is also suggested that a proper way to proceed is by obtaining some independent information on the economics of scale.

The estimation procedure is applied to data for UK, Canada, Belgium and Denmark obtained from the OECD STAN database, OECD (1996). The set of countries selected is a subset of the countries selected by Martins et al. (1996a). The countries selected are those in which the gross output and value added are at factor cost which implies that no correction for indirect taxes is necessary.

Our results indicate that the problems with the design criteria , especially autocorrelation and heteroskedasticity , are less serious than we expected and that the simultaneity bias is smaller than expected as well.

2 The Model

Consider a representative firm operating in an environment with perfectly competitive factor markets where the prices R_t and W_t of the two factors of production capital K_t and labor L_t are considered fixed, while the commodity market is an imperfect competitive market where the markup of price, P_t, over marginal cost, MC_t, is

$$\mu_t = P_t/MC_t \tag{1}$$

Hence, a markup ratio of one indicates a high competitive pressure, while a markup ratio well above one is interpreted as absence of competitive pressure.

The technology is characterized by an index of the returns to scale

$$\lambda_t = AC_t/MC_t \tag{2}$$

AC_t is the average cost defined by

$$AC_t = \left(W_t L_t + R_t K_t\right)/Q_t \tag{3}$$

where Q_t is real value added.

By use of (1), (2) and (3) we get

$$\frac{\mu_t}{\lambda_t} = \frac{P_t Q_t}{W_t L_t + R_t K_t} \tag{4}$$

From (4) it is possible to derive, see Appendix A[4]

$$\Delta y_t = \left(1 - \frac{\lambda_t}{\mu_t}\right) \Delta x_t - \frac{\lambda_t}{\mu_t} \left(\Delta\lambda_t - \Delta\mu_t\right) \tag{5}$$

where

$$\begin{aligned} \Delta y_t &= (\Delta q_t + \Delta p_t) - \alpha_t (\Delta l_t + \Delta w_t) - (1 - \alpha_t) (\Delta k_t + \Delta r_t) \\ \Delta x_t &= (\Delta q_t + \Delta p_t) - (\Delta k_t + \Delta r_t) \end{aligned}$$

The notation applied is $\Delta x_t = \nabla \log X_t = \log X_t - \log X_{t-1} \approx \frac{1}{X_t} \frac{\partial X}{\partial t}$ etc., $\Delta\lambda_t = \nabla \log \lambda_t$ and $\Delta\mu_t = \nabla \log \mu_t$, while $\alpha_t = W_t L_t / P_t Q_t$ is the labor share of revenue.

In case of a constant index of returns to scale, $\lambda_t = \lambda$, and a constant markup, $\mu_t = \mu$, whereby $\Delta\lambda_t = 0$ and $\Delta\mu_t = 0$ (5) becomes

$$\Delta y_t = \left(1 - \frac{\lambda}{\mu}\right) \Delta x_t \tag{6}$$

or if in addition $\lambda = 1$ (constant returns to scale)

$$\Delta y_t = \left(1 - \frac{1}{\mu}\right) \Delta x_t \tag{7}$$

Adding an error term to (7) gives us the estimating equation suggested by Roeger (1995) in his extension of Hall's (1988) analysis.

From a comparison of (6) and (7) it is clear that a relation between Δy_t and Δx_t cannot identify both λ and μ. As also noted by Martins et al. (1996)

$$1 - \frac{\lambda}{\mu} \gtreqless 1 - \frac{1}{\mu} \text{if } \lambda \lesseqgtr 1. \tag{8}$$

Hence by regressing Δy_t on Δx_t we get an estimate of $1 - \frac{\lambda}{\mu}$ which is a biased estimate of $1 - \frac{1}{\mu}$ unless $\lambda = 1$. In case of $\lambda < 1$ the bias is positive and if $\lambda > 1$ the bias is negative. Hence the regression will produce an estimate of μ which is biased upwards if $\lambda < 1$ (decreasing returns to scale) and biased downwards if $\lambda > 1$ (increasing returns to scale).

However, such findings depend on (6) being a proper regression with a white noise error term independent of Δx_t.

---

[4]See also Martins, Scarpetta and Pilat (1996a).

The assumption of a constant relation between λ_t and μ_t or constancy of both λ_t and μ_t seems to be quite far fetched. Especially to assume that the markup is constant over a period where we have experienced dramatic changes in market structures and demand such as in the period 1970-1992, applied by Martin et al. (1996a) or 1953-1984, applied by Roeger (1995) and Hall (1988), seem questionable.

Hence let us return to (5) and rewrite it as, see Appendix A.

$$\Delta x_t = \frac{\mu_t}{\lambda_t}\Delta z_t + (\Delta\mu_t - \Delta\lambda_t) \tag{9}$$

where $\Delta z_t = \Delta x_t - \Delta y_t$. The reason for reformulating (5) by writing Δx_t as the dependent variable is to simplify the resulting error term. Now let us assume[5]

$$\gamma_t = \frac{\mu_t}{\lambda_t} = \gamma + \varepsilon_t \tag{10}$$

where $\varepsilon_t \sim iid\,(0, \sigma^2)$, i.e. the relation between the markup and the index of returns to scale is distributed as $iid\,(\gamma, \sigma^2)$.[6] (9) can then be rewritten as

$$\Delta x_t = \gamma\Delta z_t + u_t \tag{11}$$

where

$$u_t = (\Delta z_t)\,\varepsilon_t + \frac{1}{\gamma + \varepsilon_t}(\varepsilon_t - \varepsilon_{t-1}) \tag{12}$$

From (12) it is seen that the distribution of u_t have no moments unless $\gamma + \varepsilon_t$ has a support which bounds its distribution away from zero. In (10) it is assumed that γ is the mean relation between the markup and the scale factor and as the markup cannot be close to zero, but is expected to be one or above the only possible problematic case will arise when the scale factor is very large and the variance of ε_t is large too. Hence, we find it likely that the distribution of $\gamma + \varepsilon_t$ is bounded away from zero. However, the expression for u_t in (12) also indicate that the mean will be nonzero if there is any correlation between (Δz_t) and ε_t and that the disturbance u_t will be heteroskedastic, autocorrelated, non-normal. Hence OLS on (11) will give a biased, inconsistent and inefficient estimate of γ.

---

[5] Hence $\log\gamma_t = \log\left(\frac{\mu_t}{\lambda_t}\right) = \log(\gamma + \varepsilon_t)$ whereby $\log\gamma_t - \log\gamma_{t-1} = \Delta\log\gamma_t = \Delta\log(\gamma + \varepsilon_t) = \frac{1}{\gamma+\varepsilon_t}\frac{\partial\varepsilon_t}{\partial t}$

[6] Under constant returns to scale $\lambda_t = 1$ and $\gamma_t = \mu_t = \gamma + \varepsilon_t$.

Obviously, the form of (10) eg. the form chosen for the function γ_t, which implies the form of u_t may be discussed and criticized, But most functional forms leading to regression where Δx_t is regressed on Δz_t with a constant parameter γ as the regression coefficient will lead to a disturbance term u_t being a function of Δz_t, γ and unlagged and lagged values of the disturbance in the function for γ_t.

Notice, to perform the regression of Δy_t on Δx_t as in (6) will also imply an actual error term which is correlated with Δx_t, heteroskedastic, autocorrelated and following a distribution which is a complicated function of γ, Δx_t and ε_t. In addition, both Δx_t and Δz_t may be endogenously determined.

Hence, Ordinary Least Squares will produce inconsistent and inefficient estimates of γ. What could be done?

In order to obtain consistent estimates a possible solution would be to use instrumental variables. However, instruments which are highly correlated with Δz_t and uncorrelated with u_t may be hard to find. For instance, lagged values of the variables included in the model are usually not highly correlated with Δz_t in the actual data.

The possible autocorrelation and heteroskedasticity problem may be, at best, partly taken care of by using heteroskedastic and autocorrelation consistent standard errors as suggested by Newey and West (1987) based on an extension of White (1980).

Consider the model $y_t = \mathbf{x}_t^{'}\boldsymbol{\beta} + u_t$, with $\mathbf{u} \sim N(\mathbf{0}, \sigma^2\boldsymbol{\Omega})$where $\mathbf{x}_t$ is a kx1 vector of the t'th observation on the k explanatory variables, $\boldsymbol{\beta}$ a kx1 vector of coefficients, y_t is the t'th observation of the dependent variable and u_t a disturbance term, $\mathbf{u}$ is the Tx1 vector having u_t as its t'th element, and we assume that $\mathbf{u}$ is normally distributed with mean zero and covariance matrix $\sigma^2\boldsymbol{\Omega}$.

The least squares estimator of $\boldsymbol{\beta}$ is $\widehat{\boldsymbol{\beta}} = (\sum_t \mathbf{x}_t\mathbf{x}_t^{'})^{-1}\sum_t \mathbf{x}_t y_t = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Y}$

where $\mathbf{X}$ is a Txk matrix with the t'th row equal to $\mathbf{x}_t^{'}$ while $\mathbf{Y}$ is a Tx1 vector with t'th element equal to y_t. The covariance matrix for the least squares estimator is no longer $\sigma^2(\mathbf{X}'\mathbf{X})^{-1}$, but $\sigma^2(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\boldsymbol{\Omega}\mathbf{X}\ (\mathbf{X}'\mathbf{X})^{-1}$. The suggestion by Newey and West is to estimate this covariance matrix by estimating $\sigma^2\mathbf{X}'\boldsymbol{\Omega}\mathbf{X}$ by $\widehat{\Xi} = \widehat{\Xi}_1 + \widehat{\Xi}_2$ where $\widehat{\Xi}_1 = \sum_{t=1}^{T}\widehat{u}_t^2\mathbf{x}_t\mathbf{x}_t^{'}$ and $\widehat{\Xi}_2 =$

$\sum_{j=1}^{q}[1-\frac{j}{q+1}]\sum_{t=j+1}^{T}(\mathbf{x}_t\widehat{u}_t\widehat{u}_{t-j}\mathbf{x}_{t-j}^{'} + \mathbf{x}_{t-j}\widehat{u}_{t-j}\widehat{u}_t\mathbf{x}_t^{'})$

$\widehat{u}_t$ is an estimate of the disturbance term and then pre and post multiply the kxk matrix $\widehat{\Xi}$ by $(\mathbf{X}'\mathbf{X})^{-1}$.

The first part of $\widehat{\Xi}$ eg. $\widehat{\Xi}_1$ takes care of the heteroskedasticity while the second part, $\widehat{\Xi}_2$ handles the autocorrelation of lags up to q.

In addition, an intercept may help if the correlation between Δz_t and ε_t is reasonably constant.

3 The Results

As expected it was not feasible to obtain reliable instrumental variable estimates of the parameters in (11). The lagged Δz_t values have a low correlation with Δz_t implying that the IV estimator which uses lagged Δz_t values as instruments will produce estimates with high standard errors. In fact, the application of poor instruments may yield inferior estimates compared to the OLS estimates, see for instance Nelson and Startz (1988).

Hence we have chosen to rely on the least squares estimator applied to an equation with an intercept and the standard errors computed by the method suggested by Newey and West (1987). It has not been possible to infer anything about the sign and size of the inconsistency or bias from the form of the disturbance term in (12) and/or from the possible endogeneity of Δz_t.

The results presented in Appendix B indicate that first order autocorrelation problems were present in 24 out of the 115 estimated equations[7]. Autocorrelation were found much more often in Danish and UK industries that in Belgium and Canadian industries. Heteroskedasticity were found in 28 of the 115 estimated equations[8] problems in several cases, and the distribution over countries were much uniform than for autocorrelation. Non normality was an even a less frequent problem. In addition the estimated intercept was very small, i.e. less than 0.01 and not significant in almost al. cases.

The results are summarized in Table 1 where also the corresponding results of Martins et al. (1996a) are given.

TABLE 1 in here

A comparison of the results obtained with those obtained by Martins et al. (1996a) is made in Table 2. From Table 2 we obtain the puzzling result that our estimates of the ratio between markup and scale are in general smaller

[7]Autocorrelation were measured by the LM test for an AR(1) or MA(1) form at the 10% level.

[8]Heteroskedasticity were measured by Whites LM test for heteroskedasticity using a 10% level.

than the estimates obtained by Martins et al., although they should be very close if not identical. The fact the we regress Δx_t on Δz_t while Martins et al. do the opposite cannot possibly explain the differences as the fit measured by the R^2 is very close to 1.

In Figure 1 the results from table 1 are presented graphically in order to illustrate the difference between the 4 countries and between the industries.

TABLE 2 in here

FIGURE 1 in here

From Figure 1 and Table 1 it is seen that the estimates of $\gamma = \lambda/\mu$ in the Drugs and Medicine industry are uniformly very high in Canada, Denmark and the UK where the data are available, while the ratio in the Beverage Industry varies from 1.09 in Belgium to 1.26 in Canada.

The Furniture sector has a relatively high ratio in Belgium, Canada, and Denmark, but not in the UK.

Belgium is the highest in the Professional Goods sector and in the furniture sector, but the estimated mark up returns to scale ratio for Belgium are in general on low side.

Canada has a very high γ estimate in the Petroleum and Coal industry and in Pottery and China.

Denmark scores especially high relative γ estimates in Textiles, Wearing Apparel, Metal Products, Non Metal Products, and Other Manufacturing.

The UK tops the list in Drugs and Medicine, but is otherwise having relatively low estimates of the mark up returns to scale ratio.

Hence the general picture is somewhat mixed although Canada and Denmark seem to be on the high side and UK and Belgium on the low side.

4 Conclusions

In this paper it is argued that the estimation procedure of the markup ratios suggested by Roeger (1995) does not solve the problem of endogeneity of the regressor and that a slightly more realistic assumption on the constancy of the markup returns to scale ratio, γ, implies that heteroskedasticity and first order autocorrelation must be expected. In addition we must expect to find correlation between the errors and the regressors. However, these expectation are not in general supported by the estimation results obtain form Belgium , Canadian, Danish and UK industries in the period 1970 to 1995..

In any case our estimates of the markup returns to scale ratio in general are smaller than those obtained earlier by for instance Martins et al. (1996a), although the reasons for such discrepancies are difficult to explain.

The results obtained here are found by applying the most simple model for a time varying ratio between the markup ratios and the index of returns to scale. An interesting addition to this would be to model the time varying ratio as dependent upon other variables especially variables which contain information of either the markup ratio or the index for the returns to scale. Only in this way will it be possible to identify both the denominator and the numerator.

5 Reference

Det Økonomiske Råd (DØRS), 1995, *Dansk Økonomi Efteråret 1995.* Copenhagen.

Finansministeriet, 1995. *Finansredegørelsen 95.* Copenhagen.

Hall, R.E., 1988. "The relation between price and marginal costs in U.S. industry", *Journal of Political Economy*, Vol. 96, No. 5, p.. 921-947.

Hendry, D.F. and J.A. Doornik, 1996. *Empirical Econometric Modelling Using PC Give for Windows*, International Thomson Business Press, London.

Martins, J.O., S. Scarpetta and D. Pilata, 1996a. "Mark-up ratios in manufacutring industries. Estimates for 14 OECD Countries", *Economics Department Working Papers No. 162*, OECD.

Martins, J.O., S. Scarpetta and D. Pilata, 1996b. "Mark-up pricing, market structure and the business cycle", *OECD Economic Studies* No. 27.

Nelson, C.R and R. Startz, 1988, The Distribution of the Instrumental Variables Estimator and Its t-Ratio when the Instrument is a Poor One, *NBER Technical Working Paper No. 69*

Newey, W. and K. West, 1987, "A Simple Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix", *Econometrica* 51, 703-708.

OECD, 1996. STAN Industrial Database.

Roeger, W., 1995. "Can Imperfect Competition Explain the Difference between Primal and Dual Productivity Measures ? Estimates for US Manufacturing", *Journal of Political Economy*, Vol. 103, No. 2, p.. 316-330.

White, H., 1980. "A Heteroskedasticity Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", *Econometrica* 48, 817-

838.

6 Appendix A

Consider (A1)

$$\frac{\mu_t}{\lambda_t} = \frac{P_t Q_t}{W_t L_t + R_t K_t} \tag{A1}$$

which can be rewritten as

$$\mu_t \left[W_t L_t + R_t K_t \right] = \lambda_t P_t Q_t \tag{A2}$$

Let us take the total differential of (A2) and let us use the notation $\Delta x_t = \nabla \log X_t = \log X_t - \log X_{t-1} \approx \frac{1}{X_t} \frac{\partial X}{\partial t}$ to get

$$\begin{aligned} & W_t L_t \left[\Delta l_t + \Delta w_t + \Delta \mu_t \right] + R_t K_t \left[\Delta k_t + \Delta r_t + \Delta \mu_t \right] \\ = \; & P_t Q_t \left[\frac{\lambda_t}{\mu_t} \Delta q_t + \frac{\lambda_t}{\mu_t} \Delta p_t + \frac{\lambda_t}{\mu_t} \Delta \lambda_t \right] \end{aligned} \tag{A3}$$

where $\Delta \lambda_t = \nabla \log \lambda_t$ and $\Delta \mu_t = \nabla \log \mu_t$.

By dividing through with $P_t Q_t$ and by denoting the factor shares of revenue as

$$\alpha_t = W_t L_t / P_t Q_t, \;\; \beta_t = R_t K_t / P_t Q_t$$

we get from (A3)

$$\alpha_t \left[\Delta l_t + \Delta w_t \right] + \beta_t \left[\Delta k_t + \Delta r_t \right] = \frac{\lambda_t}{\mu_t} \left[\Delta q_t + \Delta p_t \right] + \frac{\lambda_t}{\mu_t} \left[\Delta \lambda_t - \Delta \mu_t \right] \tag{A4}$$

Notice that (A1) implies that $\frac{\lambda_t}{\mu_t} = \alpha_t + \beta_t$ whereby $\beta_t = \frac{\lambda_t}{\mu_t} - \alpha_t = \left(\frac{\lambda_t}{\mu_t} - 1 \right) + (1 - \alpha_t)$.

Let us then replace β_t in (A4) by this expression and rearrange to get

$$\begin{aligned} & (\Delta q_t + \Delta p_t) - \alpha_t \left[\Delta l_t + \Delta w_t \right] - (1 - \alpha_t) \left[\Delta k_t + \Delta r_t \right] \\ = \; & \left[1 - \frac{\lambda_t}{\mu_t} \right] \left[(\Delta q_t + \Delta p_t) - (\Delta k_t + \Delta r_t) \right] - \frac{\lambda_t}{\mu_t} (\Delta \lambda_t - \Delta \mu_t) \end{aligned} \tag{A5}$$

and let us define

$$\begin{aligned} \Delta y_t &= (\Delta q_t + \Delta p_t) - \alpha_t (\Delta l_t + \Delta w_t) - (1 - \alpha_t)(\Delta k_t + \Delta r_t) \\ \Delta x_t &= (\Delta q_t + \Delta p_t) - (\Delta k_t + \Delta r_t) \end{aligned}$$

whereby (A5) can be rewritten as

$$\Delta y_t = \left[1 - \frac{\lambda_t}{\mu_t}\right] \Delta x_t + \frac{\lambda_t}{\mu_t} \left[\Delta\mu_t - \Delta\lambda_t\right] \tag{A6}$$

or

$$\Delta x_t - \Delta y_t = \frac{\lambda_t}{\mu_t} \Delta x_t - \frac{\lambda_t}{\mu_t} \left[\Delta\mu_t - \Delta\lambda_t\right] \tag{A7}$$

(A7) may be rearranged to

$$\Delta x_t = \frac{\mu_t}{\lambda_t} \Delta z_t + \left[\Delta\mu_t - \Delta\lambda_t\right] \tag{A8}$$

where

$$\begin{aligned} \Delta z_t &= \Delta x_t - \Delta y_t \\ &= \alpha_t \left[(\Delta l_t + \Delta w_t) - (\Delta k_t + \Delta r_t)\right] \end{aligned}$$

7 Appendix B

Tables B1-B4 in here

Table 1. Mark up returns to scale ratio in Belgium, Canada, Denmark and the UK 1970-1995

Sector		Country							
Name	ISIC	Belgium		Canada		Denmark		United Kingdom	
		$\hat{\hat{a}}$	Martins et al.	$\hat{\hat{a}}$	Martins et al.	$\hat{\hat{a}}$	Martins et al.	$\hat{\hat{a}}$	Martins et al.
Food products	3112	1.13* (0.02)	1.15*	1.12* (0.02)	1.09*	1.08* (0.01)	1.10*	1.06 (0.04)	1.20*
Textiles	3210	1.07* (0.03)	1.08*	1.09* (0.01)	1.20*	1.13* (0.01)	1.12*	1.06* (0.02)	1.03*
Wearing Apparel	3220	1.08 (0.04)	1.05	1.10* (0.01)	1.10*	1.16* (0.04)	1.14*	1.07* (0.03)	1.03*
Leather products	3230	-	1.28*	1.09* (0.03)	1.11*	1.12* (0.01)	1.15*	1.09* (0.04)	1.06*
Footwear	3240	0.67* (0.01)	1.10*	1.06* (0.02)	1.07*	1.09* (0.01)	1.06	1.06* (0.01)	1.04*
Wood products	3310	1.11* (0.02)	0.95	1.08 (0.05)	1.28*	1.11* (0.01)	1.12*	1.03* (0.01)	1.18*
Furniture	3320	1.16* (0.01)	1.18*	1.16* (0.01)	1.16*	1.10* (0.02)	1.16*	0.99 (0.02)	1.19*
Printing and Publishing	3420	1.08* (0.02)	1.13*	1.14* (0.02)	1.21*	1.07* (0.01)	1.11*	1.12* (0.04)	1.09*
Plastic products	3560		.	1.08* (0.02)	1.17*	1.14* (0.03)	1.18*	1.05* (0.02)	1.03

Table 1 cont.

Sector		Country							
Name	ISIC	Belgium		Canada		Denmark		United Kingdom	
		$\hat{a}$	Martins et al.	$\hat{a}$	Martins et al.	$\hat{a}$	Martins et al.	$\hat{a}$	Martins et al.
Non-metal products	3690		1.03	1.14* (0.03)	1.32*	1.19* (0.02)	1.28*	1.07* (0.02)	1.15*
Metal products	3810	1.06 (0.03)	1.08*	1.03 (0.05)	1.16*	1.23* (0.05)	1.15*	1.04 (0.02)	1.03*
Chemical products	3529	1.08* (0.02)	1.12*	1.09* (0.02)	1.20*	1.07 (0.03)	1.15*	1.10* (0.02)	1.08*
Machinery & Equipment	3829		.	1.28* (0.02)	1.15*	1.11 (0.06)	1.12*	0.97 (0.03)	1.01
Motorcycles & Bicycles	3844		.		.	1.12 (0.02)	1.13*	0.89 (0.10)	1.03
Professional Goods	3850	1.16* (0.02)	1.31*		.	1.14* (0.02)	.	1.08 (0.05)	1.16*
Other manufacturing	3900			1.12* (0.02)	1.11*	1.23* (0.05)	1.25*	1.06 (0.03)	.
Beverages	3130	1.09* (0.02)	1.19*	1.26* (0.03)	1.30*	1.15* (0.01)	1.21*	1.15* (0.02)	1.54*
Tobacco products	3140	1.05* (0.00)	1.07*	1.19* (0.04)	1.19*	1.07 (0.05)	.	1.09* (0.01)	1.56*

Table 1cont.

Sector		Country							
Name	ISIC	Belgium		Canada		Denmark		United Kingdom	
		$\hat{\hat{a}}$	Martins et al.	$\hat{\hat{a}}$	Martins et al.	$\hat{\hat{a}}$	Martins et al.	$\hat{\hat{a}}$	Martins et al.
Petroleum refineries	3530	1.03* (0.01)	1.01	1.01 (0.02)	1.01	1.07* (0.02)	1.03	1.07* (0.02)	1.07*
Petroleum & Coal products	3540		1.11	1.33* (0.04)	1.31*	1.11* (0.03)	1.33*	1.12* (0.03)	1.06*
Rubber products	3550	1.03 (0.02)	1.06*	1.06* (0.01)	1.12*	1.14* (0.01)	1.12*	1.03* (0.01)	0.99
Pottery & China	3610		1.07	1.37* (0.05)	1.40*	1.24* (0.00)	1.41*	0.94 (0.03)	0.97
Glass products	3620		1.15*	1.25* (0.03)	1.31*	1.15* (0.02)	1.22*	1.03* (0.01)	1.06*
Iron & Steel	3710	0.99 (0.01)	1.25*	1.13* (0.02)	1.25*	1.07* (0.02)	1.07	1.05* (0.02)	1.05
Non-ferrous metals	3720	1.01 (0.03)	1.17*	1.11* (0.03)	1.14*	1.00 (0.03)	1.14*	1.06 (0.03)	1.05*
Shipbuilding & Repair	3841		.	0.94 (0.03)	1.16*		.	0.90* (0.02)	0.94
Other transport equipment	3849		.	1.09* (0.02)	1.10		.	1.00 (0.05)	1.03

Table 1 cont.

Sector		Country							
Name	ISIC	Belgium		Canada		Denmark		United Kingdom	
		$\hat{\tilde{a}}$	Martins et al.	$\hat{\tilde{a}}$	Martins et al.	$\hat{\tilde{a}}$	Martins et al.	$\hat{\tilde{a}}$	Martins et al.
Industrial chemicals	3510	1.09* (0.01)	1.10*	1.14* (0.02)	1.40*	1.09* (0.03)	1.24*	1.13* (0.02)	1.06*
Drugs & Medicines	3522		.	1.21* (0.05)	1.25*	1.28* (0.07)	1.41*	1.32* (0.05)	1.16*
Office & Computing mach.	3825		.	0.98 (0.13)	1.09	1.08 (0.05)	1.44*	1.09 (0.07)	1.47*
Radio, TV & Comm. Equip.	3832		.	1.23* (0.06)	1.31*	1.10* (0.03)	1.10*	0.96 (0.03)	1.25*
Electrical apparatus	3829		.	1.08* (0.03)	1.16*	1.05 (0.05)	1.17*	1.02 (0.03)	0.89
Railroad equipment	3842		.	1.12* (0.02)	1.13*		1.05	0.99 (0.04)	0.96
Motor vehicles	3843		.	1.09* (0.02)	1.14*		.	1.04 (0.03)	1.02
Aircraft	3845		.	0.83* (0.13)	1.25		.	1.04 (0.02)	0.96

Notes: A * indicates that the estimated ã is significantly different from 1 at the 5% level. The figures in parenthesis are heteroskedastic consistent standard errors. The columns Martins et al are obtained from Martins et al (1996a)

Tabel 2. A comparison of the estimates of the Markup-Returns to Scale Ratio

Country	$\hat{\tilde{a}}>M$	$\hat{\tilde{a}}=M$	$\hat{\tilde{a}}<M$
Belgium	1	8	8
Canada	1	18	14
Denmark	1	16	11
UK	5	18	11
Total	8	60	44

Notes: The figures in the table indicate the number of industries where the estimate of $\tilde{a}$ obtained here are significantly greater ($\hat{\tilde{a}}>M$)equal to ($\hat{\tilde{a}}=M$) and smaller ($\hat{\tilde{a}}<M$) than the point estimate obtained by Martins et al. (1996a). The heteroskedastic consistent standard errors are used in these comparisons.

Fig.1.1 Mark up returns to scale ratio
Belgium, Canada, Denmark & UK, 1970-95

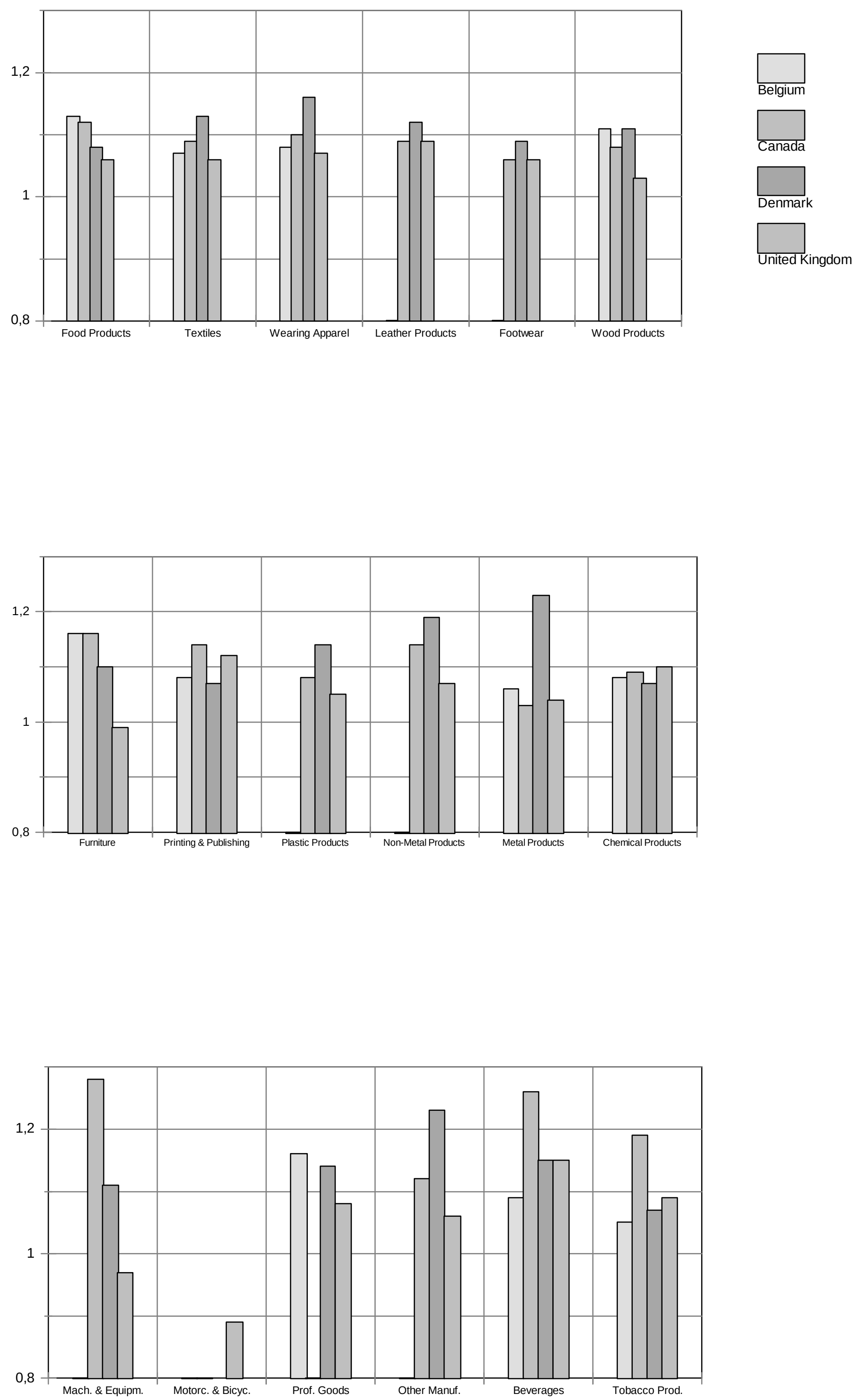
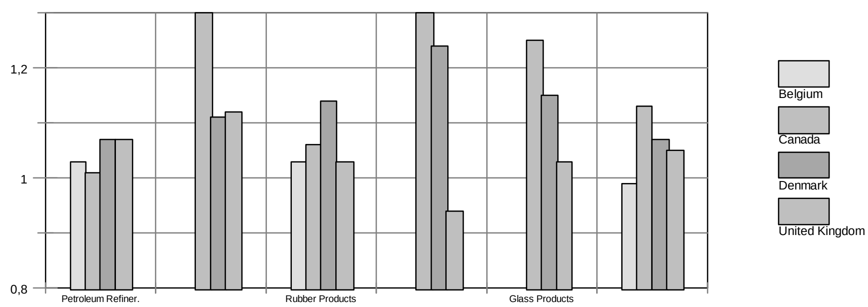
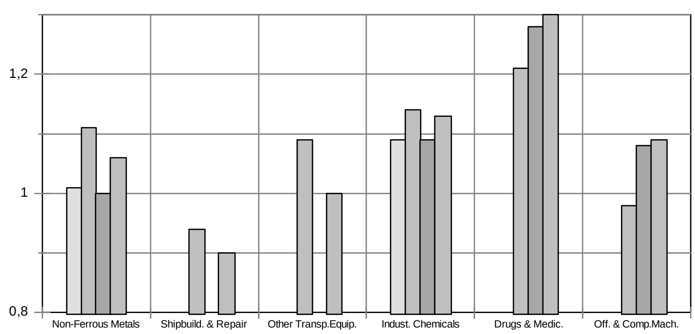


Fig.1.2 Mark up returns to scale ratio
Belgium, Canada, Denmark & UK, 1970-95





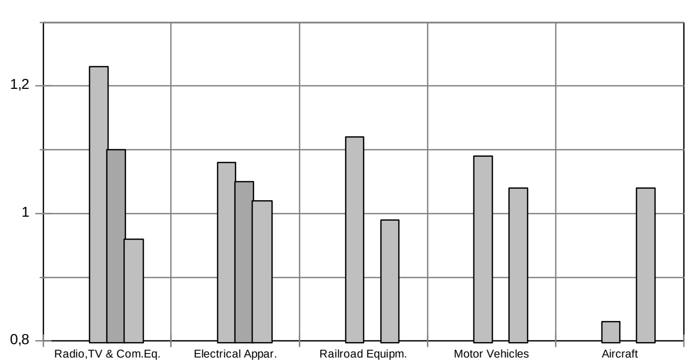


Table B.1 Belgium

Sector		Intercept $\hat{a}$	Äz ã	R^2	$\hat{ó}$	DW	AR F-stat	ARCH F-stat	WHITE 2 F-stat	RESET F-stat	Normality	T
Name	ISIC											
Food products	3112	-0.0042 (0.0022)	1.125 (0.017)	1.00	0.0094	1.68	0.41 [0.53]	0.02 [0.88]	2.08 [0.15]	2.54 [0.13]	6.02 [0.05]	24
Textiles	3210	0.0006 (0.0025)	1.070 (0.026)	0.99	0.0218	2.73	5.17 [0.03]	0.45 [0.51]	6.38 [0.007]	1.64 [0.22]	1.27 [0.53]	23
Wearing Apparel	3220	-0.0012 (0.0040)	1.081 (0.041)	0.98	0.0240	2.07	0.10 [0.75]	1.87 [0.19]	2.57 [0.10]	0.51 [0.48]	0.04 [0.98]	23
Leather products	3230	-	-	-	-	-	-	-	-	-	-	
Footwear	3240	0.0056 (0.0136)	0.666 (0.009)	0.99	0.0655	2.04	0.09 [0.77]	0.51 [0.48]	0.68 [0.52]	0.94 [0.34]	0.13 [0.94]	23
Wood products	3310	0.0003 (0.0031)	1.113 (0.015)	1.00	0.0231	1.98	0.001 [0.97]	0.17 [0.68]	2.90 [0.08]	0.40 [0.53]	14.47 [0.001]	24
Furniture	3320	-0.0009 (0.0027)	1.163 (0.0089)	1.00	0.0124	1.59	0.50 [0.49]	1.66 [0.21]	0.33 [0.72]	0.23 [0.64]	1.41 [0.49]	20
Printing & Publishing	3420	0.0003 (0.0047)	1.084 (0.016)	1.00	0.0228	1.82	0.14 [0.71]	0.06 [0.82]	2.25 [0.13]	1.90 [0.18]	0.39 [0.82]	24
Plastic products	3560											
Non-metal products	3690											
Metal products	3810	0.0020 (0.0037)	1.056 (0.033)	0.99	0.0253	2.22	0.39 [0.54]	0.55 [0.46]	2.57 [0.10]	0.01 [0.93]	0.44 [0.80]	24
Chemical products	3529	-0.0006 (0.0033)	1.077 (0.018)	0.99	0.0175	2.20	0.23 [0.64]	0.004 [0.95]	0.12 [0.89]	0.01 [0.91]	0.53 [0.77]	25
Machinery & Equipment	3829											
Motorcycles & Bicycles	3844											
Professional Goods	3850	0.0461 (0.0347)	1.157 (0.015)	1.00	0.1815	2.14	0.11 [0.74]	0.21 [0.65]	11,194.45 [0.0000]	1335.44 [0.0000]	75.00 [0.0000]	24
Other manufacturing	3900											
Beverages	3130	-0.0033 (0.0043)	1.092 (0.017)	0.99	0.0235	1.82	0.12 [0.73]	0.01 [0.94]	0.57 [0.57]	0.40 [0.50]	0.19 [0.91]	24
Tobacco products	3140	0.0011 (0.0015)	1.047 (0.004)	1.00	0.0102	2.51	2.01 [0.17]	0.81 [0.38]	0.02 [0.98]	0.14 [0.71]	2.42 [0.30]	24
Petroleum refineries	3530	0.0032 (0.0061)	1.031 (0.010)	1.00	0.0446	2.57	1.95 [0.18]	0.04 [0.85]	2.52 [0.11]	0.28 [0.61]	0.64 [0.73]	23
Petroleum & Coal products	3540											
Rubber products	3550	-0.0025 (0.0061)	1.030 (0.021)	0.99	0.0385	2.15	3.04 [0.10]	0.03 [0.86]	0.79 [0.47]	0.04 [0.84]	7.97 [0.02]	23
Pottery & China	3610											
Glass products	3620											

Table B.1 Belgium cont.

Sector		Intercept $\hat{á}$	Äz$_t$ ã	R^2	$\hat{ó}$	DW	AR F-stat	ARCH F-stat	WHITE 2 F-stat	RESET F-stat	Normality	T
Name	ISIC											
Iron & Steel	3710	-0.0021 (0.0090)	0.994 (0.0146)	0.99	0.0407	1.76	0.16 [0.69]	0.78 [0.39]	0.32 [0.73]	0.08 [0.78]	2.32 [0.31]	24
Non-ferrous metals	3720	0.0040 (0.0088)	1.009 (0.027)	0.99	0.0421	1.65	0.18 [0.67]	0.04 [0.85]	0.26 [0.77]	5.88 [0.02]	0.88 [0.64]	24
Shipbuilding & Repair	3841											
Other transport equipment	3849											
Industrial chemicals	3510	-0.0043 (0.0052)	1.098 (0.014)	0.99	0.0207	1.64	0.56 [0.46]	0.33 [0.57]	0.62 [0.55]	1.75 [0.20]	0.36 [0.83]	23
Drugs & Medicines	3522											
Office & Computing mach.	3825											
Radio, TV & Comm. Equip.	3832											
Electrical apparatus	3829											
Railroad equipment	3842											
Motor vehicles	3843											
Aircraft	3845											

Note. Regression: Äx$_t$ = á + ãÄz$_t$ + u$_t$. AR is the LM test for AR(1) or MA(1), ARCH is the LM test for ARCH(1), and White 2 are White´s tests for heteroskedasticity without the cross product of the regressors, RESET is the LM RESET test for non linearity, and Normality is the Jacque Bera test for non normality. The figures in the parenthesis are the heteroskedastic and autocorrelation consistent standard errors while the figures in brackets are p-values ie. probabilities for obtaining a value larger than the estimated value of the test stastistic.

Table B.2 Canada

Sector: Name	ISIC	Intercept $\hat{\alpha}$	Δz_t $\hat{\beta}$	R^2	$\hat{\sigma}$	DW	AR F-stat	ARCH F-stat	WHITE χ^2 F-stat	RESET F-stat	Normality	T
Food products	3112	0.0027 (0.0019)	1.118 (0.019)	0.99	0.0088	1.72	0.0004 [0.99]	4.98 [0.04]	0.13 [0.88]	0.07 [0.80]	0.79 [0.67]	20
Textiles	3210	-0.0021 (0.0028)	1.088 (0.013)	0.99	0.0191	3.11	11.51 [0.003]	5.02 [0.04]	0.66 [0.53]	1.77 [0.20]	2.93 [0.23]	20
Wearing Apparel	3220	0.0020 (0.0015)	1.104 (0.007)	1.00	0.0075	2.13	0.40 [0.54]	0.20 [0.66]	0.39 [0.68]	0.99 [0.33]	0.86 [0.65]	20
Leather products	3230	-0.0028 (0.0053)	1.086 (0.027)	0.99	0.0395	2.51	2.62 [0.12]	0.001 [0.98]	0.88 [0.43]	2.16 [0.16]	0.48 [0.79]	20
Footwear	3240	0.0006 (0.0030)	1.063 (0.018)	0.99	0.020	2.72	2.90 [0.11]	1.52 [0.23]	0.26 [0.77]	0.67 [0.42]	0.35 [0.84]	20
Wood products	3310	-0.0069 (0.0093)	1.080 (0.048)	0.94	0.0441	2.00	0.01 [0.93]	0.12 [0.74]	1.46 [0.26]	0.01 [0.97]	1.47 [0.48]	20
Furniture	3320	0.0006 (0.0031)	1.158 (0.014)	1.00	0.0164	2.10	0.32 [0.58]	0.45 [0.51]	1.87 [0.18]	0.000 [1.00]	1.08 [0.58]	20
Printing & Publishing	3420	0.0025 (0.0024)	1.135 (0.021)	0.99	0.0107	1.95	0.01 [0.92]	0.18 [0.68]	0.63 [0.55]	0.04 [0.85]	0.78 [0.68]	20
Plastic products	3560	-0.0014 (0.0018)	1.083 (0.015)	0.99	0.0120	3.14	9.89 [0.006]	0.56 [0.46]	1.42 [0.27]	0.88 [0.36]	1.44 [0.49]	20
Non-metal products	3690	-0.0030 (0.0050)	1.135 (0.030)	0.99	0.0257	1.95	0.08 [0.78]	0.11 [0.74]	5.48 [0.01]	9.24 [0.007]	0.95 [0.62]	20
Metal products	3810	-0.00001 (0.0034)	1.033 (0.024)	1.00	0.0182	2.40	1.12 [0.30]	0.30 [0.59]	3.77 [0.04]	5.15 [0.04]	1.02 [0.60]	20
Chemical products	3529	0.0040 (0.0038)	1.092 (0.016)	0.99	0.0209	2.41	1.06 [0.31]	0.19 [0.67]	0.23 [0.80]	0.12 [0.73]	3.74 [0.15]	25
Machinery & Equipment	3829	-0.0016 (0.0033)	1.276 (0.022)	0.99	0.0157	1.84	0.01 [0.92]	3.13 [0.09]	0.32 [0.73]	0.60 [0.45]	0.66 [0.72]	20
Motorcycles & Bicycles	3844											
Professional Goods	3850											
Other manufacturing	3900	0.0027 (0.0035)	1.119 (0.022)	1.00	0.0237	2.42	2.72 [0.11]	0.16 [0.69]	4.96 [0.02]	0.01 [0.91]	0.59 [0.74]	25
Beverages	3130	0.0012 (0.0052)	1.259 (0.030)	0.99	0.0224	1.14	1.95 [0.18]	0.37 [0.55]	0.94 [0.41]	0.05 [0.83]	0.38 [0.83]	20
Tobacco products	3140	0.016 (0.0078)	1.190 (0.038)	0.98	0.0430	2.17	1.34 [0.26]	0.05 [0.83]	0.28 [0.76]	2.13 [0.16]	14.77 [0.001]	20
Petroleum refineries	3530	0.0025 (0.0045)	1.014 (0.015)	0.99	0.0330	3.21	16.92 [0.001]	1.49 [0.24]	0.35 [0.71]	0.001 [0.98]	0.94 [0.63]	20
Petroleum & Coal products	3540	0.0105 (0.0098)	1.330 (0.042)	0.99	0.0628	1.75	0.24 [0.63]	0.68 [0.42]	12.22 [0.001]	3.07 [0.10]	3.23 [0.20]	20
Rubber products	3550	-0.0034 (0.0038)	1.061 (0.0091)	1.00	0.0213	2.28	0.40 [0.53]	0.001 [0.98]	0.55 [0.59]	1.12 [0.30]	1.10 [0.58]	20

TableB.2 Canada cont.

Sector		Intercept $\hat{á}$	$Äz_t$ $\hat{ã}$	R^2	$\hat{ó}$	DW	AR F-stat	ARCH F-stat	WHITE 2 F-stat	RESET F-stat	Normality	T
Name	ISIC											
Pottery & China	3610	-0.0134 (0.0169)	1.368 (0.047)	0.99	0,0822	1.95	0.0000 [1.00]	0.12 [0.73]	0.93 [0.41]	5.07 [0.04]	2.63 [0.27]	20
Glass products	3620	-0.0042 (0.0068)	1.250 (0.031)	1.00	0.044	2.21	0.62 [0.44]	0.001 [0.98]	5.16 [0.02]	21.70 [0.0002]	0.46 [0.79]	20
Iron & Steel	3710	-0.0094 (0.0077)	1.125 (0.015)	0.99	0.0396	2.12	0.39 [0.54]	0.08 [0.79]	0.59 [0.57]	0.26 [0.62]	57.59 [0.0000]	20
Non-ferrous metals	3720	-0.0028 (0.0056)	1.110 (0.026)	0.99	0.0293	1.95	0.001 [0.97]	0.93 [0.35]	1.00 [0.39]	0.01 [0.91]	0.65 [0.72]	20
Shipbuilding & Repair	3841	-0.0015 (0.0112)	0.943 (0.033)	0.97	0.0618	2.05	0.02 [0.88]	0.53 [0.48]	1.07 [0.36]	0.88 [0.36]	0.77 [0.68]	20
Other transport equipment	3849	-0.0048 (0.0091)	1.087 (0.019)	0.99	0.0626	2.26	0.58 [0.46]	0.37 [0.55]	1.54 [0.24]	5.11 [0.04]	1.17 [0.56]	20
Industrial chemicals	3510	-0.0054 (0.0109)	1.144 (0.023)	0.98	0.0487	1.82	0.00002 [1.00]	0.02 [0.90]	0.37 [0.70]	0.12 [0.74]	1.00 [0.61]	20
Drugs & Medicines	3522	0.0039 (0.0073)	1.210 (0.053)	0.98	0.0274	1.68	0.41 [0.53]	0.36 [0.56]	6.18 [0.01]	1.59 [0.22]	0.51 [0.77]	20
Office & Computing mach.	3825	-0.0131 (0.0154)	0.983 (0.134)	0.92	0.0942	1.48	0.23 [0.64]	0.10 [0.76]	3.15 [0.068]	1.52 [0.23]	73.98 [0.0000]	20
Radio, TV & Comm. Equip.	3832	0.0037 (0.0067)	1,225 (0.057)	0.94	0.0330	2.29	0.64 [0.44]	0.43 [0.52]	0.87 [0.44]	0.02 [0.88]	2.65 [0.27]	20
Electrical apparatus	3829	0.0021 (0.0029)	1.075 (0.030)	0.99	0.0187	2.59	1.86 [0.19]	0.01 [0.93]	1.21 [0.32]	0.21 [0.65]	1.66 [0.44]	20
Railroad equipment	3842	0.0065 (0.0084)	1.119 (0.023)	0.99	0.0421	1.75	0.01 [0.91]	0.22 [0.64]	0.75 [0.49]	1.90 [0.19]	0.06 [0.97]	20
Motor vehicles	3843	-0.0014 (0.0040)	1.091 (0.018)	1.00	0.0230	1.90	0.22 [0.64]	1.39 [0.26]	6.82 [0.01]	0.80 [0.38]	1.27 [0.53]	20
Aircraft	3845	-0.0007 (0.0121)	0.827 (0.130)	0.82	0.0955	2.39	1.08 [0.31]	4.04 [0.06]	6.75 [0.01]	7.52 [0.01]	0.58 [0.75]	20

Note. Regression: $Äx_t = á + ãÄz_t + u_t$. AR is the LM test for AR(1) or MA(1), ARCH is the LM test for ARCH(1), and White 2 are White´s tests for heteroskedasticity without the cross product of the regressors, RESET is the LM RESET test for non linearity, and Normality is the Jacque Bera test for non normality. The figures in the parenthesis are the heteroskedastic and autocorrelation consistent standard errors while the figures in brackets are p-values ie. probabilities for obtaining a value larger than the estimated value of the test stastistic.

Table B.3 Denmark

Sector		Intercept â	$Äz_t$ ã	R^2	ô	DW	AR F-stat	ARCH F-stat	WHITE 2 F-stat	RESET F-stat	Normality	T
Name	ISIC											
Food products	3112	0.0023 (0.0009)	1.078 (0.007)	1.00	0.0061	2.97	8.11 [0.01]	1.54 [0.23]	1.45 [0.26]	0.005 [0.94]	1.05 [0.59]	22
Textiles	3210	-0.0024 (0.0026)	1.134 (0.008)	1.00	0.0133	1.83	0.10 [0.75]	0.26 [0.62]	0.96 [0.40]	0.89 [0.36]	19.5 [0.00006]	21
Wearing Apparel	3220	0.00050 (0.0037)	1.159 (0.036)	0.99	0.0326	2.24	2.76 [0.114]	0.21 [0.65]	7.63 [0.004]	2.28 [0.14]	0.17 [0.92]	21
Leather products	3230	-0.0062 (0.0063)	1.117 (0.006)	1.00	0.0354	2.13	0.13 [0.72]	1.48 E-08 [1.00]	1.09 [0.36]	4.70 [0.04]	1.30 [0.52]	21
Footwear	3240	0.0057 (0.0071)	1.091 (0.007)	1.00	0.0371	1.76	0.05 [0.82]	1.77 [0.20]	0.68 [0.52]	0.045 [0.83]	1.97 [0.37]	21
Wood products	3310	-0.0010 (0.0016)	1.113 (0.0049)	1.00	0.0099	2.30	0.81 [0.38]	0.12 [0.74]	1.03 [0.38]	0.04 [0.85]	1.05 [0.59]	22
Furniture	3320	-0.00072 (0.0025)	1.102 (0.017)	1.00	0.017	2.43	1.40 [0.25]	0.13 [0.72]	12.57 [0.0003]	0.02 [0.89]	0.90 [0.64]	22
Printing & Publishing	3420	-0.0013 (0.0020)	1.072 (0.011)	1.00	0.0129	2.72	4.15 [0.06]	0.13 [0.72]	0.74 [0.49]	1.13 [0.30]	0.78 [0.68]	22
Plastic products	3560	0.0001 (0.0024)	1.135 (0.025)	0.99	0.0240	3.07	12.58 [0.002]	3.05 [0.10]	50.95 [0.0000]	0.52 [0.48]	0.37 [0.83]	21
Non-metal products	3690	-0.0043 (0.0052)	1.185 (0.016)	0.99	0.0269	2.28	0.68 [0.42]	0.09 [0.77]	0.50 [0.62]	1.27 [0.28]	9.19 [0.01]	21
Metal products	3810	0.0011 (0.0024)	1.210 (0.048)	0.99	0.0154	2.90	5.28 [0.03]	0.0003 [0.99]	4.70 [0.02]	2.29 [0.15]	0.28 [0.87]	22
Chemical products	3529	0.0023 (0.0022)	1.066 (0.026)	0.99	0.0190	3.03	10.58 [0.004]	0.27 [0.61]	0.28 [0.76]	0.08 [0.78]	1.14 [0.56]	22
Machinery & Equipment	3829	-0.0028 (0.0024)	1.113 (0.061)	0.98	0.0157	3.15	6.18 [0.03]	2.98 [0.11]	0.58 [0.57]	0.0006 [0.98]	0.62 [0.73]	15
Motorcycles & Bicycles	3844	0.0052 (0.0116)	1.118 (0.020)	1.00	0.0543	3.37	23.65 [0.005]	0.53 [0.50]	0.14 [0.88]	7.40 [0.04]	0.71 [0.70]	10
Professional Goods	3850	-0.0007 (0.0057)	1.139 (0.022)	0.99	0.0288	1.80	0.10 [0.75]	1.86 [0.19]	0.33 [0.73]	0.74 [0.40]	0.93 [0.63]	22
Other manufacturing	3900	0.0077 (0.0069)	1.230 (0.048)	0.98	0.0385	1.79	0.01 [0.91]	4.89 [0.04]	1.76 [0.20]	0.02 [0.88]	1.07 [0.59]	22
Beverages	3130	-0.0006 (0.0042)	1.146 (0.012)	1.00	0.026	2.83	4.06 [0.06]	0.40 [0.54]	0.16 [0.86]	3.28 [0.09]	2.96 [0.23]	22
Tobacco products	3140	0.0052 (0.0147)	1.071 (0.047)	0.97	0.085	2.54	1.94 [0.18]	0.22 [0.65]	0.02 [0.98]	0.33 [0.57]	0.11 [0.95]	21
Petroleum refineries	3530	0.0049 (0.0060)	1.072 (0.016)	1.00	0.0232	2.30	1.55 [0.23]	0.07 [0.79]	1.61 [0.23]	6.05 [0.02]	4.46 [0.11]	21
Petroleum & Coal products	3540	-0.0042 (0.0056)	1.113 (0.031)	0.99	0.0551	2.60	2.46 [0.13]	0.14 [0.72]	2.14 [0.15]	0.07 [0.79]	0.88 [0.64]	21
Rubber products	3550	-0.0020 (0.0068)	1.144 (0.010)	1.00	0.0379	1.59	0.77 [0.39]	0.78 [0.39]	4.60 [0.02]	5.17 [0.04]	2.52 [0.28]	21

Table B.3 Denmark cont.

Sector		Intercept $\hat{á}$	Äz_t ã	R^2	$\hat{ó}$	DW	AR	ARCH	WHITE 2	RESET	Normality	T
Name	ISIC						F-stat	F-stat	F-stat	F-stat		
Pottery & China	3610	-0-0305 (0.0293)	1.238 (0.002)	1.00	0.1952	2.46	1.13 [0.30]	0.24 [0.63]	2.87 [0.08]	23.28 [0.0001]	46.01 [0.0000]	21
Glass products	3620	-0.0023 (0.0107)	1.152 (0.020)	1.00	0.0655	1.78	0.14 [0.72]	0.42 [0.53]	2.75 [0.09]	0.08 [0.78]	0.41 [0.81]	21
Iron & Steel	3710	0.0049 (0.0060)	1.072 (0.016)	1.00	0.0350	2.30	1.55 [0.23]	0.07 [0.79]	1.61 [0.23]	6.05 [0.02]	4.46 [0.11]	21
Non-ferrous metals	3720	-0.0089 (0.0092)	1.003 (0.025)	0.99	0.0550	2.08	0.07 [0.79]	0.25 [0.62]	1.50 [0.25]	15.23 [0.001]	0.70 [0.70]	21
Shipbuilding & Repair	3841	-	-	-	-	-	-	-	-	-	-	-
Other transport equipment	3849											
Industrial chemicals	3510	-0.0014 (0.0051)	1.091 (0.027)	0.98	0.0260	1.91	0.27 [0.61]	0.53 [0.48]	0.15 [0.86]	0.67 [0.42]	0.01 [0.99]	21
Drugs & Medicines	3522	0.0036 (0.0066)	1.275 (0.065)	0.95	0.0399	2.50	1.24 [0.28]	0.85 [0.37]	0.006 [0.99]	0.39 [0.57]	0.99 [0.61]	21
Office & Computing mach.	3825	-0.0157 (0.0164)	1.081 (0.046)	0.98	0.0590	1.81	0.10 [0.76]	0.61 [0.48]	0.44 [0.65]	0.22 [0.65]	0.03 [0.98]	15
Radio, TV & Comm. Equip.	3832	-0.0005 (0.0044)	1.101 (0.025)	0.57	0.0298	2.64	2.11 [0.16]	0.97 [0.34]	1.22 [0.32]	0.07 [0.79]	0.62 [0.73]	21
Electrical apparatus	3829	-0.0024 (0.0055)	1.050 (0.049)	0.99	0.0357	2.24	0.31 [0.59]	0.98 [0.33]	3.68 [0.05]	0.027 [0.87]	1.42 [0.49]	21
Railroad equipment	3842											
Motor vehicles	3843	-	-	-	-	-	-	-	-	-	-	-
Aircraft	3845											

Note. Regression: Äx_t = á + ãÄz_t + u_t. AR is the LM test for AR(1) or MA(1), ARCH is the LM test for ARCH(1), and White 2 are White´s tests for heteroskedasticity without the cross product of the regressors, RESET is the LM RESET test for non linearity, and Normality is the Jacque Bera test for non normality. The figures in the parenthesis are the heteroskedastic and autocorrelation consistent standard errors while the figures in brackets are p-values ie. probabilities for obtaining a value larger than the estimated value of the test stastistic.

Table B.4 United Kingdom

Sector		Intercept $\hat{\beta}$	Δz_t $\hat{\gamma}$	R^2	$\hat{\sigma}$	DW	AR F-stat	ARCH F-stat	WHITE 2 F-stat	RESET F-stat	Normality	T
Name	ISIC											
Food products	3112	-0.0005 (0.0030)	1.061 (0.042)	0.96	0.0143	1.58	0.50 [0.49]	1.95 [0.18]	3.12 [0.07]	0.20 [0.66]	0.84 [0.66]	22
Textiles	3210	-0.0014 (0.0042)	1.060 (0.015)	0.99	0.0157	1.30	3.05 [0.10]	0.001 [0.97]	0.97 [0.40]	0.19 [0.67]	10.83 [0.004]	22
Wearing Apparel	3220	-0.0008 (0.0048)	1.069 (0.024)	0.99	0.0178	1.51	1.03 [0.32]	0.17 [0.68]	0.51 [0.61]	0.02 [0.90]	2.31 [0.31]	22
Leather products	3230	-0.0016 (0.0040)	1.094 (0.039)	0.99	0.0251	2.65	3.31 [0.08]	0.01 [0.93]	0.01 [0.99]	2.09 [0.16]	0.05 [0.98]	22
Footwear	3240	-0.0004 (0.0051)	1.059 (0.011)	0.99	0.0198	1.30	1.62 [0.22]	0.49 [0.49]	0.60 [0.56]	0.001 [0.98]	0.39 [0.82]	22
Wood products	3310	-0.0018 (0.0037)	1.029 (0.009)	0.99	0.0222	2.32	0.59 [0.45]	0.06 [0.81]	0.33 [0.72]	0.66 [0.43]	6.60 [0.04]	22
Furniture	3320	-0.0004 (0.0019)	0.991 (0.019)	0.99	0.0183	2.80	4.44 [0.05]	4.21 [0.05]	0.80 [0.47]	0.78 [0.39]	0.26 [0.88]	22
Printing & Publishing	3420	0.0013 (0.0054)	1.116 (0.039)	0.96	0.0265	1.78	0.08 [0.78]	6.27 [0.02]	0.02 [0.98]	0.21 [0.65]	3.90 [0.14]	22
Plastic products	3560	0.0023 (0.0025)	1.048 (0.021)	0.99	0.0139	1.77	0.11 [0.74]	2.00 [0.17]	0.22 [0.81]	0.07 [0.80]	2.93 [0.23]	22
Non-metal products	3690	0.0013 (0.0056)	1.071 (0.016)	0.99	0.0211	2.72	3.57 [0.07]	0.13 [0.72]	0.50 [0.62]	0.42 [0.52]	6.08 [0.05]	22
Metal products	3810	0.0001 (0.0029)	1.044 (0.021)	0.99	0.0178	2.43	1.15 [0.30]	0.93 [0.35]	0.71 [0.51]	6.62 [0.02]	0.68 [0.71]	22
Chemical products	3529	0.0024 (0.0024)	1.099 (0.020)	0.99	0.0146	2.56	2.22 [0.15]	0.01 [0.94]	0.52 [0.60]	0.001 [0.98]	0.95 [0.62]	23
Machinery & Equipment	3829	0.0023 (0.0024)	0.968 (0.026)	0.97	0.0169	2.68	2.69 [0.12]	3.39 [0.08]	1.20 [0.32]	0.54 [0.47]	1.06 [0.59]	23
Motorcycles & Bicycles	3844	-0.0062 (0.0309)	0.888 (0.091)	0.85	0.1631	1.91	0.81 [0.39]	3.47 [0.09]	0.09 [0.91]	0.07 [0.80]	8.90 [0.01]	15
Professional Goods	3850	0.0017 (0.0039)	1.077 (0.053)	0.97	0.0310	3.08	8.49 [0.09]	0.0002 [0.99]	4.95 [0.02]	15.51 [0.001]	0.50 [0.78]	22
Other manufacturing	3900	0.0021 (0.0025)	1.064 (0.026)	0.99	0.0183	2.61	2.77 [0.11]	0.17 [0.68]	0.15 [0.86]	1.80 [0.20]	0.46 [0.79]	22
Beverages	3130	-0.0017 (0.0042)	1.154 (0.018)	0.99	0.0189	1.38	1.70 [0.21]	0.42 [0.53]	0.49 [0.62]	1.01 [0.33]	0.67 [0.72]	22
Tobacco products	3140	0.0009 (0.0026)	1.092 (0.013)	1.00	0.0179	2.68	4.55 [0.05]	0.20 [0.66]	0.68 [0.52]	1.20 [0.29]	1.30 [0.52]	22
Paper products & pulp	3410											
Petroleum refineries	3530	0.0013 (0.0055)	1.071 (0.024)	0.99	0.0354	2.79	3.69 [0.07]	0.001 [0.98]	0.47 [0.63]	3.41 [0.08]	1.76 [0.41]	22
Petroleum & Coal products	3540	0.0040 (0.0056)	1.116 (0.030)	1.00	0.0391	2.16	0.16 [0.69]	0.005 [0.95]	14.05 [0.0002]	6.93 [0.02]	0.33 [0.85]	22

Table B.4 United Kingdom cont.

Sector		Intercept á̂	$\ddot{A}z_t$ ã	R^2	ó̂	DW	AR F-stat	ARCH F-stat	WHITE 2 F-stat	RESET F-stat	Normality	T
Name	ISIC											
Rubber Products	3550	-0.0002 (0.0028)	1.034 (0.014)	0.99	0.0172	2.40	1.02 [0.33]	0.03 [0.86]	0.84 [0.45]	0.58 [0.46]	0.57 [0.75]	22
Pottery & China	3610	0.0008 (0.0045)	0.937 (0.025)	0.99	0.0244	2.35	0.91 [0.35]	0.25 [0.63]	4.87 [0.02]	9.60 0.01]	1.66 [0.44]	22
Glass products	3620	-0.0019 (0.0034)	1.028 (0.011)	1.00	0.0239	2.71	3.32 [0.08]	0.79 [0.58]	0.46 [0.64]	0.20 [0.66]	1.49 [0.48]	22
Iron & Steel	3710	-0.0048 (0.0069)	1.054 (0.015)	0.99	0.0292	1.70	0.41 [0.53]	0.56 [0.46]	0.37 [0.70]	0.35 [0.56]	1.54 [0.46]	22
Non-ferrous metals	3720	-0.0016 (0.0036)	1.056 (0.030)	0.99	0.0270	2.30	0.62 [0.44]	0.42 [0.53]	11.86 [0.0005]	4.02 0.06]	0.48 [0.79]	22
Shipbuilding & Repair	3841	-0.0054 (0.0119)	0.903 (0.015)	0.98	0.0572	1.83	0.02 [0.89]	0.003 [0.96]	0.39 [0.68]	2.54 [0.13]	6.27 [0.04]	22
Other transport equipment	3849	0.0013 (0.0081)	0.995 (0.050)	0.97	0.0555	2.23	1.26 [0.28]	3.27 [0.09]	0.46 [0.64]	5.10 [0.04]	0.89 [0.64]	17
Industrial chemicals	3510	-0.0002 (0.0051)	1.134 (0.021)	0.99	0.0216	1.43	1.65 [0.21]	0.09 [0.77]	1.33 [0.29]	0.38 [0.55]	0.76 [0.68]	22
Drugs & Medicines	3522	0.0017 (0.0050)	1.318 (0.046)	0.97	0.0302	2.70	3.69 [0.07]	0.01 [0.92]	0.61 [0.55]	1.34 [0.26]	1.10 [0.58]	22
Office & Computing mach.	3825	0.00025 (0.0063)	1.085 (0.065)	0.96	0.0489	2.53	2.06 [0.17]	0.04 [0.85]	2.70 [0.09]	0.12 [0.73]	1.14 [0.57]	22
Radio, TV & Comm. Equip.	3832	0.0005 (0.0052)	1.016 (0.032)	0.97	0.0183	2.25	0.58 [0.45]	2.44 [0.13]	1.53 [0.24]	0.23 [0.64]	0.89 [0.64]	22
Electrical apparatus	3829	0.0007 (0.0027)	0.960 (0.028)	0.97	0.0172	3.02	6.99 [0.01]	0.59 [0.45]	0.53 [0.60]	0.001 [0.97]	0.27 [0.88]	22
Railroad equipment	3842	0.0063 (0.0091)	0.993 (0.040)	0.98	0.0507	2.12	0.43 [0.52]	0.0004 [0.98]	1.44 [0.27]	8.42 [0.01]	0.96 [0.62]	17
Motor vehicles	3843	-0.0013 (0.0046)	1.037 (0.034)	0.99	0.0278	2.21	0.57 [0.46]	0.39 [0.54]	0.52 [0.05]	3.05 [0.10]	0.22 [0.90]	22
Aircraft	3845	0.0039 (0.0053)	1.040 (0.021)	0.98	0.0381	2.69	3.13 [0.10]	0.38 [0.55]	2.49 [0.12]	0.07 [0.79]	1.51 [0.47]	19

Note. Regression: $\ddot{A}x_t$ = á + ã$\ddot{A}z_t$ + u_t. AR is the LM test for AR(1) or MA(1), ARCH is the LM test for ARCH(1), and White 2 are White´s tests for heteroskedasticity without the cross product of the regressors, RESET is the LM RESET test for non linearity, and Normality is the Jacque Bera test for non normality. The figures in the parenthesis are the heteroskedastic and autocorrelation consistent standard errors while the figures in brackets are p-values ie. probabilities for obtaining a value larger than the estimated value of the test stastistic.

Working Paper

1997-18	Tom Engsted and Niels Haldrup: Multicointegration in Stock-Flow Models.
1997-19	Torben M. Andersen: Persistency in Sticky Price Models.
1997-20	Toke Skovsgaard Aidt: On the Political Economy of Green Tax Reforms.
1997-21	Toke Skovsgaard Aidt: Strategic Entry, Rent-Seeking and Transfers.
1997-22	Bo Sandemann Rasmussen: Non-Equivalence of Employment and Payroll Taxes in Imperfectly Competitive Labour Markets.
1997-23	Peter Skott and Rajiv Sethi: Uneven Development and the Dynamics of Distortion.
1997-24	Ebbe Yndgaard: The Hobson-Marshall Controversy on the Marginal Product of Labour.
1998-1	Philipp J.H. Schröder: How Stakes in Restructuring put Restructuring at Stake.
1998-2	Philipp J.H. Schröder: The Fiscal Constraint to Restructuring of Firms in Transition Economies.
1998-3	Henrik Christoffersen and Martin Paldam: Markets and Municipalities. A Study of the Behaviour of the Danish Municipalities.
1998-4	Martin Paldam: Soft Criteria in Danish Development Aid. An Essay on Post-Materialist Values in Practice.
1998-5	Torben M. Andersen and Steinar Holden: Business Cycles and Fiscal Policy in an Open Economy.
1998-6	Svend Hylleberg and Rikke Willemoes Jørgensen: A Note on the Estimation of Markup Pricing in Manufacturing.

CENTRE FOR NON-LINEAR MODELLING IN ECONOMICS

DEPARTMENT OF ECONOMICS - UNIVERSITY OF AARHUS - DK - 8000 AARHUS C - DENMARK
☎ +45 89 42 11 33 - TELEFAX +45 86 13 63 34

Working papers, issued by the Centre for Non-linear Modelling in Economics:

1995-13 Tom Engsted, Jesus Gonzalo and Niels Haldrup: Multicointegration and Present Value Relations.

1996-1 Tom Engsted and Niels Haldrup: Estimating the LQAC Model with I(2) Variables.

1996-2 Peter Boswijk, Philip Hans Franses and Niels Haldrup: Multiple Unit Roots in Periodic Autoregression.

1996-3 Clive W.J. Granger and Niels Haldrup: Separation in Cointegrated Systems, Long Memory Components and Common Stochastic Trends.

1996-4 Morten O. Ravn and Martin Sola: A Reconsideration of the Empirical Evidence on the Asymmetric Effects of Money-Supply shocks: Positive vs. Negative or Big vs. Small?

1996-13 Robert F. Engle and Svend Hylleberg: Common Seasonal Features: Global Unemployment.

1996-14 Svend Hylleberg and Adrian R. Pagan: Seasonal Integration and the Evolving Seasonals Model.

1997-1 Tom Engsted, Jesus Gonzalo and Niels Haldrup: Testing for Multi-cointegration.

1997-7 Luca Fanelli: Estimating Multi-Equational LQAC Models with I(1) Variables: a VAR Approach.

1997-12 Niels Haldrup: A Review of the Econometric Analysis of I(2) Variables.

1997-14 Viggo Høst: Better Confidence Intervals for the Popoulation Mean by Using Trimmed Means and the Iterated Bootstrap?

1997-17 N.E. Savin and Allan H. Würtz: The Effect of Nuisance Parameters on Size and Power; LM Tests in Logit Models.

1997-18 Tom Engsted and Niels Haldrup: Multicointegration in Stock-Flow Models.

1998-6 Svend Hylleberg and Rikke Willemoes Jørgensen: A Note on the Estimation of Markup Pricing in Manufacturing.