

A Joint Estimation of Markups and Returns to Scale in 30 French Industries: A Structural Approach¹

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Abstract. In this paper we calculate markups for 30 French industries over the period 1977-1997 according to two methodologies. The first is based on the classical Solow residual approach, as adapted by Roeger (1995), under the assumption of constant returns to scale and constant markup over time. The second is a New Empirical Industrial Organisation (NEIO) approach used to jointly estimate markups and returns to scale, and where both markups and the index of returns to scale are allowed to vary over time. This structural approach estimates for each industry a system of 5 non-linear equations using 3 stages nonlinear least squares, in order to account for output demand, output supply and inputs demands, derived from a nonhomothetic Generalised Leontief production function and where the Herfindahl index of industry concentration is introduced into the output supply and input demands. The price of imports is included in the output demand equation to gauge better the degree of domestic market power in the presence of foreign competition.

The purpose of the paper is twofold.

Firstly, we show that by jointly estimating returns to scale and markups we can improve on the estimates of the latter when these are obtained under the CRTS assumption, like in the classical Solow's residual approach. Comparison of the empirical results obtained under the two methodologies is based on the ratio between the degree of returns to scale and markup calculated for each industry. Since this ratio theoretically should correspond to the sum of the input factor shares out of total revenue, we use actual data on the input factor shares out of total revenue as a benchmark to evaluate which approach provides the best estimate of the returns-to-scale-markup ratio. It is shown that the NEIO approach systematically provides estimates of the RTS-markup ratio closer to reality and the improvements are often substantial.

Secondly, we separate oligopoly-power and cost-efficiency effects of changes in industrial concentration and assess their impact on output prices in each industry. The empirical results indicate that output price effect is positive in 18 sectors out of 30, showing that the market power effect predominates over the cost efficiency effect in the majority of the sectors.

Key Words: *Solow Residual, New Empirical Industrial Organisation, Markups, Returns to Scale, Herfindahl index, Market Power, Cost Efficiency.*

JEL Classifications: L00, L11, L13, L60

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Introduction

Since the seminal article by Solow (1957) on total factor productivity measurement, and the approach developed by Hall (1986, 1988) to use the so-called Solow residual to estimate the markup of product prices over marginal costs, an extensive literature has been devoted to the empirical identification of market power (see, for example, Shapiro (1987) and Domowitz, *et al.* (1988).

More recently, Roeger (1995) proposed an alternative method for computing markups founded on both the Solow residual and the dual Solow residual. This method was used, among others, by Martins, *et al.* (1996) for 36 manufacturing industries in 14 OECD countries and by Hylleberg and Jørgensen (1998) for 35 manufacturing industries in Belgium, Canada, Denmark and the United Kingdom.

The estimation of markups in all the mentioned studies was however carried out under the assumptions of constant returns to scale (CRTS) and, except in Domowitz, *et al.* (1988) and Hylleberg and Jørgensen (1998), constant markups over time. However both assumptions are too strict. Firstly because the markup estimate will be biased upwards in the presence of decreasing returns to scale and it will be biased downwards in case of increasing returns to scale. Secondly because to assume a constant markup over a period where dramatic changes in market structures and demand were experienced, such as in the period 1970-1992 considered by Martins, *et al.* (1996) or the period 1953-1984 considered by Hall (1988) and Roeger (1995), seems questionable.

In this paper I present the empirical estimates of markups for 28 French industries over the period 1977-97 according to two methodologies. The first is based on the classical Solow residual approach, as suggested by Roeger (1995) under the assumption of constant returns to scale and constant markup over time. The second is a New Empirical Industrial Organisation (NEIO) approach used to jointly estimate markups and returns to scale, and where both markups and the index of returns to scale are allowed to vary over time.

The aim of this paper is therefore to compare the markup estimates obtained with the two methodologies and show that by relaxing the stringent assumptions of constant returns to scale (CRTS) and constant markup over time we can substantially improve the estimates of the returns-to-scale-markup ratios approximating better the reality.

A second objective of the paper is to draw some policy-relevant conclusions about the existence of market power, by separating out the oligopoly-power from the cost-efficiency effects of concentration on output prices.

The separation between the two effects is of public policy concern because what antitrust authorities are interested in is the trade-off between efficiency and market power. In other words, concentration will be deemed in the public interest only if the cost-efficiency gains through concentration offset the welfare losses from greater market power (Williamson 1968; Perry 1984; Brian and McFetridge 2000).

The paper is structured as follows. Section I recalls the well established Roeger's (1995) method founded on both the Solow residuals and the dual Solow residuals and the empirical methodology used to estimate it. Section II describes the NEIO model and the empirical methodology to implement it. Section III reports the empirical results of both approaches and compares them. Section IV shows the market power and the cost efficiency effects estimated using the NEIO model. Section V concludes.

The model is applied to 28 French industries (22 manufacturing, 5 services and the building sector) over the period 1977-1997. The NAP40 industrial classification was used. The data are therefore at a higher level of aggregation than is often used in studies of market power. Consequently, the estimates will be averages of sometimes disparate markets. Nevertheless, the results obtained should provide some macroeconomic guidance to ascertain what kind of returns to scale, markup, demand elasticity and conduct behaviour prevail in the industry and whether concentration did increase output prices more than it reduced costs³.

In addition to being a time-series study, it is a cross-industry one and, therefore, as suggested by Bresnahan (1989), it provides information on a wide range of industries that can be compared and it should be of interest to policy-makers, not least also because it explicitly incorporates observable structural measures of interest to them, such as industrial concentration.

Section I: The Solow Residual Approach

Since the late 1980s there has been an upsurge in interest in getting some broad information on the competitive situation in different sectors of the economy. The literature devoted to the empirical analyses of market power has particularly focussed on the identification of monopoly pricing (Schmalensee 1989; Bresnahan 1989).

The degree of monopoly power of a given producer can be viewed as the markup of product price (P_t) over marginal cost (MC_t). It can be defined as $L_t = (P_t - MC_t) / P_t$, which is the so-called *Lerner index*⁴. The higher the index, the greater the degree of monopoly power.

In those years the empirical measurement of the Lerner index, and consequently markups, was carried out using indirect measures in order to overcome the problem that marginal costs are not directly observable, unless a more structured framework is imposed by specifying a production function.

A popular indirect measure for the markup estimation was suggested by Robert Hall (1986, 1988) and it was based on a model for the Solow residual. It has been extensively applied in the empirical literature. However Hall's approach was also criticised and the results deemed somewhat dubious mostly because the estimation procedure requires use of instrumental variables, which are difficult to find in the context of imperfect competition.

Roeger (1995) proposed an alternative method of computing markups founded on both the Solow residuals and the dual Solow residuals. This method was used by Martins, *et al.* (1996) for 36 manufacturing industries in 14 OECD countries.

In what follows I recall the methodology followed by Martins, *et al.* (1996) and I point out a few slight modifications introduced hopefully to improve it, although I did not alter its basic nature.

³ However, Herfindhal indexes were weighted to reflect the more disaggregated industrial classification NAP100. See the Appendix for a breakdown of the industries considered.

⁴ See Lerner (1934).

1.1 - The markup estimating equation

Let us consider a neoclassical production function of a representative manufacturing firm operating in an environment with perfectly competitive factor markets:

$$Q_t = A_t F(K_t, L_t, M_t) \quad (1)$$

where A_t is the Hicks neutral technical progress. The firm chooses capital stock K_t in advance of the realisation of demand. On the input markets the firm can hire any amount of labour L_t at wage W_t and buy any amount of materials M_t at price P_t^M .

Prices C_t , W_t and P_t^M of the three factors of production respectively K , L and M are considered fixed (in the sense that the firm is a price-taker for inputs), while the commodity market is an imperfect competitive market where the markup of price over marginal cost MC_t is:

$$\mu_t = \frac{P_t}{MC_t} \quad (2)$$

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 characterised by an index of the returns to scale:

$$\lambda_t = \frac{W_t L_t + C_t K_t + P_t^M M_t}{Q_t MC_t} \quad (3)$$

where Q_t corresponds to gross output. Therefore (3) is the ratio between average costs and marginal costs.

Combining (2) and (3) we get:

$$\frac{\mu_t}{\lambda_t} = \frac{P_t Q_t}{W_t L_t + C_t K_t + P_t^M M_t} \quad (4)$$

which can be rewritten as:

$$\mu_t (W_t L_t + C_t K_t + P_t^M M_t) = \lambda_t P_t Q_t \quad (5)$$

Let us use the notation $\Delta x_t = \Delta \text{Log} X_t = \text{Log} X_t - \text{Log} X_{t-1} \approx \frac{1}{X} \frac{dX}{dt}$ and let us take the total differential of (5) to get:

$$\begin{aligned}
& a_t(\Delta l_t + \Delta w_t + \Delta \mu_t) + b_t(\Delta k_t + \Delta c_t + \Delta \mu_t) + g_t(\Delta p_t^M + \Delta m_t + \Delta \mu_t) \\
& = \frac{\lambda_t}{\mu_t}(\Delta q_t + \Delta p_t + \Delta \lambda_t)
\end{aligned} \tag{6}$$

where:

$$\begin{aligned}
a_t &= \frac{W_t L_t}{P_t Q_t} && = \text{factor share earned by labour} \\
b_t &= \frac{C_t K_t}{P_t Q_t} && = \text{factor share earned by capital} \\
g_t &= \frac{P_t^M M_t}{P_t Q_t} && = \text{factor share of materials in turnover} \\
&&& \Delta \lambda_t = \Delta \text{Log} \lambda_t \quad \text{and} \quad \Delta \mu_t = \Delta \text{Log} \mu_t
\end{aligned}$$

Notice that equation (4) implies that $\frac{\lambda_t}{\mu_t} = a_t + b_t + g_t$. Whereby equation (6) can be rephrased as follows:

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

where:

$$\begin{aligned}
\Delta y_t &= (\Delta q_t + \Delta p_t) - a_t(\Delta l_t + \Delta w_t) - g_t(\Delta p_t^M + \Delta m_t) - (1 - a_t - g_t)(\Delta k_t + \Delta c_t) \\
\Delta x_t &= (\Delta q_t + \Delta p_t) - (\Delta k_t + \Delta c_t)
\end{aligned}$$

In case of a constant index of returns to scale and a constant markup, $\Delta \lambda_t = \Delta \mu_t = 0$ and equation (7) becomes:

$$\Delta y_t = \left(1 - \frac{\lambda}{\mu}\right) \Delta x_t \tag{8}$$

Under the assumption of constant returns to scale ($\lambda = 1$) and adding an error term we get the estimating equation suggested by Roeger (1995):

$$\Delta y_t = \left(1 - \frac{1}{\mu}\right) \Delta x_t + \varepsilon_t \tag{9}$$

The dependent variable can be interpreted as the *nominal Solow residual*, while the explanatory variable corresponds to the *growth rate of the nominal output/capital ratio*.

By regressing Δy_t on Δx_t we get an estimate of $(1 - \lambda / \mu)$ which is a biased estimate of the Lerner index $(1 - 1 / \mu)$ unless $\lambda = 1$. The regression will produce an estimate of the markup rate, which is biased upwards if $\lambda < 1$ and biased downwards if $\lambda > 1$.

1.2 – The Empirical Methodology (part 1)

As pointed out by Hylleberg and Jørgensen (1998), an econometric problem faced when estimating (9) is the potential endogeneity of the right-hand side as well as the heteroskedasticity and autocorrelation of the disturbance term. Using OLS on (9), as e.g. Martins, *et al.* (1996) did, would thus lead to a biased, inconsistent and inefficient estimate of the Lerner index.

To tackle the endogeneity problem some studies estimate equation (9) using instrumental variables (Hall 1986, Hall 1988); Domowitz, *et al.* (1988); Hakura (1998); Jun (1998)). However, as noted by Blanchard (1986), Roeger (1995) and Hylleberg and Jørgensen (1998), instruments which are highly correlated with the independent variable and uncorrelated with the error term may be hard to find.

A solution may be to take into consideration the autocorrelation and heteroskedasticity problems directly into the estimation, by using heteroskedastic and autocorrelation consistent standard errors as suggested by Newey and West (1987). This does not solve the problem of endogeneity but it allows estimating markups with a simple procedure, already used in the literature, and that therefore can be used for comparison purposes with both previous studies and with the NEIO structural model used in the subsequent section. As it will become apparent, in fact, the NEIO model imposes a more complex structure for estimating markups, which solves the endogeneity problem.

The markup estimation takes account of labour, capital and intermediate inputs as production factors.

Following Martins *et al.* (1996), a simplified rental price of capital (C_t) inspired by the methodology of Hall and Jorgenson (1967) was defined as follows:

$$C_{i,t} = ((r_t - \pi_t^e) + \varphi_{i,t}) p_{i,t}^I \quad (10)$$

where r is the nominal market interest rate and π^e is the expected inflation rate which is generated using the low-frequency component of the annual percentage change in the GDP deflator using Hodrick-Prescott filter. The difference between these two terms represents the expected real cost of funds for the firm.

φ corresponds to the economic rate of depreciation. This in the literature is generally assumed constant through time⁵, in here I allowed a small variation through time calculating, for each industry, the rate of depreciation directly from actual data on net capital stock and investment, according to the formula

$$\delta_{i,t} = [1 - (K_{i,t} - I_{i,t}) / K_{i,t-1}] \times 100 \quad (11)$$

where K is net capital stock and I is gross fixed investment, both at constant 1980 prices. Given that the data do not support a hypothesis of constant rate of depreciation through time, I opted for an actual rate of depreciation deducted using equation (11). Finally, p^I represents the industry-wide deflator for the gross fixed investment.

⁵ See e.g. Martins, *et al.* (1996), Hall and Jorgenson (1967).

The estimation of markup is carried out using data at current prices since the variables were taken at their nominal value, except for capital. In fact, Δk is obtained using the series of net capital stock at constant prices (obtained from the series of net capital stock at current prices deflated using the industry investment deflator)⁶.

The markups are obtained as $1/(1-L)$, where L is the Lerner index and also the coefficient estimated in equation (9).

Section II: The NEIO Model

2.1 – A Structural Model

The new empirical industrial organisation (NEIO) model is a slight variant of the model developed by Lopez, *et al.* (2002), which is the oligopoly analogue of Azzam (1997) oligopsony model, which in turns extends Appelbaum (1982) model to formally include industrial concentration. In here I also take into account foreign competition in order to better gauge the measure of domestic market power. This is done, as explained later, by allowing the price of imports to affect domestic demand as an exogenous shock.

Let us consider an industry of N firms producing a homogeneous good Q requiring factors x_r for $r=1, \dots, k$ and facing a derived market demand curve

$$Q = f(p, \mathbf{z}) \quad (12)$$

where p is output price and \mathbf{z} is a vector of demand shifters. Profit maximisation by the j th firm yields the supply relation

$$p = -\frac{s_j}{\eta}(1 + \phi_j) + \frac{\partial C_j(q_j, \mathbf{w}, t)}{\partial q_j} \quad (13)$$

where $s_j = q_j/Q$ is the j th firm's market share, $\eta = (\partial Q / \partial P)(1/Q)$ is the semi-elasticity of demand ($\eta < 0$), $\phi_j = d \sum_{i \neq j}^n q_i / dq_j$ is the j th firm's conjectural variation, $C_j(\cdot)$ is the cost function, \mathbf{w} is a vector of factor prices, and t is the state of technology⁷.

By Shepard's Lemma, the derived demand for the r th factor by the j th firm is given by

⁶ As explained in Martins, *et al.* (1996, footnote 14) '[gross capital stock] only takes into account physical scrapping whereas [net capital stock] also accounts for economic depreciation. In general, the gross capital stock is more appropriate for the estimation of a production function, whereas the net capital is close to the definition of production costs'. In the estimation of markups I therefore used net capital stock.

⁷ The full analytical derivation of the model can be found in Appendix 1.

$$x_{rj} = \frac{\partial C_j(q_j, \mathbf{w}, t)}{\partial w_r} \quad \text{for } r = 1, 2, \dots, k \quad (14)$$

The cost function is assumed to take the form of a modified nonhomothetic Generalised Leontief (GL) cost function with disembodied technical change⁸

$$C_j(q, \mathbf{w}, t) = q_j \sum_r \sum_s \alpha_{rs} w_r^{1/2} w_s^{1/2} + q_j t \sum_r \gamma_r w_r + q_j^2 \sum_r \beta_r w_r \quad (15)$$

where α_{rs} , γ_r , β_r are parameters and $\alpha_{rs} = \alpha_{sr}$ ($r, s = 1, 2, \dots, k$). Note that the first set of $k(k+1)/2$ independent terms on the right-hand side of (15) corresponds to the GL cost function for a constant returns to scale technology with no technological progress (see Diewert 1971, p. 497). For the full specification of the GL cost function with arbitrary returns to scale and technical change and its properties see Diewert and Wales (1987)⁹.

Multiplying through equations (13) and (14) by s_j , using (15), and summing across the industry yields, respectively, the industry-wide analogue of the supply relation

$$p = -\frac{H(1+\Phi)}{\eta} + \sum_r \sum_s \alpha_{rs} w_r^{1/2} w_s^{1/2} + t \sum_r \gamma_r w_r + 2HQ \sum_r \beta_r w_r \quad (16)$$

and factor demand

$$\frac{X_r}{Q} = \sum_s \alpha_{rs} \left(\frac{w_s}{w_r} \right)^{1/2} + t\gamma_r + HQ\beta_r \quad \text{for } r = 1, 2, \dots, k \quad (17)$$

where $H = \sum_j s_j^2$ is the Herfindahl index, Φ is the firm-weighted conjectural variation for the whole industry¹⁰ and $X_r = \sum_j x_{rj}$ is total industry use of the r th factor¹¹.

Notice that one appealing feature of this model is that it explicitly incorporates the industrial concentration, an observable structural measure of interest to policy-makers.

It is moreover assumed that the demand function (12) takes the semi-logarithmic form

⁸ Apart from Lopez, *et al.* (2002), this version was used for example by Olson and Shieh (1989). The technical change (t) here is assumed to affect only the industry marginal cost intercept, not the slope.

⁹ The salient point to know here is that a nonhomothetic production function has an expansion path that is not necessarily a ray through the origin. In fact, the degree of returns to scale can be different for each input.

¹⁰ As is well known, the conjectural variation model can be interpreted as a reduced form of a more structured game of partial tacit collusion (Cabral 1995) or of capacity-price competition (Maggi 1996).

¹¹ The scaling of the input factors by output reduces possible heteroskedasticity in the estimation.

$$\ln Q = \delta_0 + \eta p + \sum_m \delta_m z_m \quad (18)$$

where η (the semi-elasticity of demand), δ_0 and δ_m are parameters.

The first term on the right-hand side of the supply relation in (16) is the Lerner index not divided by price. Its magnitude depends on the level of concentration (H), the semi-elasticity of demand (η), and the type of market conduct (Φ)¹². If the conduct is competitive, then $\Phi = -1$ and the Lerner index is zero. Under Cournot competition, $\Phi = 0$ and the Lerner index is $-H/(\eta P)$.

For conduct that is less competitive than Cournot, $0 < \Phi \leq (1/H) - 1$ and the upper bound on the Lerner index is $-1/(\eta P)$ ¹³.

It thus appears from (16) that for non-competitive conduct concentration affects both the Lerner index (and therefore the markup) and the marginal cost.

Following Azzam (1997) and Lopez, *et al.* (2002), Φ is treated as constant¹⁴. Differentiating (16) with respect to H gives the decomposed effects of concentration on output price (indicated subsequently with *OUTPEF*):

$$\frac{\partial p}{\partial H} = -\frac{(1+\Phi)}{\eta} + 2Q \sum_r \beta_r w_r \quad (19)$$

where the first term on the right-hand side is the market-power effect (shorted with *MKPEF*) and the second is the cost-efficiency effect, or the effect of a rise in concentration on marginal cost (shorted with *COSTEF*).

As Lopez, *et al.* (2002) note, in describing the effects of a change in concentration on price, the level of output is held constant. By fixing output, a rise in the Herfindahl index implies a change in the distribution in output across firms, with more output being produced by the larger firms. This leads to lower industry cost in the presence of economies of scale, higher industry costs in the presence of diseconomies of scale and no change in costs under constant returns to scale.

We show now how to measure economies of scale using the market-share-weighted industry cost function.

¹² Notice that the commonly-used conjectural variation elasticity, as specified in Appelbaum (1982), can be defined as $\Phi^* = (1+\Phi)H$, which ranges between 0 and 1, the price elasticity of demand is $\eta^* = \eta P$, and the industry oligopoly power (Lerner index) is defined by $L = -\Phi^* / \eta^*$.

¹³ In order to find the upper bound of the Lerner index maximise $-\frac{H(1+\Phi)}{\eta P}$ w.r.t. both H and Φ . The

first order derivatives are: $\frac{\partial L}{\partial H} = -\frac{1+\Phi}{\eta P}$ and $\frac{\partial L}{\partial \Phi} = -\frac{H}{\eta P}$, and the cross-derivative is $\frac{\partial^2 L}{\partial H \partial \Phi} = -\frac{1}{\eta P}$.

Therefore, given any elasticity of demand, the Lerner index can be at most minus that elasticity's reciprocal. The upper bound for the conduct is found by setting $-\frac{H(1+\Phi)}{\eta P} = -\frac{1}{\eta P}$ and solving for Φ .

¹⁴ Azzam (1997) tested formally the hypothesis in his model that Φ did not vary with H by setting the alternative specification $\Phi = \alpha H$, but was not able to reject the hypothesis that Φ was constant even at the 10% confidence level. Lopez, *et al.* (2002) tested two additional specifications of Φ : one by setting $\Phi = \theta_0 + \theta_1 \ln H$ following the work of Stigler (1964), and the other by including imports and exports as in Stålhammar (1991) but their results of interest somewhat deteriorated.

The industry cost elasticity with respect to output is measured by the ratio of industry marginal cost to average cost:

$$e_{cy} = \frac{A + 2HQB}{A + HQB} \quad (20)$$

where $A = \sum_r \sum_s \alpha_{rs} w_r^{1/2} w_s^{1/2} + t \sum_r \gamma_r w_r$ and $B = \sum_r \beta_r w_r$.

e_{cy} measures economies of size and is the inverse of the degree of returns to scale (or the inverse of Ohta (1975)'s dual rate of returns to scale). Therefore the degree of returns to scale is

$$\lambda = \frac{1}{e_{cy}} \quad (21)$$

If $B=0$, constant returns exist, i.e. $\lambda = 1$, and the only effect of rising concentration on price is through market power (the second term on the right-hand side of (19) is zero).

If $B>0$, diseconomies of scale exist, i.e. $\lambda < 1$, and a rise in concentration raises prices through a rise in both oligopoly power and costs.

If $B<0$, economies of scale are present, i.e. $\lambda > 1$, and the effect of a rise in concentration on price is ambiguous, i.e. it can be positive, negative or zero, depending on whether the market-power effect dominates, is dominated by, or is the same as the cost-efficiency effect.

2.2 – The Empirical Methodology (part 2)

The econometric model is based on equations (16), (17) and (18) describing pricing behaviour (supply relation), input demand relations, and the output demand relation. Although (16) is the main focus of this study, input and output demand equations are included to impose stronger theoretical restrictions and better identifying the corresponding parameters in the pricing equation, given the endogeneity of output price and quantity. This avoids the problem typically encountered with the estimation of markups in the Solow residual approach.

Three variable inputs are assumed: labour (X_L), capital (X_K), and intermediate inputs (X_M). The empirical model comprises therefore 5 equations: the pricing equation, three input demand equations, and the output demand equation. The latter is assumed to be a function of output price (P), income (Y), real interest rate (r) and price of imports (P_{IM}), where Y , P and P_{IM} are deflated by the consumer price index (CPI)¹⁵.

This specification allows an impact of different demand shocks on markups. For example, the inclusion of P_{IM} allows consideration of how relative import price changes, reflecting international competitiveness, have affected the ability of

¹⁵ The interest rate and the price of imports were also used, for example, by Morrison (1992). Lopez, *et al.* (2002) instead used income and a trend variable (t) as the only exogenous variables. In some sectors I included a trend because it turned out to give better results and closer to the priors indicated by economic theory. For the electricity sector I included the price of oil because again it was giving better estimates, and it is one of the major inputs of this industry.

domestic firms to mark up price over marginal cost. The interest rate r affects the desirability of durable goods, and can proxy wealth effects. Income Y captures the changes in overall spending. The deflator CPI measures the cost of living and therefore allows to consider the relative prices of other types of goods when estimating the demand for the industry's own product.

The endogenous variables are Q , P , X_L , X_K , and X_M . The exogenous variables are W_L , W_K , W_M , Y , t (assuming the value of 1 for 1977 through 21 for 1997), r , P_{IM} , CPI , and H .

The parameters to be estimated are Φ , η , the α_{rs} , the β_r , the γ_r , δ_0 , and δ_m . Since the sample is small and the standard errors for nonlinear models are only approximately correct for small samples, the statistical significance of the coefficients should be interpreted with caution.

Given the endogeneity of output quantity and price, the system of five equations is estimated for each industry using iterative nonlinear three stages least squares (N3SLS) in RATS, with once-lagged endogenous variables serving as instruments in addition to all the exogenous variables.

Consistency and asymptotic normality for this method-of-moments type estimator are proved in Jorgenson and Laffont (1974) and Gallant (1977).

The results are presented in the next section.

Section III: Empirical Results

3.1 – Conduct, Demand, and Returns to Scale

Table 1 presents the estimates for the parameters Φ , η , L and λ from the NEIO model. The null hypothesis for conduct is $\Phi = -1$ (competitive behaviour) but the alternative conduct hypothesis of Cournot behaviour ($\Phi = 0$) is also tested, given its common use in empirical analysis. The maximum value of the conduct, calculated as explained in footnote 13, is also provided in order to compare the estimated conduct parameter with its possible extreme value (corresponding to the perfect collusion case) and so to serve as a guide in judging the degree of non competitive behaviour in the industry¹⁶.

For the returns to scale, the null hypothesis $\lambda = 1$ (or, equivalently, $e_{cy} = 1$) is tested.

Standard errors for the constructed coefficients L and λ were calculated using the Delta Method (an account of which can be found in the Appendix 2, with the derivation of the calculations).

We can see that the conduct is rarely more competitive than the Cournot type of competition. In fact, 15 out of 30 sectors do not reject the hypothesis of Cournot behaviour ($\Phi = 0$) at 5% significance level, 9 sectors show an even more competitive behaviour ($\Phi < 0$ and the hypothesis of $\Phi = 0$ is rejected at the 1% significance level). Only 6 sectors show a certain degree of collusive behaviour (i.e. the conduct parameter is positive and the hypothesis of Cournot is rejected at the 5% significance level): oil sector, foundries and metalworking, mechanical engineering, building,

¹⁶ Notice that theoretically also monopoly is represented by a conduct parameter equal to zero, however we can easily discriminate between Cournot competition and monopoly by considering the value of the Herfindahl index.

Table 1 - Estimates of conduct, semi-elasticity of demand, Lerner index and returns to scale for 28 French industries (1977-1997) – NEIO model.

NAP 40 code	Industry	Φ conduct	Max Value Φ	η se mi- elasticity	L Lerner index	λ returns to scale	Hypothesis tests (p-values)	
							$\Phi = 0$	$\lambda = 1$
T02	Meat and milk	2.216*** (1.241)	118.90	-0.342** (0.140)	0.088*** (0.020)	1.014*** (0.011)	0.074	0.206
T03	Other food	-0.573** (0.173)	13.90	-0.514*** (0.170)	0.060*** (0.010)	1.034*** (0.008)	0.001	0.000
T04	Solid mineral fuels, and coke	-0.948 (0.077)	3.43	-0.327** (0.150)	0.042 (0.053)	1.400*** (0.071)	0.000	0.000
T05	Oil and natural gas	0.428*** (0.116)	5.56	-0.954*** (0.068)	0.257*** (0.017)	1.100*** (0.017)	0.000	0.000
T06	Electricity, gas and water	-0.424*** (0.094)	0.38	-0.678*** (0.088)	0.663*** (0.046)	2.048*** (0.210)	0.000	0.000
T07	Ferrous ores and metals	-0.907 (0.189)	5.83	-0.181 (0.353)	0.084*** (0.018)	1.038*** (0.010)	0.000	0.000
T08	Non ferrous ores and metals	0.273*** (0.312)	12.56	-1.324*** (0.147)	0.086*** (0.023)	1.140*** (0.023)	0.382	0.000
T09	Sundry minerals, Build. materials	2.655* (1.905)	51.90	-0.740** (0.308)	0.097*** (0.025)	1.076*** (0.027)	0.163	0.005
T10	Glass	0.482*** (0.555)	16.88	-0.923*** (0.140)	0.095*** (0.033)	1.018*** (0.037)	0.384	0.619
T11	Chemical, synthetic fibres	0.759* (0.971)	43.32	-0.595** (0.299)	0.079*** (0.024)	1.037*** (0.011)	0.435	0.001
T12	Parachemicals, pharmaceutical	3.911** (2.402)	89.00	-0.597*** (0.158)	0.100** (0.040)	0.992*** (0.192)	0.104	0.681
T13	Foundries and metalworking	73.419 (15.595)	168.02	-3.510*** (0.485)	0.126*** (0.021)	1.072*** (0.019)	0.000	0.000
T14	Mechanical engineering	13.761** (6.289)	82.71	-2.398*** (0.487)	0.075*** (0.026)	1.070*** (0.018)	0.029	0.000
T15	Electric and electronic equip.	0.247*** (0.365)	16.68	-1.217*** (0.068)	0.061*** (0.017)	1.153*** (0.020)	0.498	0.000
T15b	Consumer durable goods	0.387*** (0.283)	11.27	-1.384*** (0.176)	0.104*** (0.018)	1.056*** (0.019)	0.171	0.003
T16	Ground transport equipment	-0.257*** (0.266)	11.02	-1.670*** (0.249)	0.037*** (0.014)	1.000*** (0.009)	0.335	0.958
T17	Shipbuilding, aeronau., armam.	-0.980 (0.099)	7.34	-0.068 (0.311)	0.036 (0.035)	1.028*** (0.028)	0.000	0.322
T18	Textiles and clothing	11.376 (8.663)	347.77	-0.551*** (0.184)	0.069 (0.044)	1.020*** (0.047)	0.189	0.666
T19	Leather and footwear	1.607 (2.539)	63.82	-1.551*** (0.246)	0.025 (0.024)	1.014*** (0.020)	0.527	0.487
T20	Wood, furniture, miscellan. indus.	5.328** (3.225)	151.63	-0.393*** (0.137)	0.114*** (0.026)	1.153*** (0.020)	0.098	0.000
T21	Paper and board	-0.564 (0.493)	112.49	-0.100 (0.693)	0.041 (0.032)	0.982*** (0.030)	0.253	0.558

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). The standard errors (s.e.) are indicated in brackets. The s.e. for L and λ were calculated using the Delta Method (see Appendix 2).

The Lerner indexes and the returns to scale are calculated at mean values.

The null hypothesis for Φ is -1 (perfect competition). The fourth column reports the upper bound value of Φ for each sector, obtained as explained in footnote 13. The last two columns provide the p-value of the tests for Cournot behaviour ($\Phi = 0$) and constant returns to scale ($\lambda = 1$). These results are based on the joint estimation of equations (16),(17) and (18) using nonlinear 3 stages least squares.

Table 1 (cont.) - Estimates of conduct, semi-elasticity of demand, Lerner index and returns to scale for 28 French industries (1977-1997) – NEIO model.

NAP 40 code	Industry	Φ conduct	Max Value Φ	η se mi- elasticity	L Lerner index	λ returns to scale	Hypothesis tests (p-values)	
							$\Phi = 0$	$\lambda = 1$
T22	Press and edition	8.954 (13.557)	255.53	-1.976*** (0.196)	0.019 (0.026)	1.006*** (0.014)	0.509	0.666
T23	Rubber and plastics	-0.676 (0.249)	16.25	-0.363 (0.244)	0.056*** (0.021)	1.050*** (0.017)	0.007	0.003
T24	Building	66.679*** (16.353)	583.65	-0.839*** (0.194)	0.148*** (0.014)	1.149*** (0.015)	0.000	0.000
T25- T28	Trade	16.655*** (5.546)	154.92	-0.431*** (0.123)	0.264*** (0.019)	0.956*** (0.006)	0.003	0.000
T29	Motor car trade and repairs	12.834*** (1.692)	157.05	-0.528*** (0.027)	0.148*** (0.018)	0.926*** (0.015)	0.000	0.000
T31	Transports	-0.901** (0.043)	4.35	-0.245*** (0.083)	0.079*** (0.020)	1.018*** (0.014)	0.000	0.193
T32	Telecommunicat. and post	-0.783*** (0.035)	0.73	-1.211*** (0.100)	0.127** (0.024)	0.872*** (0.019)	0.000	0.000
T34	Market services to households	1.484** (1.021)	25.40	-0.261*** (0.099)	0.363*** (0.029)	1.082*** (0.013)	0.146	0.000
T37	Financial institutions	-0.953*** (0.015)	1.67	-0.254*** (0.076)	0.065*** (0.016)	1.005*** (0.002)	0.000	0.042

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). The standard errors (s.e.) are indicated in brackets. The s.e. for L and λ were calculated using the Delta Method (see Appendix 2).

The Lerner indexes and the returns to scale are calculated at mean values.

The null hypothesis for Φ is -1 (perfect competition). The fourth column reports the upper bound value of Φ for each sector, obtained as explained in footnote 13. The last two columns provide the p-value of the tests for Cournot behaviour ($\Phi = 0$) and constant returns to scale ($\lambda = 1$).

These results are based on the joint estimation of equations (16),(17) and (18) using nonlinear 3 stages least squares.

trade, motor car trade and repairs.

In order to rank the degree of collusion across all industries for which $\Phi > 0$, I construct an *index of relative collusion* as the ratio between the estimated conduct parameter Φ and the upper bound of Φ occurring when perfect collusion exists (derived as explained in footnote 13).

Table 2 shows that, not surprisingly, the six industries that do reject the hypothesis of Cournot behaviour are associated with the highest indexes of relative collusion: oil and natural gas (T05) exhibits 7.3%; motor car trade and repairs (T29) 8.2%; trade (T25-28) 10.8%; construction (T24) 11.4%; mechanical engineering (T14) 16.6% and, on top, foundries and metalworking (T13) with 43.7%. The finding of foundries and metalworking as the most collusive industry is perhaps not surprising in the industrial economics literature, being an example of activity which typically requires investment in capacity that must be planned well in advance, therefore rivals can easily monitor each player's moves on the market and the pricing process becomes more transparent, making collusion a more viable option. Therefore, capacity can be

used as a strategic commitment to collude. Along the same lines of reasoning could be interpreted the conduct parameter of the building sector.

Table 2– Indexes of relative collusion across industries with $\Phi > 0$

Industry	Relative collusion	Industry	Relative collusion	Industry	Relative collusion
T02	0.019	T13	0.437	T22	0.035
T05	0.073	T14	0.166	T24	0.114
T08	0.022	T15	0.015	T25-T28	0.108
T09	0.051	T15b	0.034	T29	0.082
T10	0.029	T18	0.033	T34	0.058
T11	0.018	T19	0.025		
T12	0.044	T20	0.035		

A few sectors exhibit a conduct parameter near the lower bound of -1 , which could be interpreted as Bertrand collusion. These sectors are: solid mineral fuels and coke, which is a highly subsidised industry; ferrous ores and metals; shipbuilding, aeronautics and armament; transports; telecommunications and post; and financial institutions. It is possible that some of these industries behave nearly perfectly competitive because the price is set by external agents, like the government (or public authorities) or it is strongly influenced by the price of oil, and therefore imports. This extends also to the utilities sector T06, which shows a highly competitive conduct as well. An argument based on regulation could be at least partly applied to the three service sectors (transports, telecommunication and post, and financial institutions), which interestingly show a very competitive conduct.

A similar argument could probably put forward for the other big public sector T17 (shipbuilding, aeronautics and armament) where the nearly perfect competitive behaviour (the conduct parameter is the closest to -1) could reflect public procurement kind of contracts and fixed amount of output decided by the government in advance, which must be allotted to the existing players in the market.

Given that in Table 1 the estimated semi-elasticity was reported, Table 3 shows the value of the elasticity of demand, calculated at mean values, across industries. We notice that demand is elastic only in 6 industries, shows unit elasticity in 3 industries and is inelastic in the remainder 21 industries. Perhaps this is somehow justified by the broad definition of the sectors, which reduces the extent of substitutability of goods.

The sector with the most inelastic demand is shipbuilding, aeronautics and armament.

Table 3 - Elasticity of demand per industry, calculated at mean values

Industry	Elasticity	Industry	Elasticity	Industry	Elasticity
T02	-0.307	T12	-0.546	T21	-0.093
T03	-0.476	T13	-3.485	T22	-2.031
T04	-0.281	T14	-2.354	T23	-0.335
T05	-0.812	T15	-1.160	T24	-0.782
T06	-0.629	T15b	-1.089	T25-T28	-0.429
T07	-0.162	T16	-1.667	T29	-0.590
T08	-1.092	T17	-0.067	T31	-0.234
T09	-0.716	T18	-0.516	T32	-0.986
T10	-0.871	T19	-1.586	T34	-0.259
T11	-0.499	T20	-0.365	T37	-0.273

Only 10 sectors out of 30 do not reject the hypothesis of constant returns to scale at 5% significance level, proving that the working assumption of constant returns to scale so extensively used in the applied literature is ill founded. Interestingly, all the other sectors show increasing returns to scale to a different extent, with the exception of three service sectors which shows decreasing returns to scale: trade, motor car trade and repairs, and telecommunication and post.

3.2 – *Markups Estimates: A Comparison between the Solow Residual Approach and the NEIO Approach*

Given that in the Solow residual approach (SRA) the markups are estimated under the crucial assumption of constant returns to scale and constant markups over time, it is interesting to compare the results obtained for the markups using this NEIO structural approach, which relaxes the assumption of CRTS and allows the markups to vary over time.

Markups μ are obtained from the Lerner index L according to the following relationship:

$$\mu = \frac{1}{1 - L}$$

The ratio between the degree of returns to scale and markup (λ / μ) is also calculated for each industry. This ratio corresponds to the sum of the input factor shares out of total revenue as shown in section I. This allows us to use the actual data to test which approach provides the best estimate of λ / μ .

Table 4 shows the results for markups under the Solow residual approach (called *markups-Solow*) and under this NEIO structural approach (called *markups-NEIO*). Estimates of the degree of returns to scale are taken from Table 1 and the ratio λ / μ is calculated for both the NEIO approach (labelled λ / μ -NEIO) and the Solow approach (labelled $1 / \mu$ -*Solow* instead of λ / μ -*Solow* given the CRTS assumption). Comparison with the actual data is accomplished by reporting the sum of the three input factor shares out of total revenue, herein called *actual- λ / μ* . It is in fact interesting to check whether in those cases of estimated constant returns to scale under the NEIO, the ratio λ / μ estimated under the two approaches differ and to see which one approximates better reality.

In general we can see that the markups estimated are lower under the NEIO approach than the SRA.

In 26 out of 30 sectors the estimated RTS/markup ratio is closer to the actual one under the NEIO approach than the SRA, only in T15 (electric and electronic equipment), T19 (leather and footwear) and T20 (wood, furniture and miscellaneous industries) and T37 (financial institutions) it is the opposite (although in three out of these four cases the difference is as small as around 2%-4%). The evidence therefore indicates that by estimating simultaneously markups and returns to scale in a structural model we can approximate better the reality since the estimated RTS/markup ratio is systematically closer the actual one than under the case which assumes constant returns to scale.

Table 4 - Comparisons of markups and λ/μ

<i>NAP40 Code</i>	<i>Industry</i>	<i>Markups -Solow</i>	<i>Markups -NEIO</i>	<i>1 / μ Solow (1)</i>	<i>λ / μ NEIO (2)</i>	<i>Actual λ / μ (3)</i>	<i>(3)-(1)</i>	<i>(3)-(2)</i>
T02	Meat & milk	1.092*** (0.018)	1.096*** (0.018)	0.916	0.925	0.971	0.056	0.046
T03	Other food	1.322*** (0.038)	1.064*** (0.012)	0.756	0.972	0.874	0.118	-0.098
T04	Solid mineral fuels, and coke	0.817*** (0.002)	1.044*** (0.058)	1.224	1.341	1.520	0.296	0.179
T05	Oil and natural gas	1.554*** (0.172)	1.345*** (0.030)	0.643	0.818	0.740	0.097	-0.078
T06	Electricity, gas and water	1.624*** (0.101)	2.965*** (0.403)	0.616	0.691	0.963	0.347	0.272
T07	Ferrous ores & metals	1.200*** (0.044)	1.092*** (0.021)	0.833	0.950	1.048	0.215	0.098
T08	Non ferrous ores and metals	1.267*** (0.087)	1.094*** (0.028)	0.789	1.042	1.011	0.222	-0.031
T09	Sundry minerals, Building material	1.306*** (0.031)	1.107*** (0.030)	0.766	0.972	0.929	0.163	-0.043
T10	Glass	1.241*** (0.044)	1.105*** (0.040)	0.806	0.921	0.919	0.113	-0.002
T11	Chemical, synthetic fibres	1.283*** (0.058)	1.086*** (0.028)	0.780	0.954	0.957	0.178	0.003
T12	Parachemicals, pharmaceuticals	1.202*** (0.047)	1.111*** (0.049)	0.832	0.893	0.919	0.087	0.026
T13	Foundries and metalworking	1.190*** (0.014)	1.145*** (0.028)	0.840	0.936	0.935	0.095	-0.001
T14	Mechanical engineering	1.149*** (0.019)	1.081*** (0.030)	0.870	0.990	0.947	0.077	-0.043
T15	Electric and electronic equip.	1.180*** (0.037)	1.065*** (0.020)	0.847	1.083	0.9180	0.070	-0.165
T15b	Consumer durable goods	1.221*** (0.051)	1.116*** (0.023)	0.819	0.948	0.979	0.160	0.031
T16	Ground transport equipment	1.181*** (0.038)	1.039*** (0.015)	0.847	0.963	0.982	0.135	0.019
T17	Shipbuilding, aeronau., armam.	1.135*** (0.049)	1.037*** (0.037)	0.881	0.991	1.030	0.149	0.039
T18	Textiles and clothing	1.141*** (0.023)	1.074*** (0.050)	0.877	0.950	0.955	0.078	0.005
T19	Leather and footwear	1.118*** (0.023)	1.026*** (0.025)	0.894	0.988	0.931	0.036	-0.057
T20	Wood, furniture, miscellan. indus.	1.205*** (0.013)	1.128*** (0.034)	0.830	1.022	0.906	0.076	-0.116
T21	Paper and board	1.125*** (0.013)	1.043*** (0.035)	0.889	0.942	0.950	0.062	0.008
T22	Press and edition	1.195*** (0.019)	1.019*** (0.027)	0.837	0.987	0.929	0.092	-0.058
T23	Rubber and plastics	1.185*** (0.028)	1.059*** (0.023)	0.844	0.991	0.958	0.114	-0.033
T24	Building	1.235*** (0.020)	1.174*** (0.020)	0.809	0.979	0.915	0.106	-0.064

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). The standard errors are indicated in brackets.

Table 4 (cont.)- Comparisons of markups and λ/μ

<i>NAP40 Code</i>	<i>Industry</i>	<i>Markups -Solow</i>	<i>Markups -NEIO</i>	<i>1 / μ Solow (1)</i>	<i>λ / μ NEIO (2)</i>	<i>Actual λ / μ (3)</i>	<i>(3)-(1)</i>	<i>(3)-(2)</i>
T25-T28	Trade	1.644*** (0.065)	1.359*** (0.035)	0.608	0.704	0.722	0.114	0.018
T29	Motor car trade and repairs	1.450*** (0.055)	1.174*** (0.024)	0.690	0.788	0.776	0.086	-0.012
T31	Transports	1.256*** (0.028)	1.086*** (0.024)	0.796	0.937	1.064	0.268	0.127
T32	Telecommunicat. and post	1.674*** (0.046)	1.146*** (0.032)	0.597	0.761	0.873	0.276	0.112
T34	Market services to households	1.947*** (0.060)	1.570*** (0.071)	0.514	0.689	0.630	0.116	-0.059
T37	Financial institutions	1.084*** (0.062)	1.069*** (0.018)	0.922	0.940	0.787	-0.135	-0.153

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). The standard errors are indicated in brackets.

Moreover, the superiority of the NEIO model in getting more reliable estimates is shown by the fact that even in those cases where constant returns to scale are found (i.e. λ is not statistically different from 1) the estimates of the markups are in general *different* between the two approaches (with the only exception of meat and milk) and – as shown by the last two columns in Table 4 - the gap between actual RTS/markup ratio and the estimated one is substantially reduced under the NEIO approach, which thus proves to approximate systematically better the true data.

Section IV: Market Power vs. Efficiency Effects

Table 5 presents the results based on equation (19) for the separate effects of changes in the Herfindahl index on market power, cost efficiency, and output price. These effects were calculated and tested at mean values of the data.

Standard errors for the constructed coefficients *MKPEF*, *COSTEF* and *OUTPEF* were calculated using the Delta Method (see Appendix 2 for the derivation of the calculations).

The output price effect is positive in 18 sectors out of 30, showing that the market power effect predominates over the cost efficiency effect in the majority of the sectors. If we consider the statistical significance of the output effects, we see that only 10 sectors out of 18 for which *OUTPEF* is positive show a 5% statistical significance (two other cases are significant at the 10% level) whereas only 6 out of 12 sectors for which *OUTPEF* is negative the statistical significance of 5% is reached (also here a seventh case is significant at the 10% level). Before this evidence, there is no doubt about the predominance of the cases in which prices are increased by a rise in the Herfindahl index compared to the cases in which prices are reduced.

If we consider however the two components of *OUTPEF*, namely the markup power effect and the cost efficiency effect, we notice that 10 out of 12 sectors for which *OUTPEF* resulted negative show a *COSTEF* significant at 1% significance level, lending support to the conclusion that in a third of sectors considered in this study the increase in concentration leads to cost efficiency effects that are bigger

Table 5 - Impacts of industrial concentration on market power, cost efficiency and output price

NAP40 code	Industry	Impact of H on:		
		Market power MKPEF	Cost efficiency COSTEF	Output price OUTPEF
T02	Meat & milk	9.399*** (2.121)	-2.674 (2.071)	6.725*** (1.469)
T03	Other food	0.829*** (0.144)	-0.889*** (0.204)	-0.059 (0.154)
T04	Solid mineral fuels, and coke	0.160 (0.204)	-2.833*** (0.380)	-2.673*** (0.333)
T05	Oil and natural gas	1.497*** (0.097)	-0.874*** (0.137)	0.623*** (0.094)
T06	Electricity, gas and water	0.849*** (0.059)	-0.916*** (0.082)	-0.067 (0.061)
T07	Ferrous ores and metals	0.514*** (0.108)	-0.420*** (0.110)	0.094 (0.086)
T08	Non ferrous ores and metals	0.961*** (0.262)	-2.839*** (0.402)	-1.879*** (0.266)
T09	Sundry minerals, building material	4.942*** (1.275)	-7.052*** (2.371)	-2.110 (1.690)
T10	Glass	1.606*** (0.550)	-0.564 (1.113)	1.042* (0.573)
T11	Chemical, synthetic fibres	2.958*** (0.894)	-2.508*** (0.702)	0.450 (0.687)
T12	Parachemicals, pharmaceuticals	8.220** (3.252)	1.170 (0.685)	9.390*** (2.203)
T13	Foundries and metalworking	21.203*** (3.529)	-21.096*** (5.189)	0.107 (2.943)
T14	Mechanical engineering	6.156*** (2.119)	-10.645*** (2.561)	-4.489** (2.038)
T15	Electric and electronic equipment	1.025*** (0.287)	-4.867*** (0.543)	-3.842*** (0.348)
T15b	Consumer durable goods	1.001*** (0.175)	-0.989*** (0.310)	0.013 (0.177)
T16	Ground transport equipment	0.445*** (0.163)	-0.011 (0.216)	0.434** (0.170)
T17	Shipbuilding, aeronautics, armament	0.297 (0.285)	-0.447 (0.444)	-0.150 (0.417)
T18	Textiles and clothing	22.448 (14.300)	-12.540 (28.522)	9.908 (14.405)
T19	Leather and footwear	1.681 (1.587)	-1.782 (2.527)	-0.102 (1.581)
T20	Wood, furniture, and miscellan. industries	16.084*** (3.743)	-38.634*** (3.982)	-22.550*** (1.690)
T21	Paper and board	4.359 (3.396)	3.585 (6.199)	7.944* (4.673)
T22	Press and edition	5.037 (6.950)	-3.186 (7.360)	1.851 (8.222)

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). The standard errors (s.e.) are indicated in brackets and are calculated using the Delta Method as shown in Appendix 2. These results are based on equation (19).

Table 5 (cont.) - Impacts of industrial concentration on market power, cost efficiency and output price

NAP40 code	Industry	Impact of H on:		
		Market power MKPEF	Cost efficiency COSTEF	Output price OUTPEF
T23	Rubber and plastics	0.892*** (0.331)	-1.527*** (0.484)	-0.634* (0.380)
T24	Building	80.658*** (7.876)	-139.220*** (11.786)	-58.565*** (6.124)
T25-T28	Trade	41.007*** (2.915)	10.082*** (1.394)	51.089*** (2.648)
T29	Motor car trade and repairs	26.187*** (3.121)	21.893*** (4.736)	48.080*** (4.170)
T31	Transports	0.404*** (0.102)	-0.170 (0.128)	0.234** (0.099)
T32	Telecommunications and post	0.179** (0.034)	0.319*** (0.053)	0.498*** (0.050)
T34	Market services to households	9.511*** (0.753)	-2.550*** (0.371)	6.961*** (0.486)
T37	Financial institutions	0.185*** (0.046)	-0.026** (0.013)	0.159*** (0.047)

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). The standard errors (s.e.) are indicated in brackets and are calculated using the Delta Method as shown in Appendix 2. These results are based on equation (19).

than the markup power effects. In other words the increasing (decreasing) concentration causes statistically significant increases (decreases) in social welfare in 10 out of 30 sectors.

We also notice from Table 5 that in three sectors, namely trade, motor car trade and repairs and telecommunications and post, the cost efficiency effects are positive, in other words there are cost inefficiency in these industries that reinforce, instead of counteracting, the impact of market power effects on output price. These two sectors are, not surprisingly, the only three sectors for which decreasing returns to scale were found.

All in all, although in the majority of the industries analysed there is a positive relationship between the change in concentration and the change in price, this is not as pervasive as common wisdom might suggest. In fact, one third of the industries exhibit a negative relationship between change in concentration and change in price, supporting the idea that in a number of industries, following output redistribution from smaller towards bigger firms, cost efficiency effects predominate over oligopoly power effects and cause a reduction in the product price.

Table 6 gives the full account of the other parameters estimated.

When the coefficients gamma take on positive values technical change is said to be factor-using whereas a negative sign means factor-saving technical change.

Strikingly, for all sectors except the utilities (T06), technical change is labour saving. Technical change is instead capital saving in 12 out of 30 sectors (although in one it is not statistical significant) and is intermediate inputs saving in 7 out of 30 sectors

Table 6 - Other Parameters Estimates per Industry

<i>Other Parameters Estimates</i>	T02 Meat & milk	T03 Other food	T04 Solid min. fuels, coke	T05 Oil and natural gas	T06 Electr. Gas, water	T07 Ferrous ores and metals	T08 Non ferrous ores and metals	T09 Sundry miner. & build. mat.	T10 Glass	T11 Chemical, synthet. fibres
γ_1	-0.00002***	-0.00008***	-0.00026***	-0.00001***	0.00001*	-0.00009***	-0.00005***	-0.00018***	-0.00018***	-0.00009***
γ_2	0.00313***	0.00210	-0.03097***	-0.00369***	0.05309***	-0.01600***	0.01791***	-0.00372*	omitted	-0.00503***
γ_3	-0.00291***	0.00496***	0.00133	0.00119***	-0.01267***	-0.00353***	omitted	0.00304***	omitted	-0.00164***
β_1	0.00164	-0.00077	-0.12959***	0.00064***	-0.00053***	-0.00160*	-0.00934***	-0.03335	0.21971***	-0.01141***
β_2	3.19259***	-0.04158	-69.45058***	0.15516**	-0.43948	1.29414***	-3.49005***	-17.02613***	37.73646***	-0.07405
β_3	-1.53903*	-0.20120***	9.29162***	-0.41763***	-0.31329***	-0.39333***	-1.74411***	-1.99162	-20.65453***	-0.36823
α_{11}	0.00152***	0.00560***	0.00908***	0.00068***	0.00302***	0.00423***	0.00303***	0.00812***	0.00590***	0.00303***
α_{22}	0.19850***	0.61621***	3.26441***	0.69544***	1.41680***	0.74135***	1.17942***	0.88267***	0.34864***	0.72947***
α_{33}	0.80824***	0.68458***	0.29498***	0.89670***	0.40210***	0.65034***	0.74175***	0.55700***	0.64305***	0.71743***
α_{12}	-0.00790***	-0.01207***	-0.00005	0.00331***	-0.04208***	-0.02813***	-0.01720***	-0.00696**	omitted	-0.00152
α_{13}	0.00694***	-0.00954***	0.01972***	0.00373***	0.00875***	0.00731***	0.00323**	-0.00765***	omitted	0.00220
α_{23}	0.05276***	0.04825	-0.03304	-0.10803***	0.98392***	0.34523***	0.02622	0.10255***	omitted	-0.03182
δ_0	0.77269***	0.34994*	1.16242***	0.93561***	0.58096***	-1.46432***	omitted	-1.20067***	-0.88104***	-1.75632***
δ_1 (income)	0.00615***	0.02353***	-0.11188***	omitted	-0.00499	0.02018***	-0.00433***	0.01840***	omitted	0.05762***
δ_2 (int. rate)	0.67951***	1.20495***	-1.39612**	omitted	3.46896***	-1.95312***	3.17806***	1.74638***	1.70006***	-1.03980***
δ_3 (imp. P)	-0.20288**	0.07472	omitted	0.68738***	0.10405***	0.95443***	0.57710***	0.85077***	-0.13827	0.90266***
δ_4 (trend)	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). These results are based on the joint estimation of equations (16), (17) and (18) using nonlinear 3 stages least squares. For sector T05 an exception was made and instead of income the price of oil was used in the demand equation, deeming that oil is the major input cost for the industry and given the insignificance of income.

Table 6 (cont.) - Other Parameters Estimates per Industry (cont.)

<i>Other Parameters Estimates</i>	T12 Parachem., pharmaceut.	T13 Foundries, metalwork.	T14 Mechanical engineering	T15 Electric and electro. equip.	T15b Consumer durable goods	T16 Ground transp. equip.	T17 Shipbuilding, aerona., armam.	T18 Textiles and clothing	T19 Leather and footwear	T20 Wood, furnit., miscel. Indus.
γ_1	-0.00013***	-0.00016***	-0.00016***	-0.00025***	omitted	omitted	-0.00017***	-0.00030***	-0.00019***	-0.00019***
γ_2	-0.00503***	0.01626***	0.00882***	0.00524***	-0.01531***	omitted	0.01265***	omitted	0.01228***	0.01383***
γ_3	0.00102	omitted	0.00217***	0.00340***	-0.01117***	omitted	0.00449***	0.00304***	0.00521***	0.00886***
β_1	0.02680***	-0.00690	-0.03158***	-0.01037***	-0.10327***	-0.01437***	-0.00436***	-0.06342	-0.17594	-0.04444
β_2	6.68597***	-24.29038***	-1.80810***	-1.82011***	2.63389***	1.56446***	0.30482	-41.97560	-14.85723	-38.60340***
β_3	-2.46607*	-4.70255***	-1.33599***	-0.54021***	2.97105***	0.61981***	0.00768	2.51265	3.86645	-17.57231***
α_{11}	0.00371***	0.00958***	0.00876***	0.01123***	0.00619***	0.00680***	0.00717***	0.00946***	0.01242***	0.00900***
α_{22}	0.35447***	0.46151***	0.33019***	0.90722***	0.38157***	0.18713***	0.39786***	0.54946***	0.56907***	0.60494***
α_{33}	0.59840***	0.48096***	0.56346***	0.61062***	0.59539***	0.55695***	0.44991***	0.57827***	0.48789***	0.70750***
α_{12}	-0.00285***	-0.03751***	-0.01973***	-0.02682***	omitted	-0.01530***	-0.03853***	0.00085	-0.01592***	0.00079
α_{13}	0.00373	-0.00023	-0.00483*	-0.01285***	omitted	omitted	0.00576	omitted	-0.00659***	-0.01510***
α_{23}	0.01349	0.31319***	0.15099***	0.08275***	0.04298***	0.14788***	0.30652***	omitted	0.06499***	-0.03286
δ_0	-0.14716	2.44629***	2.26498***	1.04624***	-0.87514***	0.34946***	0.14212	-0.31207***	-1.37994***	-0.97444***
δ_1 (income)	0.01596***	0.01121**	0.01770***	0.02289***	0.01764***	0.02883***	-0.02359***	0.03088***	-0.01087**	omitted
δ_2 (int. rate)	omitted	2.63070***	omitted	2.54172***	omitted	3.42647***	omitted	omitted	1.40801***	0.032789*
δ_3 (imp. P)	-0.06496	0.89373***	0.10963	-0.18478***	0.14451	0.79643 ***	omitted	0.43830***	1.45981***	1.09173***
δ_4 (trend)	0.02769***	omitted	-0.00981**	omitted	omitted	omitted	0.02821***	omitted	omitted	0.02075***
δ_5 (im. pen.)								-1.05747***		

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). These results are based on the joint estimation of equations (16), (17) and (18) using nonlinear 3 stages least squares.

Table 7 (cont.)- Other Parameters Estimates per Industry (cont.)

<i>Other Parameters Estimates</i>	T21 Paper and board	T22 Press and edition	T23 Rubber and plastics	T24 Building	T25-T28 Trade	T29 Motor car trade & repa.	T31 Transports	T32 Telecommu. and post	T34 Market services to households	T37 Financial institutions
γ_1	-0.00011***	-0.00013***	-0.00018***	-0.00019***	-0.00014***	-0.00013***	-0.00012***	-0.00043***	-0.00004***	-0.00024***
γ_2	0.00953***	0.00846***	-0.00133	-0.00565***	0.01208***	0.00578***	-0.02759***	-0.08236***	0.02133***	-0.02910***
γ_3	0.00383***	0.00633***	0.00681***	0.00272***	omitted	0.00558***	-0.00013	-0.00598***	omitted	0.04246***
β_1	-0.16564***	-0.04008	-0.0116***	-0.22525***	-0.02886***	0.16293***	-0.00023	0.00144***	-0.01255***	0.00004***
β_2	21.77973	-27.58359**	-1.57371***	-0.61507	-7.27171***	6.87542***	-0.16381*	0.44829***	-1.47560***	-0.00155*
β_3	12.02271**	4.18770	-0.31068	-5.15811***	3.75988***	6.47269***	-0.00463	0.02376**	0.17448***	-0.00643***
α_{11}	0.00511***	0.00718***	0.00810***	0.01046***	0.01087***	0.00853***	0.00641***	0.00921***	0.00735***	0.00579***
α_{22}	0.57585***	0.47451***	0.59399***	0.38072***	0.60656***	0.45158***	2.51990***	3.22428***	0.63163***	0.98020***
α_{33}	0.56592***	0.57759***	0.59061***	0.60409***	0.08054***	0.29604***	0.20250***	omitted	0.28842***	0.30636***
α_{12}	-0.01183**	-0.00164*	-0.00238	0.00296**	-0.00892	0.00904***	-0.02683***	-0.03117***	0.00646**	0.03419***
α_{13}	0.00623**	-0.00661**	-0.00347	-0.00952***	omitted	omitted	0.01792***	0.02505***	omitted	-0.01194***
α_{23}	-0.01475	omitted	0.00097	omitted	0.11444**	-0.05052***	0.16945***	0.00273	-0.07832**	-0.39225***
δ_0	-1.85355***	omitted	-2.22290***	2.09259***	0.87954***	omitted	0.12874	1.36517**	omitted	omitted
δ_1 (income)	0.04929***	0.05382***	0.06888***	omitted	0.03390***	omitted	0.02651***	-0.03483***	0.02677***	omitted
δ_2 (int. rate)	-0.88040***	1.50717***	-0.32827*	2.23938***	0.38605***	-1.10442**	-0.11076	omitted	omitted	-9.58185***
δ_3 (imp. P)	omitted	0.16686	0.30623**	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
δ_4 (trend)	omitted	omitted	omitted	omitted	0.00437***	0.02488***	0.01220***	0.05277***	0.02456***	0.14820***

Levels of statistical significance are represented by * (10%), ** (5%) and *** (1%). These results are based on the joint estimation of equations (16), (17) and (18) using nonlinear 3 stages least squares.

(although in one it is not significant)¹⁷.

Section V: Conclusions

In this paper we have presented a comparison between two methodologies used in the literature to calculate markups at industry level. The first methodology was established in the 1980s thanks to Roeger's (1995) adaptation of the Solow residual approach, and it has been extensively used in the empirical literature until recently, although it assumes constant returns to scale, constant markup over time and does not tackle the problem of output and price endogeneity in a convincing and formal manner. The second methodology is based on a recent New Empirical Industrial Organisation model by Lopez, *et al.* (2002), in which I also introduce a foreign dimension to competition by including the price of imports. This structural approach relaxes the stringent assumptions of the Solow residual approach (SRA) and tackles directly and formally the endogeneity problem by estimating a complete system of output demand, output supply and input demands for each industry.

The comparison between the two approaches shows that the markups estimated with this NEIO model are generally lower than the ones obtained using the SRA, the reduction being quite substantial in many cases. However the comparison between the actual returns-to-scale-markup ratios and the estimated ones show that the NEIO approach systematically provides estimates of the RTS/markup ratios that are closer to actual ratios, even when constant returns to scale are found. This casts some doubt about the markups results previously published and based on the SRA.

Moreover, given that only 10 sectors out of 30 do not reject the hypothesis of constant returns to scale at 5% significance level, there is evidence that the working assumption of constant returns to scale so extensively used in the applied literature is ill founded. Interestingly, all the other sectors show increasing returns to scale to a different extent, with the exception of three service sectors which show decreasing returns to scale: trade, motor car trade and repairs, and telecommunication and post.

Since two thirds of the industries analysed show non-constant returns to scale, it appears clear that it is worth adopting a methodology that estimates simultaneously markups and returns to scale when addressing the issue of markup estimation.

A second objective of the paper was to discriminate between market power effects and cost efficiency effects following a change in industry concentration, and evaluate the overall combining effect on output price.

The output price effect was found positive in 18 sectors out of 30, showing that the market power effect predominates over the cost efficiency effect in the majority of the sectors. Although in the majority of the industries analysed there is a positive relationship between the change in concentration and the change in price, this is not pervasive. In fact, one third of the industries exhibit a negative relationship between the change in concentration and the change in price, supporting the idea that in a number of industries, following output redistribution from smaller towards bigger firms, cost efficiency effects predominate over oligopoly power effects and cause a reduction in the product price. The fact that an increase in industry concentration is welfare-enhancing in so many sectors of the economy is one finding that might be of interest to policy makers.

¹⁷ In a few sectors the technical progress for some input factors was insignificant and set to zero to improve the estimates. The same was done for some alpha parameters.

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Appendix 1: Derivation of the Model

DERIVATION OF EQUATION (13)

Profit for the j th firm is defined as $\pi_j = p \cdot q_j - C_j(q_j, \mathbf{w}, t)$.

Profit maximisation implies the following first order condition (FOC):

$$\frac{\partial \pi_j}{\partial q_j} = p + \frac{dp}{dQ} \cdot \frac{dQ}{dq_j} \cdot q_j - \frac{\partial C_j(q_j, \mathbf{w}, t)}{\partial q_j} = 0$$

which rephrased is:

$$p = -\frac{dp}{dQ} \cdot Q \cdot \frac{1}{Q} \cdot \frac{dQ}{dq_j} \cdot q_j + \frac{\partial C_j(q_j, \mathbf{w}, t)}{\partial q_j}$$

Now, defining the reaction of total output produced in the industry to a change in the j th firm's output as

$$\frac{dQ}{dq_j} = \frac{d \sum_i q_i}{dq_j} = \frac{dq_j + d \sum_{i \neq j} q_i}{dq_j} = 1 + \phi_j$$

where i indexes all the other firms in the industry different from j , the FOC can be simplified to

$$p = -\frac{s_j}{\eta} (1 + \phi_j) + \frac{\partial C_j(q_j, \mathbf{w}, t)}{\partial q_j}$$

where the firm's market share s_j and the semi-elasticity of demand η were defined in the main text.

DERIVATION OF EQUATION (16)

Multiplying through equation (13) by s_j and using the GL cost function in (15) yields

$$p \cdot s_j = -\frac{s_j^2}{\eta} (1 + \phi_j) + s_j \sum_r \sum_s \alpha_{rs} w_r^{1/2} w_s^{1/2} + s_j t \sum_r \gamma_r w_r + 2s_j q_j \sum_r \beta_r w_r$$

Summing across the N firms in the industry and multiplying and dividing by Q the last term on the right hand side yields

$$p \sum_j^N s_j = -\sum_j^N \frac{s_j^2}{\eta} (1 + \phi_j) + \sum_j^N s_j \sum_r \sum_s \alpha_{rs} w_r^{1/2} w_s^{1/2} + \sum_j^N s_j t \sum_r \gamma_r w_r + 2 \sum_j^N s_j \frac{q_j}{Q} Q \sum_r \beta_r w_r$$

By substituting in the above expression the following identity

$$\sum_j^N s_j^2 \phi_j = \sum_j^N \left(\frac{q_j}{Q} \right)^2 \phi_j = \frac{\sum_j^N q_j^2 \phi_j}{\left(\sum_j^N q_j \right)^2} = \frac{\sum_j^N q_j^2}{\left(\sum_j^N q_j \right)^2} \frac{\sum_j^N q_j^2 \phi_j}{\sum_j^N q_j^2} = H\Phi$$

where recall that the Herfindahl index is defined as $H = \sum_j^N s_j^2$ and the firm-weighted

conjectural variation for the whole industry is defined as $\Phi = \frac{\sum_j^N q_j^2 \phi_j}{\sum_j^N q_j^2}$, and given that

$\sum_j^N s_j = 1$, we obtain equation (16)

$$p = -\frac{H(1+\Phi)}{\eta} + \sum_r \sum_s \alpha_{rs} w_r^{1/2} w_s^{1/2} + t \sum_r \gamma_r w_r + 2HQ \sum_r \beta_r w_r$$

Appendix 2: The Delta Method

The Delta Method¹⁸ is an intuitive technique for approximating the moments of functions of random variables. It is therefore used in econometrics to estimate the standard error of a transformed parameter. Put simply, after the estimation of a set of parameters, if there is the need to calculate a new parameter, which is a function of the estimated parameters, the Delta Method provides a way to calculate the standard error of such a new transformed parameter.

The Delta Method, in its essence, expands a function of a random variable about its mean, usually with a 1-step Taylor approximation, and then takes the variance. For example, if we want to approximate the variance of $G(X)$ where X is a random variable with mean μ and $G(\cdot)$ is differentiable, we can calculate

$$G(X) \cong G(\mu) + (X - \mu)G'(\mu)$$

so that

$$\text{Var}(G(X)) \cong \text{Var}(X) * [G'(\mu)]^2$$

where $G'(\cdot) = dG / dX$. This is only a good approximation if X has a high probability of being close enough to its mean (μ) so that the Taylor approximation is still good. This idea can easily be expanded to vector-valued functions of random vectors:

$$\text{Var}(\mathbf{G}(\mathbf{X})) \cong G'(\boldsymbol{\mu}) \text{Var}(\mathbf{X}) [G'(\boldsymbol{\mu})]^T \quad (22)$$

and that in fact is the basis for deriving the asymptotic variance of maximum-likelihood estimators. In the above, \mathbf{X} is a $1 \times m$ column vector; $\text{Var}(\mathbf{X})$ is its $m \times m$ variance–covariance matrix; $\mathbf{G}(\cdot)$ is a vector function returning a $1 \times n$ column vector; and $\mathbf{G}'(\cdot)$ is its $n \times m$ matrix of first derivatives. T is the transpose operator. $\text{Var}(\mathbf{G}(\mathbf{X}))$ is the resulting $n \times n$ variance–covariance matrix of $\mathbf{G}(\mathbf{X})$.

From equation (16) we need to estimate the Lerner index in order to evaluate the degree of market power. The new parameter L to construct is, as we have seen,

$$L = - \frac{(1 + \hat{\Phi})\bar{H}}{\hat{\eta}\bar{P}}$$

where \bar{H} and \bar{P} are the non-stochastic regressors valued at mean and $\hat{\Phi}$ and $\hat{\eta}$ are estimated parameters (random variables). L is therefore a function of $\hat{\Phi}$ and $\hat{\eta}$: $L = G(\hat{\Phi}, \hat{\eta})$. Calculating the first derivatives

$$G'_{\hat{\Phi}} = - \frac{\bar{H}}{\hat{\eta}\bar{P}} ; \quad G'_{\hat{\eta}} = \frac{(1 + \hat{\Phi})\bar{H}}{\hat{\eta}^2 \bar{P}}$$


and using (22), gives

¹⁸ See Oehlert (1992) and Rice (1995).

$$Var(L) = \begin{bmatrix} -\frac{\bar{H}}{\hat{\eta}P} & \frac{(1+\hat{\Phi})\bar{H}}{\hat{\eta}^2\bar{P}} \\ \frac{Cov(\hat{\eta}, \hat{\Phi})}{\hat{\eta}P} & \frac{Cov(\hat{\Phi}, \hat{\eta})}{\hat{\eta}^2\bar{P}} \end{bmatrix} \begin{bmatrix} Var(\hat{\Phi}) & Cov(\hat{\Phi}, \hat{\eta}) \\ Cov(\hat{\eta}, \hat{\Phi}) & Var(\hat{\eta}) \end{bmatrix} \begin{bmatrix} -\frac{\bar{H}}{\hat{\eta}P} \\ \frac{(1+\hat{\Phi})\bar{H}}{\hat{\eta}^2\bar{P}} \end{bmatrix} \quad (23)$$

Similarly, but slightly more complicated, we can obtain the variance for the RTS parameter, at mean values, from equation (21).

$$RTS = \frac{\hat{A} + \bar{H}\bar{Q}\hat{B}}{\hat{A} + 2\bar{H}\bar{Q}\hat{B}}$$

where $\hat{A} = \sum_r \sum_s \hat{\alpha}_{rs} \bar{w}_r^{1/2} \bar{w}_s^{1/2} + \bar{t} \sum_r \hat{\gamma}_r \bar{w}_r$ and $\hat{B} = \sum_r \hat{\beta}_r \bar{w}_r$, with $r, s = 1, \dots$, 

The first derivatives are:

$$RTS'_{\hat{\alpha}_{rs}} = \frac{\bar{H}\bar{Q}\hat{B}(\bar{w}_r \bar{w}_s)^{1/2}}{(\hat{A} + 2\bar{H}\bar{Q}\hat{B})^2} \quad (24)$$

$$RTS'_{\hat{\gamma}_r} = \frac{\bar{H}\bar{Q}\hat{B}\bar{w}_r \bar{t}}{(\hat{A} + 2\bar{H}\bar{Q}\hat{B})^2} \quad (25)$$

$$RTS'_{\hat{\beta}_r} = \frac{-\hat{A}\bar{H}\bar{Q}\bar{w}_r}{(\hat{A} + 2\bar{H}\bar{Q}\hat{B})^2} \quad (26)$$

with $r, s = 1, \dots, k$ and $\hat{\alpha}_{rs} = \hat{\alpha}_{sr}$. Defining $\mathbf{rts}'_{\hat{\alpha}}$ as the row vector of dimension $k(k+1)/2$ containing the elements defined by equation (24); $\mathbf{rts}'_{\hat{\gamma}}$ and $\mathbf{rts}'_{\hat{\beta}}$ as the row vectors of dimension k containing the elements given by equations (25) and (26) respectively, and using (22) again, we get

$$Var(RTS) = \left[\mathbf{rts}'_{\hat{\alpha}} \quad \mathbf{rts}'_{\hat{\gamma}} \quad \mathbf{rts}'_{\hat{\beta}} \right] \Sigma_{\hat{\alpha}\hat{\gamma}\hat{\beta}} \left[\mathbf{rts}'_{\hat{\alpha}} \quad \mathbf{rts}'_{\hat{\gamma}} \quad \mathbf{rts}'_{\hat{\beta}} \right]^T$$

where $\Sigma_{\hat{\alpha}\hat{\gamma}\hat{\beta}}$ is a $\left(\frac{k(k+1)}{2} + 2k \right) \times \left(\frac{k(k+1)}{2} + 2k \right)$ matrix whose main diagonal elements are the variances of the parameters α_{rs} , γ_r and β_r , and the off-diagonal elements are the covariances between the same parameters¹⁹.

¹⁹ In this paper since $k=3$ (three input factors), the matrix has dimension 12 x 12.

The other three constructed parameters to which the Delta Method was applied are the market power effect (MKPEF), the cost efficiency effect (COSTEF) and the output price effect (OUTPEF) of a change in H, as defined by equation (19):

$$MKPEF = -\frac{(1+\hat{\Phi})}{\hat{\eta}} \quad (27)$$

$$COSTEF = 2\bar{Q} \sum_r \hat{\beta}_r \bar{w}_w \quad (28)$$

$$OUTPEF = MKPEF + COSTEF = -\frac{(1+\hat{\Phi})}{\hat{\eta}} + 2\bar{Q} \sum_r \hat{\beta}_r \bar{w}_w$$

By deriving (27) with respect to $\hat{\Phi}$ and $\hat{\eta}$ we get

$$MKPEF'_{\hat{\Phi}} = -\frac{1}{\hat{\eta}}, \quad MKPEF'_{\hat{\eta}} = \frac{(1+\hat{\Phi})}{\hat{\eta}^2}$$

using (22) we obtain the variance for the markup power effect:

$$Var(MKPEF) = \begin{bmatrix} -\frac{1}{\hat{\eta}} & \frac{(1+\hat{\Phi})}{\hat{\eta}^2} \end{bmatrix} \begin{bmatrix} Var(\hat{\Phi}) & Cov(\hat{\Phi}, \hat{\eta}) \\ Cov(\hat{\eta}, \hat{\Phi}) & Var(\hat{\eta}) \end{bmatrix} \begin{bmatrix} -\frac{1}{\hat{\eta}} \\ \frac{(1+\hat{\Phi})}{\hat{\eta}^2} \end{bmatrix}$$

The first derivatives of (28) with respect to β_r are:

$$COSTEF'_{\hat{\beta}_r} = 2\bar{Q}\bar{w}_r, \text{ for } r=1, \dots, k \quad (29)$$

Defining $\mathbf{costef}'_{\hat{\beta}}$ as the row vector of dimension k whose elements are given by (29), and $\Sigma_{\hat{\beta}}$ as the $k \times k$ matrix of the variances-covariances of parameters β_r , and again using (22), we calculate the variance for the cost efficiency effect of a change in H:

$$Var(COSTEF) = \mathbf{costef}'_{\hat{\beta}} \Sigma_{\hat{\beta}} \mathbf{costef}'_{\hat{\beta}}{}^T$$

And finally, defining $\Sigma_{\hat{\Phi}\hat{\eta}\hat{\beta}}$ as the $(k+2) \times (k+2)$ matrix of variances-covariances of the parameters $\hat{\Phi}$, $\hat{\eta}$ and $\hat{\beta}_r$ (for $r=1, \dots, k$), the variance of the output price effect is

$$Var(OUTPEF) = \begin{bmatrix} -\frac{1}{\hat{\eta}} & \frac{(1+\hat{\Phi})}{\hat{\eta}^2} & \mathbf{costef}'_{\hat{\beta}} \end{bmatrix} \Sigma_{\hat{\Phi}\hat{\eta}\hat{\beta}} \begin{bmatrix} -\frac{1}{\hat{\eta}} & \frac{(1+\hat{\Phi})}{\hat{\eta}^2} & \mathbf{costef}'_{\hat{\beta}} \end{bmatrix}^T$$

Appendix 3: Data Description

The markup estimation takes into account labour, capital and intermediate inputs as production factors. The series for gross output, employment, wage compensation, intermediate inputs, gross and net capital stock by industry were provided by INSEE, Paris. Many of these data are also available from Lienhardt (1999).

The period of availability of these data according to the NAP40 industrial classification is 1977-1997. The *Nomenclature d'activité et de produit* (NAP classification) was replaced by the *Nomenclature des activités françaises* (NAF classification) in 1993 and thus data according to the NAP are available only until 1997.

For the services sectors it was impossible to consider the external dimension of competition since data on imports are available starting only from the year 1985.

Three service sectors had to be excluded from this study for lack or inaccuracy of data: T35 (insurance) lacks data on labour remuneration, whilst for T36 (lettings) Herfindahl indexes are not available before 1984 (except only for 1979), and the Herfindahl indexes for T30 (hotels, cafés and restaurants) shows a big structural break in the data from 1983, due to different survey methods, and the number of firms increases dramatically.

Following Martins *et al.* (1996), a simplified **rental price of capital** ($W_{K_{i,t}}$) inspired by the methodology of Hall and Jorgenson (1967) was defined as follows:

$$W_{K_{i,t}} = ((i_t - \pi_t^e) + \delta_{i,t}) p_{i,t}^I \quad (10)$$

where i is the nominal market interest rate, π^e is the expected inflation rate, δ is the economic rate of capital depreciation and p^I is the investment deflator for the industry. The **expected inflation rate** is generated using the low-frequency component of the annual percentage change in the GDP deflator using the Hodrick-Prescott filter. The difference between these two terms, which is the **real interest rate** r , represents the expected real cost of funds for the firm. The nominal market interest rate used was taken from the OECD (2000), series France 14 IRL (interest rate, long term).

δ corresponds to the **economic rate of depreciation**. This in the literature is generally assumed constant²⁰, in here I allowed a small variation through time, since I calculated, for each industry, the rate of depreciation directly from actual data on net capital stock and investment, according to the formula

$$\delta_{i,t} = [1 - (K_{i,t} - I_{i,t}) / K_{i,t-1}] \times 100 \quad (11)$$

where K is net capital stock and I is gross fixed investment, both at constant 1980 prices.

To measure the total labour input, **labour compensation** was used, which includes wages and salaries for employees plus non-wage labour costs such as employers' contributions to national insurance and pensions. Data on labour compensation in the

²⁰ See e.g. Martins, *et al.* (1996), Hall and Jorgenson (1967).

NAP40 classification were only available until 1992, thereafter these series were constructed according to a more detailed classification available from OECD(2000) but incomplete for some sectors. Given that the reconstruction of precise data in the NAP40 classification would have been too insidious and by no means complete, I decomposed labour compensation in total number of hours worked (for which data were available) and average compensation per hour. I then assumed that the annual growth rate of the average compensation per hour for the years 1993-97 was equal to the mean of the annual growth rate of the average compensation per hour over the 5-year period 1988-1992.

The **price of imports** was calculated from the annual change in imports prices with respect to the previous year reported in Lienhardt (1999) by transforming it in a 1980 base series. This was then deflated by the deflator of imports of goods and services with base 1980=100 (source OECD (2000), code FRA1205S2).

The real average compensation per hour, the price of intermediate inputs, the user cost of capital, the price of output (or producer price index) and the price of imports were deflated by the CPI.

The **Herfindahl-Hirschman Indexes** were provided by INSEE with the NAP600 classification for the period 1977-1992 and NAF700 for the period 1993-1998²¹.

For year 1977 the indexes were forecasted using autoregressive models²².

Given that it was not possible to convert the data from one classification to the other, in order to obtain a consistent time series for the whole period under consideration I recalculated the indexes according to the 3-digit NAP100 classification. I then aggregate them further to obtain *weighted* Herfindahl indexes according to the NAP40 classification, where the weights are given by the relative market share of each sub-industry. Since the data on labour, intermediate inputs, capital and output are available only at the NAP40 level for the time span employed, the use of weighted Herfindahl indexes reflecting the NAP100 classification at least in part mitigates the aggregation bias when calculating market concentration.

²¹ Whilst NAP600 is a 4-digit classification, NAF700 adds extra detail to the 4th digit level by the use of alphabetic codes.

²² Details the AR models estimated are available upon request.

Table 7 - Breakdown of NAP40 industries in NAP100 sub-industries

T01	Agricultural, forestry, fishery		
T02	Industries of meat and milk		
	<i>S35 - Meat industry</i>		
	<i>S36 - Dairy products</i>		
T03	Other food industries		
	<i>S37 - Fish, potatoes, fruits and pulses</i>		
	<i>S38 - Bread and pastries</i>		
	<i>S39 - Cereals, food for animals, biscuits, industrial pasta, and malt.</i>		
	<i>S40 - Oils, fats and margarine, sugar, chocolate, jams, tea, coffee, seasonings, sauces, infant and diet foods.</i>		
	<i>S41 - Bottled water, soft drinks, alcoholic drinks (wine excluded).</i>		
	<i>S42 - Tobacco.</i>		
T04	Solid mineral fuels, coke – S04		
T05	Oil and natural gas – S05		
T06	Electricity, gas and water		
	<i>S06 – Electricity</i>		
	<i>S07 - Gas</i>		
	<i>S08 -Water</i>		
T07	Ferrous ores and metals		
	<i>S09 - Extraction of iron minerals.</i>		
	<i>S10 - Iron metallurgy.</i>		
	<i>S11 - Production of steel pipes, wires and first stage steel transformation.</i>		
T08	Non ferrous ores and metals		
	<i>S12 - Extraction of uranium and non-ferrous ores and metals.</i>		
	<i>S13 - Production of nuclear materials, non-ferrous ores and metals.</i>		
T09	Sundry minerals, building materials		
	<i>S14 - Extraction of minerals for the chemical industry, production of salt, and peat.</i>		
	<i>S15 - Extraction of stones, sand, clay; production of pottery, bricks, tiles, cement, plaster and concrete.</i>		
T10	Glass industry – S16		
T11	Chemical, synthetic fibres		
	<i>S17 - Basic chemical industry and basic pharmaceutical industry.</i>		
	<i>S43 - Production of synthetic fibres.</i>		
T12	Parachemicals and pharmaceuticals		
	<i>S18 - Agrochemical products, paints, soaps, detergents, perfumes, explosives, gelatines and glues, chemical products for photography, abrasives.</i>		
	<i>S19 - Medicines and other pharmaceutical products.</i>		
		T13	Foundries and metalworking
			<i>S20 - Production of cast iron pipes; foundries.</i>
			<i>S21 - Metallic elements for building; forge, stamping, pressing, powders metallurgy; treatment of metals, general mechanics; cutlery and tools; other metal works; production of arms.</i>
		T14	Mechanical engineering
			<i>S22 - Production of agricultural machinery.</i>
			<i>S23 - Mechanical tools, machine tools.</i>
			<i>S24 - Metallic tanks, boilers and radiators;</i>
			<i>steam generators, nuclear boiler making, boiler piping; mechanical equipment; ovens and burners, industrial refrigerators wrapping equipment, conditioning equipment, sundry general use machinery; specific use machinery (for agribusiness, textiles, paper and board, printing, plastic materials, and other).</i>
			<i>S25 - Equipment for lifting and maintenance; metallurgic machinery, and machinery for extraction and building.</i>
			<i>S34 – Production of precision material</i>
		T15A	Industrial electrical and electronic equipment
			<i>S27 - Maintenance and repair of office machinery and data processing material; production of office machinery and computers.</i>
			<i>S28 – Production of electric material</i>
			<i>S291 – Professional and household electronic material</i>
		T15B	Consumer durables
			<i>S292 - Apparels for reception, recording and reproduction of sounds and images.</i>
			<i>S30 - Household appliances.</i>
		T16	Ground transport equipment – S31

Table 7 - Breakdown of NAP40 industries in NAP100 sub-industries (cont.)

T17	Shipbuilding, aeronautics, armament S26 - Armament. S32 - Navigation aid equipment; construction and repair of war and civil ships. S33 - Aerospace construction.	S69 – Road transport, urban transport and transport by driver S70 – Inland navigation S71 – Naval transport S72 – Transport by air S73 – Activities linked to transport and depots. S74 - Activities auxiliaries to transport and travel agencies.
T18	Textiles and clothing S44 – Textiles S47 Clothing	
T19	Leather and footwear S45 – Leather S46 - Footwear	
T20	Wood, furniture, miscellaneous industries S48 - Wood working S49 – Furniture S54 - Miscellaneous products	
T21	Paper, board – S50	
T22	Press, edition – S51	
T23	Rubber, plastic S52 – Tyres and other rubber products S53 – Plastic materials transformation	
T24	Building; civil and agricultural Engineering – S55	
T25 – T28	Trade S57 – Wholesale food trade S58 – Wholesale non-food trade S59 – Wholesale inter-industry trade S60 – Middlemen trade S62 – Specialised food retail trade S63- Non-specialised food retail trade S64 – Specialised non-food retail trade	
T29	Motor car trade and repairs – S65	
T30	Hotels, cafes, restaurants – S67	
T31	Transports S68- Railway transport	
		T32
		Telecommunications and post – S75
		T33
		Business services S56 – Credit recovery S76 – Business administration S77 – Consulting and assistance activities S78 – Auxiliaries activities of insurance and finance, portfolio and assets management S79 – Real estate S80 – Car rental; other transport equipment rental; machinery and equipment leasing; other leasing. S82 – Tuition and training S83 – Research and development
		T34
		Market services to households S66 – Repairing activities S84 – Private healthcare S86 – Cultural, recreational and sports services S87 – Other private services
		T35
		Lettings – S81
		T36
		Insurance – S88
		T37
		Services of financial institutions – S89
		T38
		Non market services – S90 ÷ S99

