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MARK-UP PRICING. MARKET STRUCTURE AND THE BUSINESS CYCLE

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INTRODUCTION

Imperfections in product markets affect economic performance in a number of ways. Among the most important of these is the effect on the price setting of firms. When product markets are characterised by a lack of competition, firms may be able to charge a mark-up over their marginal costs and achieve monopoly rents. if such rents persist over time, and if they can be related to specific barriers to competition, prices are higher than they ought to be and output is lower than it could be. In this situation, policy action might aim to foster stronger competition, in order to reduce the scope for mark-up pricing and lower price levels.

The existence of a mark-up also has some implications for our understanding of macroeconomic behaviour. For instance, in the NAIRU framework mark-ups have a direct impact on unemployment (Geroski, Gregg and Van Reenen, 1996), while the existence and behaviour of a mark-up over the business cycle also helps explain why productivity, wages and employment appear to be pro-cyclical. In addition, macroeconomic policy would have a different impact on output and prices if product markets were characterised by a high degree of mark-up pricing (Silvestre, 1993).

A prevalence of mark-up pricing could thus have a number of important implications for policy. But before looking further into these implications, it is necessary to evaluate empirically the occurrence of mark-up pricing in the economy. A substantial body of literature has been devoted to this issue (Schmalensee, 1989; Bresnahan, 1989).This literature has recognised the mark-up of product prices over marginal costs (the so-called *Lerner index)* as one of the more direct indicators of monopoly power. However, the empirical measurement of the Lerner index and related measures is quite difficult. The main problem arises from the fact that while prices can be measured, marginal costs are not directly observable. In addition. the economic literature has given little guidance on how to establish appropriate measures at an aggregated level. Consequently, there have been few empirical studies identifying market power at this level (Geroski *et al.,* 1996).

Recently, the research on models of real business cycles and, more precisely, on explanations of the observed correlation between productivity shocks and aggregate output growth has produced – as a by-product – a new methodology to estimate the mark-up of prices over marginal costs at the aggregate level. This method uses the short-run fluctuations of the difference between the growth rates of output and production inputs by sector (Hall, 1986 and 1988; and Bils, 1987), or the so-called Solow residual, a popular measure of total factor productivity. The approach, proposed by Robert Hall, has been extensively applied in the empirical literature (Shapiro, 1987; Domowitz *et al.*, 1988; Caballero and Lyons, 1990). Nonetheless, Hall's approach has been criticised on the grounds that it relies on somewhat dubious econometric techniques, leading to implausibly high mark-ups which are difficult to reconcile with the absence of high pure profits in aggregated industries. More recently, Roeger (1995) proposed a significant modification to Hall's original method, leading to more reliable estimates of mark-ups for US manufacturing industries.

This paper extends Roeger's method and provides mark-up estimates over the period 1970-92, for 36 detailed manufacturing industries (at the 3-4 digit level of ISIC) and several service sectors in 14 OECD countries. Thus, it provides the first comprehensive and comparable picture of the level and structure of mark-ups for a large number of sectors and OECD countries.

The paper also makes an effort to interpret the mark-up estimates. Although high mark-ups may be a sign of a lack of competition, they are also related to the market structure prevailing in an industry. For instance, sunk costs or a high degree of innovation may give rise to mark-up pricing that is required to sustain the competitive process in some industries. To evaluate the degree of mark-up pricing, and assess whether a case can be made for policy action, it is therefore important to establish the *type* of competition prevailing in different industries.

The paper is organised as follows. The next section provides the theoretical background to the measurement of mark-ups, and sets out the methodological details. The estimates of mark-ups are discussed in the third section of the paper, which also compares the results with some other evidence on mark-up pricing. The fourth section aims to provide an interpretation of the estimated mark-ups, using a taxonomy that classifies the sectors according to the type of competition. In section five, the cyclicality of the mark-ups is tested. The final section draws the main conclusions.

ESTIMATING MARK-UPS: METHODOLOGY AND MEASUREMENT ISSUES

The methodology

The basic indicator of the mark-up of prices (P) over marginal costs (MC), the so-called *Lerner index* (B), can be defined as $(P - MC)/P$. With perfect competition, price equals marginal cost and the index will be equal to zero. When pries exceed marginal cost, the Lerner index becomes positive and varies between zero and unity. The closer the value of the index is to unity, the greater the degree of market power. This indicator is a static measure of *actual* conduct and may not reflect the potential for monopolistic behaviour on the part of the firm. The latter is more directly related to the type of market structure, *i.e.* some market structures will favour the development of permanent market power more than others. For the discussion that follows, it is useful to establish the relation between the Lerner index and the mark-up ratio (*P/MC*), that will be designated hereafter by μ:

$$B = \frac{P - MC}{P} = 1 - \frac{1}{\mu} \quad or\ \mu = \frac{1}{1 - B} \qquad [1]$$

Hall's approach to the estimation of mark-ups is based on ideas contained in Solow's seminal (1957) paper on productivity measurement. The most common method of calculation of total factor productivity (TFP) is the so-called Solow residual (hereafter, *SR*), *i.e.* the difference between the growth rate of output and a weighted average of the growth rate of factor inputs The basic idea can be derived from Hall (1986) (see *Annex 1*):

$$SR = \Delta q - \alpha\Delta l - (1 - \alpha)\,\Delta k = B \cdot (\Delta q - \Delta k) + (1 - B) \cdot \theta \qquad [2]$$

where Δq, Δl and Δk correspond, respectivefy, to the growth rates of real value added, labour and capital inputs, α is the labour share in total value added and θ is the (unobservable) rate of technical progress. Equation [2] shows that, under perfect competition, the Lerner index (*B*) is equal to zero and the *SR* is thus identical to the productivity term. Moreover, perfect competition also implies that the *SR* should not be correlated with the growth rate of the output/capital ratio – the so-called "invariance property" of the Solow residual.[1] However, this property often fails to be observed. Typically, the estimated productivity residual tends to be pro-cyclical, *i.e.* higher in years of expansion than in years of recession. From this observation, Hall concluded that the hypothesis of perfect competition is rejected by the data.[2]

Along these lines, the mark-up ratio can be estimated from Equation [2]. By assuming that the rate of technological progress can be described as a random deviation from an underlying constant rate and assuming that the mark-ups are constant through time, Equation [2] can be re-arranged as follows

$$\Delta\,(q_t - k_t) = (\mu\alpha_t) \cdot \Delta\,(l_t - k_t) + \theta + u_t \qquad [3]$$

The (observed) labour share in total value added is used as a benchmark. Under perfect competition the coefficient associated with the growth of the labour/capital ratio should be equal to the labour share. In principle, this would enable the identification of the value of the mark-up coefficient. But, as Hall (1986) has pointed out, Equation [3] cannot be estimated directly. Indeed, with imperfect competition, the labour/capital ratio is correlated with the productivity term (and consequentiy with the error term) and ordinary least square (OLS) estimates will not be consistent. The usual way to correct for this bias is to replace the labour/capital ratio by a set of instrumental variables, *i.e.* variables which are correlated with the growth of the labour/capital ratio and, at the same time, are not correlated with the productivity shocks.[3] For the case of the United States, Hall proposed a number of instruments, including overall real GDP, military spending, the oil price and the political party of the president.

However, some of these instruments have been criticised as being rather implausible. Moreover, the problem with the instrumental variable approach is that, in small samples, the relative merits of this procedure compared with standard OLS estimates are not clear-cut. For example, a very small correlation between the instruments and productivity growth may prove much more problematic than the biases emerging from the OLS procedure (Caballero and Lyons, 1989)

In order to overcome the econometric problems arising from the correlation between the explanatory variable and the error term, Roeger (1995) proposed a different way of estimating mark-ups. Instead of using the Solow residual, he used the difference between the latter and the dual Solow residual First, he derived the dual productivity measure, *i.e.* a price-based Solow residual (*SRP*) as follows:

$$SRP = \alpha \cdot \Delta w + (1 - \alpha) \cdot \Delta r - \Delta p = -B \cdot (\Delta p - \Delta r) + (1 - B) \cdot \theta \qquad [4]$$

where **Ap, Aw** and **Ar** correspond, respectively, to the growth rates of output price, wages and the rental price of capital. Then, by subtracting [4] from Equation [2] and adding an error term, he obtained a tractable expression for the estimation of :

$$\Delta y_t = B \cdot \Delta x_t + \varepsilon_t \qquad [5]$$

where:

$$Ay = (Aq + Ap) - a \cdot (\Delta l + Aw) - (1 - a) \cdot (Ak + Ar)$$
$$Ax = (A9 + Ap) - (Ak + Ar)$$

The dependent variable **(Ay)** can be interpreted as a "nominal" Solow residual, while the explanatory variable is the growth rate of the nominal output/capital ratio. The appealing feature of Equation [5] is that the productivity term vanishes and a direct estimation of B can be carried out by the usual econometric techniques. Another advantage of this method is that the price and volume variables can be grouped together so that only nominal variables appear in the equation, thereby helping to overcome some availability problems associated with price data.

A straightforward extension of Equation [5] makes it possible to incorporate intermediate inputs and define the mark-up ratios over gross output instead of value added This adjustment is crucial. Defining the mark-up over value added induces a clear upward bias in the estimation {Norrbin, 1993, and Basu, 1995). When intermediate inputs are taken into account, the dependent and explanatory variables of Equation [5] become

$$\Delta y^o = (\Delta q^o + \Delta p^o) - \alpha^o \cdot (AI + \Delta w) - \beta \cdot (\Delta m + \Delta p_m) - (1 - \alpha^o - \beta) \cdot (Ak + Ar)$$
$$\Delta x^o = (\Delta q^o + \Delta p^o) - (Ak + Ar) \qquad [6]$$

where q^o **and** p^o correspond to gross output and its respective price, m and p_m to intermediate inputs and their prices, and α^o and β to the respective shares of labour and intermediate costs in gross output. As noted above, only the nominal values are required to carry out this calculation. However, the treatment of capital costs requires a separate computation of the volume and rental price of capital (see below and *Annex* 2).

Interpretation and possible estimation biases

Equation [5] is striking by its simplicity but its intuitive meaning is not immediately clear. In fact, Roeger's equation can also be derived from the definition of an "average" mark-up (μ^a),[4] *i.e.* the ratio between prices and average costs (AC):[5]

$$\mu^a = \frac{P}{(W \cdot L + R \cdot K)/Q} = \frac{\mu}{\lambda} \qquad [7]$$

which by definition is equal to the mark-up over marginal costs divided by an index of returns to scale ($h = AC/MC$). Under the assumption that this average mark-up is constant, this relation can be transformed as follows (*Annex 1*):

$$\Delta y_t = [\lambda \cdot (B - 1) + 1] \cdot \Delta x_t + \varepsilon_t \qquad [8]$$

where Δx and Δy are defined as previously. The above equation shows that, with constant returns to scale ($h = 1$), Roeger's method provides an unbiased estimate of the Lerner index B. With increasing returns to scale ($\lambda > 1$), there would be a downward bias to the estimated value of the mark-up.[6] In other words, Roeger's method only takes into account the part of the mark-up corresponding to the difference between price and average costs, *i.e.* the mark-up net of the influence of returns to scale.

The presence of sunk costs is also likely to generate a downward bias in Equation [5]. indeed, if a fraction of the capital stock is sunk, this has to be subtracted from the total capital stock leading to lower marginal cost and a higher mark-up. The same reasoning can be applied to downward rigidities of the capital stock or labour input (so-called labour hoarding). When the capital stock or the labour force cannot be adjusted downwards during a recession, the marginal costs would be higher than under a situation of perfectly flexible production inputs. Correcting for these biases would imply higher mark-ups than those estimated on the basis of Equation [5]

To sum up, the mark-ups derived from Roeger's method, as estimated in this paper, are likely to represent a lower bound for industries operating under increasing returns to scale, large sunk costs or strong adjustment rigidities over the business cycle.

Data and measurement issues

The mark-up estimation takes account of labour, capital and intermediate inputs as production factors. The series for gross output, employment, wage compensation and intermediate inputs (defined as gross output minus value added) were taken from OECD's STAN database (OECD, 1995, 1996). Estimates of gross capital stock by industry were provided by the EAS Division of OECD's Directorate for Science, Technology and Industry.[7] Concerning the rental price of capital, no sector-specific information was available enabling the implementation of the Hall and Jorgenson (1967) method. However, inspired by their methodology, a simplified rental price of capital was defined *(Annex 2)*.

The mark-up estimation discussed above is based on nominal output data, which often include net indirect taxes *(i.e.* indirect taxes minus subsidies). The inclusion of net indirect taxes generally produces an upward bias to the mark-up estimates and for this reason previous studies used nominal output at factor costs. If the net indirect tax rate is constant, an adjusted estimate of the mark-up can simply be obtained by dividing the estimated mark-up by the net indirect tax rate.[8]

The tax data were derived from national sources, including detailed national accounts, input-output tables and manufacturing census data. The corrected mark-ups are generally lower than the unadjusted mark-ups, except where the net indirect tax rate for manufacturing is negative *(i.e.* where subsidies exceed indirect taxes). Moreover, the value-added tax rates have to be adjusted for the fact that the mark-up is calculated over gross output. The adjustment can be done simply by multiplying the tax rate by the ratio of value added to gross output for each industry. Both the detailed tax rates by industry and country and the value added/gross output adjustment factors are provided in Oliveira Martins, Scarpetta and Pilat (1996).

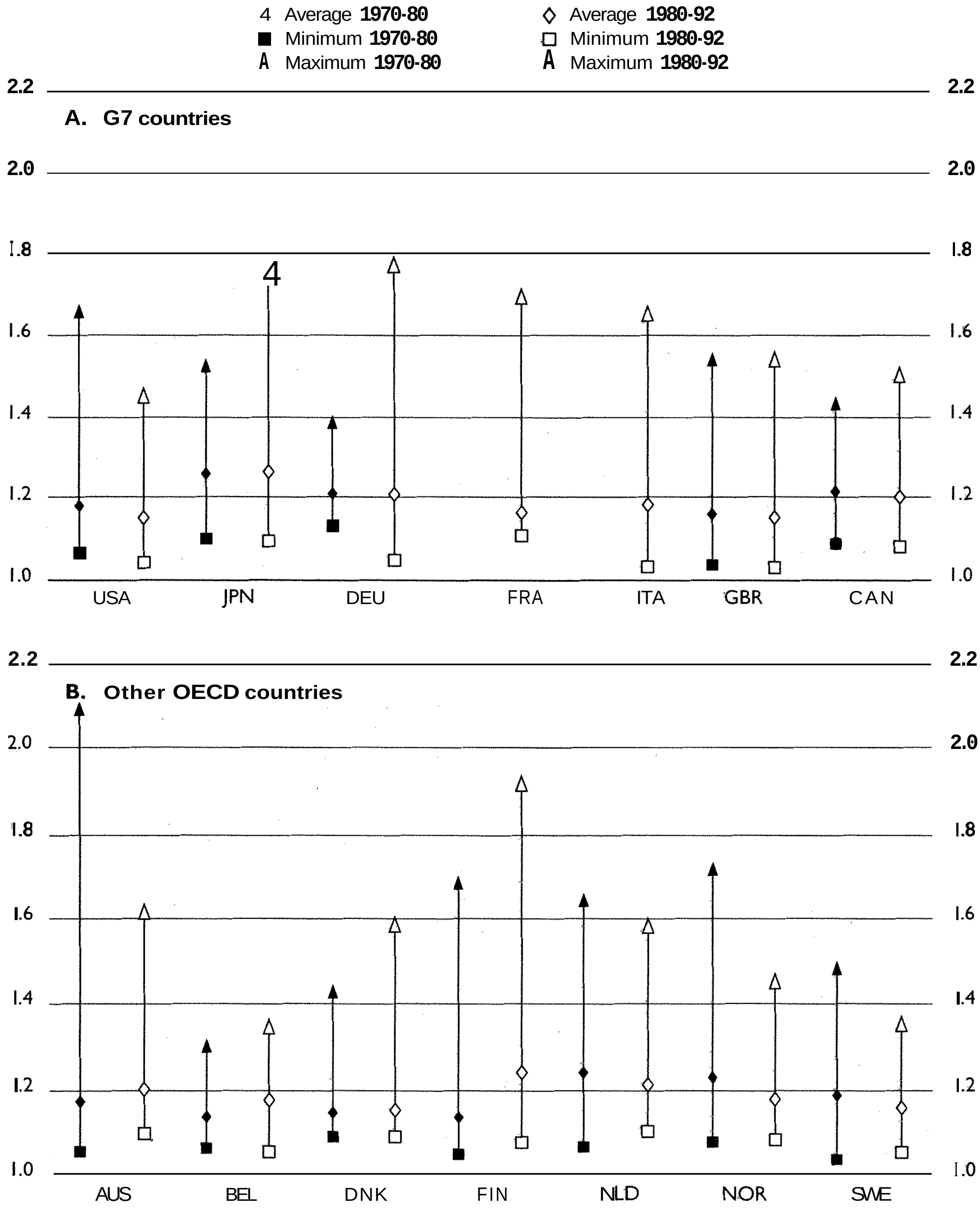
EVIDENCE ON MARK-UP PRICING

Mark-ups for manufacturing sectors

Equation [6] was used to estimate mark-ups for the 14 OECD countries for which sufficient data were available and for the 36 manufacturing sectors available from OECD's STAN database.[9] The mark-up ratios are obtained as $1/(1 - B)$, where B is the coefficient of the Roeger equation

A synthetic view of the estimates is provided in Figure 1 which shows the maximum, minimum and average mark-up in each country for the sub-periods 1970-80 and 1980-92.[10] The average mark-up ratios range from 1.13 in Belgium and Finland over the 1970s to 1.26 for Japan over the period 1980-92 and for the Netherlands over the period as a whole. This range seems more plausible than the very high mark-ups obtained in previous studies (see below). In the 1970s, the estimated mark-up ratios are highest for Japan, the Netherlands, Norway and Canada, while they are relatively low for Belgium, Denmark, Finland and the United Kingdom. For the 1980s, the highest mark-ups are observed for Finland, Japan, Germany and the Netherlands, whereas the lowest mark-ups are estimated for Denmark, the United States and the United Kingdom. However, there is no systematic pattern of change of the mark-up between the two periods.

◆ Figure 1. ***Mark-up ratios in manufacturing, 1970-80 and 1980-92***[1]



1. Average mark-ups are weighted by 1990 production shares.

Source: Olivera Martins, Scarpetta and Pilat (1996).

Table 1. **Estimated mark-up ratios for manufacturing industries: *G-7* countries[1]**

Period 1980-92

Sector	United States	Japan	Germany	France	Italy	United Kingdom	Canada
Food products	1.07	1.35	1.10	1.10	–	1.19	1.10
Textiles	1.09	1.17	1.13	1.10	1.18	1.03	1.23
Wearing apparel	1.11	–	1.08	1.14	1.16	1.03	1.11
Leather products	1.10	–	1.14	1.11	1.17	1.04	1.15
Footwear	1.10	–	1.04	1.10	1.15	–	1.08
Wood products	1.23	–	1.17	1.14	1.18	1.17	1.24
Furniture	1.05	1.18	1.13	1.19	1.21	1.15	1.14
Printing and Publishing	1.22	–	1.15	1.16	1.19	1.07	1.17
Plastic products	1.06	1.15	–	–	1.05	–	1.15
Non-metal mineral products	1.19	1.30	1.28	1.19	1.31	1.20	1.31
Metal products	1.10	1.12	1.20	1.17	1.42	1.03	1.14
Chemical products	1.26	1.37	1.29	1.19	–	1.05	1.21
Machinery and equipment	–	1.14	–	1.12	1.18	–	1.16
Motorcycles and bicycles	1.09	–	1.34	–	–	–	–
Professional goods	1.07	1.27	1.77	–	1.24	1.28	–
Other manufacturing	1.08	1.47	1.25	–	1.10	–	–
Beverages	1.04	1.09	1.31	1.64	–	1.54	1.22
Paper products and pulp	1.12	1.23	1.23	1.11	1.15	1.04	1.37
Petroleum and coal products	1.12	1.15	1.08	–	–	1.08	1.25
Rubber products	–	1.10	–	1.16	1.12	–	–
Pottery and china	1.10	1.15	1.26	1.19	1.31	–	1.44
Glass products	1.17	1.72	1.27	1.23	1.31	1.08	1.30
Iron and steel	1.10	1.43	1.18	1.11	1.14	–	1.26
Non-ferrous metals	1.12	1.21	1.09	1.25	1.11	1.05	1.18
Shipbuilding and repair	–	1.29	–	–	–	–	1.19
Other transport equipment	–	–	–	–	1.05	–	–
Tobacco products	1.73	–	1.60	3.17	–	1.67	1.12
Petroleum refineries	1.05	–	–	1.16	–	1.07	–
Industrial chemicals	1.22	1.27	1.40	1.21	1.17	1.05	1.50
Drugs and medicines	1.45	1.75	1.49	–	–	1.11	1.27
Office and computing machinery	1.39	1.32	–	1.18	1.65	1.43	1.14
Radio, TV and comm equipment	1.38	1.15	1.28	1.11	1.19	1.28	–
Electrical apparatus	–	–	–	1.27	1.08	–	1.14
Railroad equipment	–	–	–	1.70	–	–	1.13
Motor vehicles	1.06	1.18	1.13	1.13	1.02	–	1.14
Aircraft	–	–	–	1.19	1.11	–	–

1 Reported mark-up estimates are statistically significant at the 5 per cent level or above
2 A dash indicates that no data were available or that the estimated mark-up was not statistically significant
Source Oliveira Martins. Scarpetta and Pilat (1996)

The detailed sectoral results for the period 1980-92 are given in Tables 1 (G-7 countries) and 2 (other OECD countries). The tables only show cases where the estimate of *B* is significantly different from zero at the 5 per cent level or above. There is slightly more regularity in the sectoral patterns than in the overall results.

Table 2. **Estimated mark-up ratios for manufacturing industries: other OECD countries**[1]

Period 1980-92

Sector	Australia	Belgium	Denmark	Finland	Netherlands	Norway	Sweden
Food products	1.14	1.16	1.12	1.07	–	–	–
Textiles	1.14	1.12	1.11	1.22	–	1.13	1.13
Wearing apparel	1.12	–	1.18	1.12	–	.13	–
Leather products	1.17	1.35	1.21	1.14	1.11	.15	1.12
Footwear	1.14	1.12	–	1.09	–	.16	–
Wood products	1.20	–	1.13	1.24	1.19	.17	1.16
Furniture	1.13	1.29	1.15	1.31	–	.14	1.05
Printing and Publishing	1.21	1.16	1.10	1.20	1.22	.11	1.15
Plastic products	1.21	–	1.16	1.34	1.14	.11	1.21
Non-metal mineral products	1.21	1.09	1.25	1.39	–	1.25	1.12
Metal products	1.17	1.18	1.14	1.22	1.10	1.16	1.12
Chemical products	1.25	1.13	1.12	1.26	–	1.08	1.17
Machinery and equipment	1.15	–	1.12	1.22	–	1.11	–
Motorcycles and bicycles	–	–	–	1.31	1.20	–	–
Professional goods	1.23	–	–	–	1.24	1.31	1.12
Other manufacturing	1.24	–	1.22	.24	1.13	12	–
Beverages	1.29	1.12	–	.63	1.59	–	1.23
Paper products and pulp	1.20	1.21	1.13	.24	1.15	11	1.19
Petroleum and coal products	1.33	–	1.39	.16	–	15	–
Rubber products	1.10	1.05	1.13	.50	–	13	–
Pottery and china	1.17	–	1.36	.82	–	17	–
Glass products	1.33	–	–	.22	1.36	–	1.13
Iron and steel	1.31	1.30	1.09	1.30	1.39	1 25	1.09
Non-ferrous metals	1.28	1.17	1.17	1.13	1.27	1 35	–
Shipbuilding and repair	1.19	–	–	–	–	–	1.14
Other transport equipment	–	–	–	1.33	–	1 15	–
Tobacco products	1.58	1.08	–	1.30	1.51	–	–
Petroleum refineries	1.21	–	–	1.22	–	–	–
Industrial chemicals	1.20	1.17	1.26	1.27	1.19	1 28	1.18
Drugs and medicines	1.35	–	1.59	1.57	–	1 24	1.35
Office and computing machinery	–	–	1.44	1.92	–	145	1.17
Radio, TV and comm. equipment	1.61	–	1.10	1.59	1.17	1.16	1.30
Electrical apparatus	–	–	1.21	1.22	–	115	–
Railroad equipment	1.44	–	–	1.22	–	–	–
Motor vehicles	1.12	–	–	1.17	1.15	1.19	1.12
Aircraft	–	–	–	–	1.44	–	–

1 Reported mark-up estimates are statistically signihcant at the 5 per cent level or above
2 A dash indicates that no data were available or that the estimated mark-up was not statistically signihcant
Source Oliveira Martins Scarpetta and Pilat (1996)

Indeed, relatively high mark-ups (often over 40 per cent) appear in several countries in industries such as radio, TV and communication equipment, beverages, tobacco products, railroad equipment, drugs and medicines and in office and computing machinery. On the other hand, estimated mark-ups are relatively low in all countries in textiles, clothing, leather, footwear, food products, printing and publishing, machinery and equipment, electric machinery and motor vehicles [11]

The above estimates relate only to the most recent period for which data were available. Given the economic turbulence and the many structural changes that have occurred across the OECD area over the past decades, it is of interest to analyse whether there have been any changes over time in the pattern of sectoral mark-ups. The detailed sectoral mark-ups for the period 1970-80 were presented in Oliveira Martins *et al.* (1996). It appears that the incidence of high mark-ups (over 40 per cent) was higher in all countries in the 1970s than it was for the period 1980-92, with the sole exceptions of Finland and Japan. Notwithstanding, the pattern of mark-ups across industries has not changed much from the 1970s to the 1980s. In both periods, the main incidence of high mark-ups is in tobacco products, industrial chemicals, radio, TV and communication equipment, drugs and medicines and computer equipment. However, high mark-ups cannot be taken unconditionally as evidence of persistent rents stemming from market power. For innovative industries, for instance, high mark-ups may result from temporary innovation rents. Furthermore, the type of competition prevailing in an industry also has to be taken into account (see below).

Mark-ups for selected service sectors

Most studies on mark-up pricing have concentrated on the manufacturing sector. However, both Hall's and Roeger's method can be applied also to service sectors A clear advantage of Roeger's method in this regard is that it does not requires information on prices, but only nominal variables. This is particularly appealing for service industries, given the poor statistical information on prices. Table 3 presents estimates of mark-up ratios for the period 1980-92 for seven service sectors in 14 OECD countries. For comparative purposes, average mark-ups for the manufacturing sector are also included in the Table The calculations are based primarily on OECD's ISDB database (Meyer zu Slochtern and Meyer zu Slochtern, 1994; OECD, 1995*a*) However, as ISDB does not contain information on gross output, an adjustment from mark-ups estimated over value-added to mark-ups over gross output was based on information derived from country-specific input-output tables (OECD, 19956).

The estimated mark-up ratios for services are more tentative than those for manufacturing for two reasons First, the service industries shown represent much broader aggregates than the industry detail used for the manufacturing sector, hence, firms operating in (some of) these service sectors are likely to be quite heterogeneous. Second, the quality of statistical information for the service sectors is poorer than that available for manufacturing industries (OECD, 1996*a*)

Table 3. **Mark-ups for manufacturing and selected service sectors, 1980-92**[1]

	Manufacturing[2]	Electricity gas and water	Construction	Wholesale, retail trade, restaurants, hotels	*of which:* Wholesale, retail trade	*of which:* Restaurants, hotels	Transport, storage and communication	*of which:* Communication
United States	1.15	1.34	1.17	125	128	1.24	1.33	1.68
Japan	1.26	1.58	1.26	–	125	–	1.29	–
Germany	1.21	139	23	1 34	139	1.18	1.35	.75
France	1 16	1 50	19	1 48	152	1.40	1.39	.57
Italy	1 18	128	39	1 96	2 15	1.53	1.37	.18
United Kingdom	115	1 34	25	137	–	–	1.25	–
Canada	120	2 54	16	1.28	1.29	1.26	1.37	.58
Australia	120	155	128	–	1 32	–	1.47	–
Belgium	1 17	1 52	126	1.80	182	1.75	1.68	1.62
Denmark	1 15	1 36	1 09	1 64	173	1.15	1.29	1.52
Finland	124	1 29	1 19	124	–	–	1.36	–
Netherlands	121	125	1 06	145	155	1.48	1.45	–
Norway	1 18	156	1 09	–	1.20	1.12	1.25	1.19
Sweden	1 16	2 07	1 12	1 16	1 16	1.13	1.20	–
Average[3]	1 19	1 54	120	145	147	1.32	1.36	1.51
Standard deviation	0 03	0 35	0 09	0 25	0 30	0.21	0.12	0.21

1 A dash indicates that no data were available or that the estimated mark-up was not statistically signihcant The estimates are adjusted for material inputs and are net of net indirect taxes
2 The average mark-ups for manufacturing are based on the detailed sectoral mark-ups and are weighted by 1990 production shares
3 Unweighted average of data for individual countries

Source Calculations on the basis of ISDB database (OECD 1995*a*); Manufacturing based on Tables 1 and 2

With the exception of the construction sector, the mark-up ratios for services tend to be higher than those in manufacturing. There is also a greater cross-country variation in service mark-ups than there is in mark-ups in the manufacturing sector. Mark-ups in the electricity, gas and water sector are particularly high in Canada, Sweden and Norway, but also in Japan, Australia, Belgium and France. In the former three countries, and particularly in Canada, high mark-ups are likely related to natural resource rents, as a significant part of electricity generation in these countries is based on cheap and abundant hydro-power. For the other group of countries, natural resource rents are less important, suggesting that other factors, including possibly the state of competition, may play a major role.

Mark-ups in the construction sector are relatively close to those estimated for many manufacturing industries. This sector tends to be relatively fragmented, with a large number of firms generating a relatively competitive environment. Mark-ups in this sector are relatively high in Italy. In the distribution sector, mark-ups vary substantially across countries. The highest mark-ups in wholesale and retail trade are observed in Italy and Belgium. Although it is difficult to establish a causal relationship, both countries have important regulations restricting entry to the sector (Høj, Kato and Pilat, 1996), suggesting that part of the high level of mark-ups may be due to a lack of competition in these countries.

Mark-ups in the communication sector are also quite high. In the telecommunications industry, high mark-ups may partly be due to innovation rents. However, the sector is characterised by public monopolies or a low degree of competition in many countries, suggesting that monopoly rents may contribute to high mark-ups in some countries. The transport, storage and communication industry as a whole has an estimated mark-up between 20 and 40 per cent in most countries. Some parts of this industry are highly fragmented, for instance road freight transport, and therefore likely to have low mark-ups, whereas others are more segmented and sometimes characterised by (public) monopolies, *e.g.* airlines and railways.

Comparison with previous studies and other evidence on mark-up pricing

Our estimates of mark-ups for manufacturing range, with some exceptions, from zero to 30 per cent. These values are substantially lower, and intuitively more plausible, than the results of previous studies In the results reported by Hall (1990) for the US manufacturing sector, there are a significant number of sectors (7 out of 21) where the standard errors are quite large or the estimated mark-up ratio is less than one. On the other hand, many of Hall's significant mark-up ratios are close to, or over, 100 per cent. This appears not very plausible for manufacturing industries, as these tend to be highly exposed to international competition and such high mark-ups would be contested.[12]

The mark-up estimates in Tables 1 and 2 are also substantially lower than those derived by Roeger (1995). For example, the price-cost margins estimated by Hall and Roeger for the US textile sector were 158 and 34 per cent, respectively, whereas our estimate of the price-cost margin is approximately 8 per cent (i.e. a mark-up ratio of 1.08). Roeger's estimates of mark-up ratios for US manufacturing sectors range from 15 to 175 per cent, with most sectors having 30 to 60 per cent mark-ups over marginal costs. Our estimates are in many cases below or close to 10 per cent, while high mark-ups (over 40 per cent) are only observed in a few sectors. In broad terms, the difference between Roeger's results and the results presented here is primarily due to the adjustment for intermediate inputs. This adjustment tends to lead to significantly lower mark-up estimates, in particular for sectors with a large share of intermediate inputs in total output.

Consequently, the results presented in this paper are more in line with estimates of profit rates typically reported in the industrial organisation (IO) literature. For example, Schmalensee (1989) surveys a range of studies showing low accounting rates of return, *e.g.* around 10 per cent. Bresnahan (1989) reviewed empirical evidence on case studies attempting to estimate the mark-up ratio by alternative methods. Typically, the estimated price-cost margins obtained in these studies are in the range of 10 to 20 per cent and seldom exceed 50 per cent.

INTERPRETING MARK-UPS: THE ROLE OF MARKET STRUCTURE

The IO literature typically associates the degree of market power with a number of structural variables (establishment size, concentration, degree of vertical integration, etc.). A starting point is the observation that differences in market power across manufacturing industries must in part be due to differences in entry conditions into each industry. Traditionally, entry conditions and the resulting market structures have been related to technological conditions, such as economies of scale and scope (Panzar, 1989). Firms may also be able to influence the demand for their products under a regime of monopolistic competition (Dixit and Stiglitz, 1977), where limited market power can arise from the combination of returns to scale and horizontal product differentiation Nevertheless, the entry of new firms can be expected to bring prices down to average costs over the long run. More recent research has focused on so-called "vertical" product differentiation, where firms are able to influence the perceived quality of their products. Firms that engage in such product differentiation strategies may be able to influence entry conditions in the market.[13] Generally, this influence is related to endogenous sunk costs associated with advertising or R&D expenditures [14]

Mark-ups are therefore likely to be related to a range of structural variables, such as establishment size and capital intensity; innovation variables, such as RGD intensity; and competition variables, such as export intensity, entry rates or tariff rates. However, the rationale for high mark-ups can differ according to the type of industry. A crucial point in the recent IO literature is the insight that the relation between market structure variables and, say, profitability cannot be captured by estimating the usual linear (or log-linear) relationship. Instead, this relation can be quite complex and may be non-monotonic.[15] For example, Sutton (1991, 1995) put forward a framework involving the estimation of "bounds" for the size distribution of firms which leads to the identification of different types of market structures instead of a continuum of situations from competition to monopoly. In other words, it matters in the first place to identify the *type* rather than the *intensity* of competition.

To identify the type of competition and ultimately relate it to the mark-up estimates, a market structure taxonomy was established. The basic principles in establishing the taxonomy are the following. The 36 manufacturing industries for which mark-up estimates were calculated, were classified according to two indicators. The first indicator – *relative establishment size* – is a proxy for the existence of size advantages, such as scale economies at the firm level. Sectors with a small average establishment size are termed "fragmented" industries. In these industries, the number of firms typically grows in line with the size of the market. Sectors characterised by the existence of large establishments, covering a large proportion of employment and output, were termed "segmented" industries. In these sectors, concentration remains relatively stable or converges towards a finite lower bound.

The second indicator, *R&D intensity*, can be taken as a rough proxy for product differentiation and innovation. It would be better to make a distinction between product and process innovation, but the available data do not permit us to make this distinction.

The combination of these two indicators provides the breakdown by type of market structure. First, the sectors were ranked by average establishment size in order to make a distinction between fragmented and segmented industries. Within each of these two groups, industries were subsequently ranked according to R&D intensity by establishment.[16] The border lines between the four groups are approximate. For the establishment size indicator, they correspond roughly to a threshold around the average for total manufacturing. For R&D intensity, there is an observable jump in the value of the indicator between low- and high-differentiation groups. It turns out that this market structure taxonomy can also be related to more direct indicators of sunk costs and product innovation and to qualitative information about the different industries (Oliveira Martins, 1995).

While this two-by-two classification of market structure can be criticised as being too simplistic, it helps to interpret the observed mark-ups. Average mark-ups for the four groups of fragmented and segmented industries are presented in Table 4. It appears that mark-ups tend to be lower in fragmented industries than in segmented industries, confirming that these industries may indeed be closer to a

Table 4. Average mark-up ratios by market structure type, 1970-92

	Fragmented industries	Segmented industries	Fragmented, homogeneous industries	Fragmented, differentiated industries	Segmented, homogeneous industries	Segmented, differentiated industries
United States	1.11	122	1 11	1 12	1 12	133
Japan	1.21	1 23	120	1 24	1 23	123
Germany	1.21	129	1 16	1.32	122	1 38
France	1 16	125	1 16	1 16	128	123
Italy	1 18	1 19	1.19	1 16	117	120
United Kingdom	1 10	1 19	1.10	1 12	115	1.24
Canada	1.17	125	117	1.15	126	123
Australia	1 18	126	1.17	1.21	1.18	1.38
Belgium	1 16	1 15	1.14	122	1.16	1.10
Denmark	1 15	1.24	1.15	1 16	1.22	1.27
Finland	1 16	123	1.14	1 19	1.19	1.28
Netherlands	1 16	124	1.14	121	1.28	1.19
Norway	1 15	1.24	1.15	1 17	1.20	1.29
Sweden	1 12	120	1.12	1.10	1.15	1.25
All countries	1 16	1 23	1.15	1.19	1.21	1.26

Note The mark-ups are simple (unweighted) averages of industry mark-ups
Source Based on mark-ups presented in Oliveira Martins, Scarpetta and Pilat (1996), following the industry classification described in that study

state of perfect competition There are, however, substantial differences between countries

Within fragmented and segmented industries, the distinction between differentiated and non-differentiated industries also helps to interpret the mark-ups (Table 4). Average mark-ups are lowest in fragmented, non-differentiated industries, which confirms that these industries may indeed have the least potential to exercise market power Mark-ups are higher in fragmented, differentiated industries, which may partly be taken as a sign of innovation rents. However, the variation across countries suggests that other variables contribute to the explanation of mark-ups. Mark-up levels are substantially higher in segmented industries, which could be taken as a sign of market power in industries with a low degree of product differentiation, although it may well be an indication of innovation rents in industries with high product differentiation Mark-ups are particularly high in segmented, differentiated industries, where the market structure is expected to have many oligopolistic features Again, the variation across countries is quite large, which may partly be due to the impact of specific policies. Such policies may create entry barriers in a particular country or industry, thus reinforcing market power and contributing to mark-ups.

Table 5 explores the correlation between mark-ups and structural variables *within* each type of market structure. There is no correlation between concentration rates and mark-ups However, as expected, entry rates have a negative and significant correlation with mark-ups, particularly in fragmented and non-differentiated industries that are most likely to be characterised by perfect competition. When considered by market structure type, establishment size and capital intensity appear to have no significant link with the mark-ups.

The correlations between mark-ups and export intensity and import penetration indicate that the effect of these variables differs according to market structure type. In low-differentiated industries, and particularly in those that are fragmented, import competition contributes to lower mark-ups However, in differentiated industries, and particularly in those that are segmented, access to international markets apparently allows industries to benefit from scale economies and probably also from product differentiation strategies.

As expected, R&D intensity has a high, positive and significant impact on the estimated mark-ups in segmented, differentiated industries. It is also positively linked to mark-ups in fragmented, low-differentiated industries, which may indicate that even in industries dominated by price competition, R&D can be an effective way to capture product rents. The impact of trade barriers on mark-ups differs according to market structure type, but they mainly play a role in low-differentiated industries. In fragmented, low-differentiated industries, the correlation between trade barriers and mark-ups is negative, as trade barriers in these industries are primarily used to protect inefficient and non-competitive firms. In segmented, low-

Table 5. **Mark-up correlations by market structure**

T-statistics in parenthesis

	Concentration	Entry rates	Establishment size	Capital intensity	Export intensity	import penetration	RGD intensity	MFN tariff rates 1988	Ratio of core NTB 1988
All countries									
Fragmented, low-differentiation	−0.20	−0.25	−0.04	0.19	−0.19	−0.31	0.20	−0.21	−0.39
	(−1.52)	(−2.35)	(−0.50)	(2.28)	(−2.19)	(−3.78	(2.27)	(−2.49)	(−4.81)
Fragmented, high-differentiation	−0.08	−0.25	0.14	−0.07	0.22	0.26	0.06	0.01	−0.29
	(−0.39)	(−1.58)	(0.93)	(−0.46)	(1.57)	(1.87)	(0.40)	(0.09)	(−2.07)
Segmented, low-differentiation	−0.07	−0.15	0.11	−0.06	0.01	−0.17	0.04	0.43	0.25
	(−0.51)	(−1.37)	(1.07)	(−0.63)	(0.05)	(−1.72)	(0.43)	(4.78)	(2.55)
Segmented, high-differentiation	0.05	−0.12	0.03	−0.14	0.23	0.18	0.49	0.15	−0.05
	(0.36)	(−1.10)	(0.25)	(−1.29)	(2.26)	(1.74)	(5.29)	(1.46)	(−0.50)

Source: Based on market structure breakdown reported in Oliveira Martins, *et al.* (1996); calculation on the basis of 1980-92 mark-up estimates from Tables 1 and 2. Concentration rates from Van Ark and Monnikhof (1996); entry rates from Schwalbach (1991), Management and Coordination Agency (1989/90 and 1993/94) and Kleijweg and Lever (1994); establishment size from OECD-ISIS database (OECD, 1995*c*); capital intensity, export intensity and import penetration from OECD-STAN database (OECD, 1995, 1996); RGD intensity from OECD-ANBERD database (OECD, 1995*d*); tariff rates and NTB ratios from OECD (1996*b*).

differentiated industries, the correlation is positive and significant. In these sectors, price competition plays an important role, and trade barriers may reinforce the domestic market power of producers.

MARK-UP PRICING AND THE BUSINESS CYCLE

A large number of studies have indicated that price margins vary over the business cycle.[17] However, the Hall methodology for estimating the mark-up, which is used by most of these studies, is ill-suited for assessing the responsiveness of mark-ups to the cycle. Indeed, the high price margins which often result from the Hall methodology are likely to lead to a biased or inconclusive test as regards cyclicality. For example, firms may react differently to changes in demand when their margins are very high then when they are positive but small.[18] On the contrary, the present mark-up estimates may offer a more solid ground for shedding light on the pricing behaviour of firms over the business cycle, as they offer more plausible estimates of the mark-ups that are also in line with evidence from micro-studies.

The theoretical literature does not offer a clear-cut answer as to whether price margins should be pro- or counter-cyclical. This is likely to depend on the specific product market conditions in which each firm operates. For instance, under a regime of monopolistic competition firms may find it efficient to set counter-cyclical mark-ups. Profit maximisation conditions imply that the mark-up is an inverse function of the elasticity of demand. The latter is likely to be pro-cyclical if, for example, product variety is also pro-cyclical (Kalecki, 1938; Weitzman, 1982). A similar outcome would emerge if firms find it optimal to develop their customer base in periods of up-turns, as suggested by Bils (1989) and by Phelps in his "customer market" model (Phelps, 1994). Certain collusion models also hint at counter-cyclical mark-ups. For example, if firms defecting from a cartel are able to expand their market shares in booms, then the gains from defection may outpace the long-term losses from punishment (Rotemberg and Saloner, 1986; Chevalier and Scharfstein, 1996). If, on the contrary, firms operate in oligopolistic markets with homogeneous goods, the behaviour of each firm depends upon the conjectured responses of all other competitors.[19] Under these conditions, the cyclicality of mark-ups depends on specific market characteristics, such as the existence of capacity constraints. If firms operate under full capacity and, thus, are not able to raise their output in response to a competitor (*i.e.* a Cournot competition model), then mark-ups are likely to be pro-cyclical because capacity constraints are pro-cyclical.

Whether the mark-up is pro- or counter-cyclical then becomes an empirical question. We assume a simple relationship between the Lesner index and the proxy variable for business cycle fluctuations, as follows:

$$B_t = \overline{B} + \gamma \cdot CYCL, \qquad [9]$$

where $\bar{B}$ is a fixed component corresponding to the average mark-up over the cycle. A negative (positive) sign for y indicates counter-cyclical (pro-cyclical) mark-ups. The new estimating equation cannot be obtained by simply inserting relation [9] into our estimating Equation [5] above. One must take account of the fact that a variable Lerner index has different implications for the primal and the dual Solow residuals (see Annex 1 for details). Taking this into consideration, the correct specification of Equation [5], under the assumption of constant returns to scale ($\lambda = 1$), is the following:

$$\Delta y_t = \bar{B} \cdot Ax, + \gamma\ (CYCL, \cdot \Delta x_t + \Delta CYCL_t) + \varepsilon, \qquad [10]$$

where Δy_t and $Ax,$ are defined as previously

Ideally, the cyclical variable *(CYCL)* should account for variations of the demand in each industry. In practice, given data limitations, most empirical studies have opted for an aggregate measure of the cycle Obviously, there is a trade-off between ignoring differences in sectoral demand conditions on the one hand, and higher accuracy when using an aggregate measure on the other hand, given the wider information available at the aggregate level on structural constraints and limitations on production. Despite this trade-off, an aggregate measure does not seem appropriate in the context of the current study. In particular, given that sectoral output (which is likely to reflect sectoral demand) already influences the first explanatory variable of estimating Equation [5], an aggregate variable is not likely to add significant explanatory power to the regression.[20] Accordingly, we opted for a measure of the cycle based on the industry output gap which relates actual and trend sectoral output.[21]

Two functional forms of Equation [10] were estimated Firstly, the parameter y was allowed to vary across all sectors and countries Secondly, since the cyclicality of the mark-up is likely to depend on market structure characteristics, equation [10] was also estimated allowing only for variations of γ across the four market groups defined above, i.e. keeping it constant within the sectors of each group. Equation [10] was estimated only for the manufacturing sector

In the sector-by-sector estimates (not presented)[22], the y parameter is negative in most cases, thereby implying counter-cyclical mark-ups [23] These results are consistent with Bils (1987), Rotemberg and Woodford (1992) and Morrison (1994), who found counter-cyclical mark-ups for the US manufacturing sector.[24] Our results extend their findings to a wider sample of OECD countries A summary of the empirical evidence in favour of the counter-cyclicality of the mark-up is given in Table 6 which presents the results aggregated by type of market structure. The cyclical variable is negative and significantly different from zero in three-quarters of the cases. It is important to note that the introduction of the cyclical variable tends to improve the statistical estimation of the mark-up. Moreover, correcting for cyclicality does not substantially change the average value of the mark-up, as estimated

Table 6. **The responsiveness of mark-ups to the business cycle, 1970-1992**

Estimates of the γ coefficients by type of market structure, T-statistics in parenthesis[1]

	Fragmented Industries				Segmented Industries			
	Low differentiation		High differentiation		Low differentiation		High differentiation	
United States	–0.065	(–2.12)	–0.158	(–4.63)	–0.115	(–4.06)	–0.130	(–8.16)
Japan	–0.021	(–0.58)	–0.031	(–0.56)	–0.063	(–2.46)	–0.142	(–4.64)
Germany	–0.135	(–4.03)	–0.234	(–4.54)	–0.187	(–8.67)	–0.281	(–9.86)
France	–0.078	(–1.45)	–0.077	(–0.49)	–0.019	(–0.47)	–0.067	(–1.28)
Italy	–0.158	(–2.13)	–0.030	(–0.22)	–0.088	(–1.48)	–0.114	(–1.89)
United Kingdom	–0.001	(–0.04)	–0.008	(–0.14)	–0.065	(–1.95)	0.012	(0.33)
Canada	–0.026	(–0.94)	0.048	(0.68)	–0.114	(–4.72)	–0.184	(–8.14)
Australia	–0.091	(–1.83)	–0.046	(–0.34)	–0.150	(–3.06)	–0.269	(–4.40)
Belgium	–0.093	(–3.99)	0.102	(2.11)	–0.106	(–8.32)	–0.071	(–1.56)
Denmark	–0.071	(–2.93)	–0.118	(–2.49)	–0.130	(–7.44)	–0.093	(–2.85)
Finland	–0.123	(–2.30)	–0.255	(–4.42)	–0.263	(–8.27)	–0.296	(–8.63)
Netherlands	–0.051	(–1.48)	–0.140	(–2.10)	–0.189	(–8.28)	–0.248	(–9.92)
Norway	–0.066	(–1.77)	0.005	(0.13)	–0.186	(–6.25)	–0.123	(–6.05)
Sweden	–0.120	(–2.64)	–0.077	(–2.46)	–0.127	(–3.85)	–0.250	(–7.32)

Note The cyclical variable is the output gap $[(O_A/O_T)-1]$, where O_A is actual output and O_T is trend output obtained through a H-P filter process (see main text for details)

1 A negative (positive) sign of the γ coefficient indicates a counter-cyclical (pro-cyclical) mark-up

Source Calculations on the basis of OECD STAN database (OECD, 1995, 1996) above. Therefore, the previous results can be considered as a good approximation of the average, though variable, mark-up.

These results also suggest that there are important differences in the responsiveness of price margins to the cycle by type of market structure. The estimated impact of the cycle on the mark-up tends to be higher in segmented industries than in fragmented ones. This seems to lend support to the hypothesis that the counter-cyclical pattern of mark-ups is the result of increased competition during economic booms. The latter is indeed likely to be more apparent for the industries characterised by the dominance of large firms with market power.

An appealing feature of our results is that they shed light on some macroeconomic phenomena. In particular, a counter-cyclical mark-up offers a possible explanation for the well-known puzzle of *pro-cyclical real wages*.[25] The puzzle arises from the tendency of aggregate real wages to move in the same direction as output and employment during boom periods. With counter-cyclical mark-ups, this occurrence is perfectly plausible insofar as *the* negative movement in output prices would shift the labour demand curve and thus give rise to a co-movement of output and real wages. In addition, this hypothesis would reduce the need to rely solely on technology-driven shocks to explain macroeconomic fluctuations (Barsky and Solon, 1989; Rotemberg and Woodford, 1991).

CONCLUDING REMARKS

This paper reports estimates of mark-ups of prices over marginal costs for 36 manufacturing industries and 7 service sectors in 14 OECD countries. The main results of the paper are the following:

- In general, the estimated mark-ups in the manufacturing sector are positive and statistically significant in all of the countries considered, and in almost all manufacturing industries. This suggests that departures from perfect competition are very common in the manufacturing sector.
- The estimated mark-ups for manufacturing industries are substantially lower, and more in line with observed profit rates, than those presented in previous studies. With some exceptions, their level ranges from 5 to 25 per cent.
- Mark-ups in the service sectors are generally higher than those in manufacturing, suggesting that departures from perfect competition are even more frequent in these sectors than in manufacturing. In several services, entry-restricting regulations are likely to contribute to high mark-ups.
- Where manufacturing industries are concerned, the level of mark-ups appears related to the market structure of a particular industry. They are substantially lower in fragmented industries than in segmented industries.

– Mark-ups can partly be related to competitive conditions by market structure type. Entry conditions and openness to international trade appear to contribute to the variation in mark-ups, although their effect differs by market structure type.
– Some of the variation in mark-ups may be due to innovation rents. R&D intensity is positively correlated with high mark-ups in differentiated industries. In particular, high mark-ups were estimated for radio, TV and communication equipment, drugs and medicines and computer equipment, all sectors that are likely to have significant rents from innovation.
– There is a considerable variation of mark-ups across countries and across industries. This indicates a large role for country-specific influences and policies.
– At the level of sectoral disaggregation used in this study, the tests for the cyclicality of the mark-ups suggest counter-cyclical price margins in most manufacturing industries.

There are several areas where the estimation and interpretation of mark-up ratios could be improved. *First,* it would be important to decompose the mark-up in a part due to structural characteristics of an industry (and therefore not susceptible to direct policy intervention), innovation rents (and therefore not a particular concern for policymakers) and a part that is related to entry barriers and particular policies. *Second,* in the presence of imperfections in the labour market, the estimated mark-up is not a fully appropriate measure of total product market rents, as some rents may emerge in the form of wage premia. *Third,* the mark-up estimates might be corrected for the potential downward bias induced by increasing returns, sunk costs or adjustment rigidities. It would also be interesting to disentangle the components of the total mark-up due to these factors, from the pure profits resulting from the difference between prices and average costs. *Fourth,* mark-up estimates are only one possible measure of the pricing behaviour of firms, and further evidence would be needed before drawing strong conclusions on the degree of competition in the product market. *Fifth,* the empirical evidence on mark-up pricing in the economy could have substantial implications on the analysis of macro-structural interactions, related to imperfect competition in the product markets.

NOTES

1. More precisely, under Solow's assumptions the following theorem should hold: *The productivity residual is uncorrelated with any variable that is uncorrelated with the rate of growth of true productivity* (Hall, 1990).
2. Other possible causes for the pro-cyclicality of the productivity residual have recently been discussed in the literature. For example, Burnside, Eichenbaum, and Rebelo (1995) argue that capital stocks are a poor measure of the actual capital services provided. Basu and Fernald (1995) suggest that the aggregate (economy-wide or sectoral) pro-cyclicality of the residual may be due to aggregation effects, whereas Basu (1996) argues that the pro-cyclical productivity puzzle cannot be explained by the presence of increasing returns to scale and suggests an alternative explanation based on cyclical fluctuations in labour and capital utilisation.
3. See Blanchard's (1986) comments on Hall's paper for a discussion of the plausibility and the implications of assuming sectoral productivity shocks orthogonal to the business cycle. A correlation between productivity shocks and the business cycle may explain why the estimated elasticity of output to labour is much higher than the observed labour share in national income. This is the basic assumption underlying the so-called Real Business Cycle (RBC) theory. Hall's approach offers an alternative route of explanation based on the existence of positive mark-ups.
4. Kalecki (1940) developed a theory of imperfect competition where firms set the product price as a mark-up over average variable costs. This has become a standard assumption in many macroeconomic models.
5. Thanks are due to Sveinbjorn Blondal for this insight.
6. For example, if the "true" B coefficient is 0.25 and λ is equal to 1.2, the mark-up estimated by means of the Roeger equation (*i.e.* assuming $\lambda = 1$) will be 1.10 instead of 1.33. Conversely, the presence of decreasing returns to scale induces an upward bias in the estimation of the mark-up.
7. These estimates use the available data on capital stocks and capital formation from OECD's ISDB database (Meyer zu Slochtern and Meyer zu Slochtern, 1994) and the detailed material on capital formation from STAN to derive capital stock series at the level of detail of the STAN database.
8. For Canada, Denmark and the United Kingdom, sectoral value added in STAN is available at factor cost, *i.e.* net of all indirect taxes and subsidies. In the other countries

covered by STAN, sectoral value added includes specific indirect taxes and subsidies, but excludes value-added taxes and import duties ("producer value"). This implies that the bulk of all indirect taxes will show up in sectoral value added in countries where such taxes are levied directly on goods (*e.g.* the United States, Japan and Australia), whereas they will not be reflected in sectoral value added in countries where indirect taxes are primarily levied on value added.

9. Although the STAN database is not as detailed as the information used by Roeger to calculate the mark-ups for the US manufacturing sector, the replication of Roeger's (*1995*) estimates (based on value-added) with our data set produced quite similar results.

10. The average mark-up is a weighted average of the sectoral mark-ups using gross output weights.

11. However, the estimated mark-up for food products in Japan – *1.35* – is relatively high compared with both other countries and many other sectors in Japan.

12. Hall's methodology has also been applied to other countries (*e.g.* Baba, *1995* for japan; and Van Dijk and Van Bergeijk, 1996, for the Netherlands). In general, these studies also find several industries with very high mark-ups, but also several cases with negative mark-ups. Van Dijk and Van Bergeijk also apply Roeger's method and find this yields more plausible results.

13. A survey of this literature can be found in Encaoua (*1989*) and Beath and Katsoulacos (1991).

14. Shaked and Sutton (*1983*) argue that firms in industries with differentiated products tend to increase the level of sunk costs by making strategic investments in advertising or R&D. Similarly, Leahy and Neary (1995) show that R&D joint ventures may imply a form of collusion – by lowering sunk costs for the collaborators – in markets with product differentiation.

15. See, for example, the attempt reported in Blanchard (*1986,* p. *326*) to estimate a cross-industry relation between the level of mark-ups estimated by Hall (*1986*) and concentration ratios.

16. The ranking according to R&D intensity is primarily based on the R&D intensity by establishment. The rankings according to R&D intensity per unit of output and cumulated R&D expenditures (R&D stocks) per unit of output were quite similar, with two exceptions, namely the tobacco industry and petroleum refineries. These industries were therefore classified as segmented, low-differentiated industries.

17. Among others, see Bils (*1987*) ; Domowitz *er al.* (*1988*) ; Rotemberg and Woodford (*1992*) ; Morrison (*1994*) ; Haskel *et al.* (*1995*).

18. See for example, the comments by Ramey (*1992*) on the analysis of mark-up cyclicality by Rotemberg and Woodford (*1992*).

19. It can be demonstrated that in a market characterised by oligopolistic competition, the profit-maximising mark-up level of a firm is a function of the degree of concentration in the market and the firm's conjecture of the output responses of other firms to a change in its output.

20. See the critique of Jimenez (1996) to the test for aggregate demand carried out by Roeger (1995).

21. Trend output was obtained by applying a Hodrick-Prescott filter to the output series. The weighting factor was set at 100.

22. These results are not shown here, but are available from the authors upon request.

23. In order to assess the robustness of our results to the choice of the cyclical variable, several alternative specifications of Equation [10] were considered. In particular, two aggregate measures of the cycle were considered: *i)* a measure of aggregate capacity utilisation ; and *ii)* an index of aggregate factor utilisation, based on the ratio between actual output and potential output (Giorno *et al.,* 1995). The aggregate factor utilisation index is based on the ratio between actual output and potential output, the latter being derived from OECD estimates (see Giorno *et al.,* 1995). Finally, the index of aggregate capacity utilisation is derived from the OECD Main Economic Indicators. Moreover, in order to take into account possible differences in the time lag with which mark-ups react to changes in the business cycle, two different measures of each cyclical variable were used: *i)* the current level of the variable; and *ii)* a five-year lag structure. in case *ii)* the cyclical component of the Lerner index is defined as:

$$CYCL_t = \sum_{i=0}^{4} \varphi_i Z_{t-i}$$

where Z_t accounts for the position in the business cycle at time t. The results are less clear-cut if the sectoral measure of the cycle is replaced by either aggregate capacity utilisation or aggregate factor utilisation. In both cases, a number of sectors show pro-cyclical mark-ups whereas the others show counter-cyclical or stable mark-ups. As stressed above, this is likely to be due to sector-specific factors not fully accounted for by the aggregate measures. Yet the discrepancy in the results also points to the need for a more accurate measure of sectoral demand fluctuations than the rather simple gap measure used in this study. Interestingly, the use of a five-year lag structure instead of the current GAP value did not alter the results significantly.

24. Other studies have suggested pro-cyclical mark-ups. For example, Domowitz *et al.* (1988) for US manufacturing, Morrison (1994) for Canadian manufacturing and Haskel et al. (1995) for UK manufacturing all found pro-cyclical mark-ups. However, all these studies use aggregate measures of the cycle which, for the reasons explained in the text, present a number of obvious drawbacks.

25. Keane, Moffitt and Runkle (1988) suggested, however, that pro-cyclical real wages may result from an aggregation bias and that, once individual specific variables are considered, real wages may show counter-cyclical behaviour.

Annex I

MATHEMATICAL DERIVATIONS

I) DERIVATION OF EQUATION [2] IN THE TEXT:

For a firm enjoying technical progress in the use of labour and capital, a reasonable approximation of its marginal cost can be given by the following expression:

$$MC = \frac{W \cdot \Delta L + R \cdot \Delta K}{\Delta Q - \theta Q} \qquad |A1|$$

where Q is real value added; Wand **R** are the wage rate and the rental price of capital, respectively; and q is the rate of technical progress In the denominator, the change in output is adjusted for the amount by which output would rise if there were no increase in the production inputs. Equation |A1| can be re-arranged as follows:

$$\Delta q = \frac{W \cdot L}{MC \cdot Q} \Delta l + \frac{R \cdot K}{MC \cdot Q} \Delta k + \theta \qquad [A2|$$

where lowercase variables indicate log-levels. Under the assumption of perfect competition, the shares of capital and labour in output valued at marginal costs measure the elasticity of output with respect to inputs. Under constant returns to scale, these shares sum to one.' Under these assumptions, and defining the mark-up ratio as $\mu = P/MC$, Equation |A2| can be rearranged as follows:

$$\Delta q = \mu\alpha\Delta l + (1 - \mu\alpha) \cdot \Delta k + \theta \qquad |A3|$$

where $a = W \cdot L/P \cdot Q$, i.e. the labour share in total value added By subtracting **a** (AI – Δk) from both sides of the equation, the so-called Solow residual {SR) can be obtained.

$$SR = \Delta q - \alpha\Delta l - (1 - \alpha)\,\Delta k = (\mu - 1) \cdot \alpha \cdot (\Delta l - \Delta k) + \theta \qquad |A4|$$

By replacing $\mu = 1/(1 - B)$ into equation |A4| and rearranging, Equation |2| in the text can be obtained:

$$SR = \Delta q - \alpha\Delta l - (1 - \alpha)\,Ak = B \cdot (\Delta q - \Delta k) + (1 - B) \cdot \theta \qquad [A5]$$

II) DERIVATION OF EQUATION [8] IN THE TEXT:

The "average" mark-up (μ^a), *i.e.* the ratio between prices and average costs (AC), can be obtained as:

$$\mu^a = \frac{P}{(W \cdot L + R \cdot K)/Q} = \frac{\mu}{\lambda} \qquad [A6]$$

which by definition is equal to the mark-up over marginal costs divided by an index of returns to scale *(h=AC/MC)*. Under the assumption that this average mark-up is constant, and after re-arranging, taking the total differential and changing Equation [A6] into a growth-rate form, the following relation can be derived:

$$\Delta\ (p + q) = \frac{\mu}{\lambda} \left(\frac{W \cdot L}{P \cdot Q} \Delta\ (w + l) + \frac{R \cdot K}{P \cdot Q} \Delta(r + k) \right) \qquad [A7]$$

which can also be expressed as:

$$A\ (p + q) = \frac{\mu}{\lambda}\, a \cdot \Delta\ (w + l) + \left(1 - \frac{\mu}{\lambda}\, a \right) \cdot \Delta\ (r + k) \qquad [A8]$$

Finally, by noting that $\mu = 1/(1 -$ €3) and adding an error term, Equation [8] in the text can be obtained:

$$\Delta y_t = [\lambda \cdot (B - 1) + 1] \cdot \Delta x_t + \varepsilon_t \qquad [A9]$$

where **Ax** and **Ay** are defined as in the text.

III) DERIVATION OF EQUATION [10) IN THE TEXT:

The price-based Solow residual presented in Equation [4] in the main text is based on three fundamental relationships (Roeger, 1995):

$$\Delta mc = \frac{W \cdot L}{C(\cdot)} \cdot \Delta w + \left(1 - \frac{W \cdot L}{C(\cdot)} \right) \cdot \Delta r - \theta \qquad [A10]$$

and:

$$(1 - B) \cdot P = MC \qquad [A11]$$

and, assuming a constant B:

$$Amc = Ap \qquad [A12]$$

where *mc* is the logarithm of marginal costs and *C(·)* accounts for total costs. If, however, B is defined as in equation [9] in the main text, equation [A12] becomes:

$$Amc = Ap - \frac{}{(1 - B)}\ ACYCL \qquad [A13]$$

and, consequently, equation [4] in the main text becomes:

$$SRP = \alpha \cdot \Delta w + (1 - \alpha) \cdot \Delta r - \Delta p = - B \cdot (\Delta p - \Delta r) + (1 - B) \cdot \theta - \gamma \cdot \Delta CYCL$$ [A14]

and, by taking the difference between the primal and dual Solow residual, the new specification (Equation [10] in the text) becomes:

$$\Delta y_t = \overline{B} \cdot Ax, + \gamma \cdot (CYCL, \cdot \Delta x_t + ACYCL,) + \varepsilon,$$ [A15]

Annex **2**

MEASUREMENT ISSUES

The main data source used in this study is the OECD-STAN data base. The latest version of STAN (OECD, 1996) covers 21 OECD Member countries and 36 manufacturing sectors (at the 3-4 ISIC digit-level) for the period 1970-1994. STAN provides data on the following variables. production, value added in current and constant prices, gross fixed capital formation, employment (number of persons engaged), labour compensation, exports and imports. For seven OECD countries (Austria, Greece, Iceland, Mexico, New Zealand, Portugal and Spain) covered by STAN, the available data were insufficient to estimate mark-ups at a meaningful level of detail.

The formula for the rental price of capital is (Hall, 1990):

$$R = (\rho + \delta) \frac{1 - k - \tau d}{1 - \tau} p_k$$

where ρ is the firm's real cost of funds, 6 the economic rate of depreciation, k the effective rate of the investment tax credit, d the present discounted value of tax deductions for depreciation, τ the tax rate on capital and p_k the deflator for fixed business investment. The terms related to investment taxes, capital taxes and deductions for depreciation enter in a log-additive way in the equation and do not have a strong variability through time Therefore, while they are important to compute the *level* of capital costs, these terms are not expected to have a strong influence on the *growth rates* of the rental price of capital. Also, several of these variables are not available for each industry or country. Therefore, the rental price of capital was defined more simply as follows:

$$R = [(i - \pi_e) + \delta] \cdot p_k \qquad [A16]$$

where i is the representative long-run nominal interest rate and π_e is the expected inflation rate.[2] The difference between these two terms represents the expected real cost of funds for the firm. The d coefficient can be interpreted here as the discard rate corresponding to the gross capital stock[3] In accordance with the capital stock series, this coefficient was set at 5 per cent across all sectors which is equivalent to an average service life of 20 years The final term p_k represents the economy-wide deflator for fixed business investment, and was derived from OECD's ADB database.

NOTES

1. Alternatively, if the capital stock is assumed to remain fixed from one year to the next, only labour input appears in the expression for marginal cost. This would allow the calculation of estimates which are independent of the method of construction selected for the capital stock series.
2. Nominal long-term interest rates are proxied by yields on benchmark public sector bonds of around 10 years maturity. Inflation expectations are generated using the low-frequency component of the annual percentage change in the GDP deflator using a Hodrick-Prescott filter. In the filtering process, a lambda value of 1 600 was used. The nominal long-term interest rates and GDP deflators are both derived from the OECD Analytical Database (OECD-ADB).
3. There is a trade-off between the use of gross and net capital stocks. The former only takes physical scrapping into account whereas the latter 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 stock is more suitable for the definition of production costs. From the point of view of the methodology used in this study, only the nominal variables are relevant. Consequently, the crucial point is to define the δ coefficient in a consistent way with the available capital stock series.

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