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Market Power in Manufacturing and Services Industries

Poder de Mercado nas Indústrias Transformadoras e de Serviços

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ABSTRACT
This study analyzes the extent of the market power of the manufacturing and services industries in Portugal over the last decade. The results show that Portuguese industries are mostly operating under imperfect competition. Mark-ups are heterogeneous across industries, with services having higher mark-ups on average than manufacturing. The *apparel* and the *administrative activities* industries have the highest mark-ups; in turn, the *food* and the *beverages* industries have the lowest mark-ups, while the *rubber and plastics* industry seems to operate under competitive conditions. There is therefore room for improving product market competition in Portugal.
Keywords: Mark-up ratio; Market power; Manufacturing; Services; Portugal.

JEL Classification: L13; L16; L60; D43

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1. Introduction[1]

The analysis of market power is essential for researchers, managers and policymakers to better understand the functioning of the markets, the implications that this power may have on the economy and, consequently, to support their decision making (Christopoulou & Vermeulen, 2012). In particular, the knowledge of the level of market power can be useful for regulatory reforms, which is a growing concern in Portugal. The practice of market power itself is not forbidden, but its abuse is, as it leads to a reduction in consumer welfare due to restrictions on competition. Although several studies can be found for different European countries (see Polemis & Fotis, 2016, for a survey), there are few works analyzing the level of market power in Portugal.

This study contributes to this strand of the literature by investigating the market power in the manufacturing and service industries in Portugal over the last decade. The price-cost margin has a long tradition as a measure of market power: the difference between price and marginal cost is zero under conditions of perfect competition; the larger the gap, the closer to a monopoly the industry is. However, since marginal costs are not directly observable in the data, the challenge is how to estimate them. Several authors have proposed analyzing market power using the mark-up index, defined as the ratio between price and marginal cost, where a result greater than one nullifies the hypothesis of perfect competition, using either the Solow residual or the production function (Hall, 1988; Roeger, 1995). For the purposes of this study, we estimate the mark-up index using both methods. First, we will use the macroeconomic (or industry-level) model proposed by Hall (1988) and Roeger (1995) and extended by Polemis (2014), which uses the Solow residual to estimate the market power (here abbreviated as HR). We then move on to the microeconomic methodology proposed by De Loecker and Warzynski (2012), which uses the firm's production function to estimate the mark-up index (abbreviated as DLW). As far as we know, this is the first study to apply the DLW method to the Portuguese case.

2. Background

2.1. Theoretical framework

Market power can be defined as the ability of a firm (or a group of firms acting together) to profitably raise price above marginal cost. When a firm exercises market power, it may result in allocative inefficiency. Conversely, if markets are perfectly competitive, the allocation of resources is efficient, ensuring equality between the marginal cost and price.

The degree of competition in each market depends on technology and therefore varies from industry to industry. However, competition may also be affected by factors such as the number and size of firms operating in the market, the degree of concentration, the regulatory

[1] A previous version of this work was presented by Leonor Mesquita, as a Master's Thesis, with the title "Poder de mercado em Portugal: Uma comparação das indústrias transformadoras e de serviços", under the supervision of professors Carlos Carreira and Rita Martins, at the University of Coimbra, Faculty of Economics.

regime, the degree of openness to international competition, the existence of anti-competitive behavior, product differentiation, and barriers to entry, among others (Martins et al, 1996).

The number of firms operating in a market is a key factor. In principle, the greater the number of firms, the greater the competition and the lower the market power. However, the size of the firms also affects competition. Large firms can exercise market power and deter the entry of new competitors.

There are two measures of market power widely used in the literature: the Lerner index and the mark-up index (Christopoulou and Vermeulen, 2012). The Lerner index is widely used in Industrial Organization and is given by:

$$B_{it} = \frac{P_{it} - MC_{it}}{P_{it}}, \tag{1}$$

where P_{it} denotes the price of a product produced by the firm i in year t, and MC_{it} is its marginal cost. The Lerner index varies from zero in the case of perfect competition (i.e., $P_{it} > CM_{it}$) to one in the case of a monopoly where the price exceeds the marginal cost (i.e.,).

The mark-up index is defined as the ratio between price and marginal cost and indicates how much the price of a product is higher than its marginal cost:

$$\mu_{it} = \frac{P_{it}}{CM_{it}}, \tag{2}$$

This index varies between one and infinity, and the higher it is, the greater the market power. The relationship between the two indices is: $\mu_{it} = \frac{1}{1 - B_{it}}$.

The main disadvantage of both indices is that marginal costs are not directly observable. Besides, estimating marginal costs is also not straightforward. Two main methods are proposed in the literature: the first is based on the cost function; and the second, which is the most commonly used, is based on the production function (Hall, 2018; De Loecker et al., 2020). We follow the latter study.

Hall (1988) rearranges the Solow residual by removing the assumption of perfect competition in product markets to estimate the industry-level mark-up index. The Solow residual must be independent of the log variation in output if there is no monopoly. The problem with Hall's (1988) methodology, however, is that technical progress is not a directly observable variable. Roeger (1995) proposes a solution that eliminates this problem. Instead of the Solow residual based on the production function (primal), he creates the Solow residual based on the cost function (dual). By subtracting both equations, technical progress is eliminated (see Section 3.2 for a more detailed technical description). The advantage of the HR method is its ease of implementation.

De Loecker and Warzynski (2012) estimate the firm-level mark-up index linking the production function, input shares and the price-cost margin. The empirical implementation of the DLW method is straightforward, as it is determined by the relationship between the

input elasticities and the input shares in production (see Section 3.3 for a detailed technical description).

The DLW method is advantageous not only because it does not require a model of firm demand or input prices, but also because it makes use of directly observable data (De Loecker et al., 2020). Moreover, it does not assume the rather restrictive hypothesis of constant returns to scale, which in the case of the HR method is likely to give us a biased assessment of mark-ups.

2.2. Related literature

While the HR and DLW methods have been increasingly used in various studies, there are only a small number of studies on Portugal. Most of the studies conclude that the mark-up ratio exceeds unity in a large number of industries, thus the hypothesis of perfect competition is rejected.

We begin the literature review by mentioning works that use the HR method. Martins et al. (1996) estimate mark-ups for 36 manufacturing industries in 14 OECD countries for the period 1970-1992. They found that mark-ups greater than one are statistically significant in all countries and in almost all manufacturing industries, indicating deviations from perfect competition. The authors conclude that the level of mark-ups is directly related to the market structures of a given industry and is significantly lower in fragmented industries than in concentrated ones. The highest mark-ups for radio, television and communication equipment, pharmaceutical products, and computer equipment can be explained by innovation. They also conclude that the differences between countries can be explained by the specific policies of each country.

Christopoulou and Vermeulen (2012) confirmed the findings of Martins et al. (1996) by analyzing 50 industries in eight countries in the Eurozone and the US over the period 1981–2004. In particular, the authors found that mark-ups are generally greater than one and therefore rejected the perfect competition hypothesis for almost all industries in all countries. Christopoulou and Vermeulen (2012) also observed heterogeneity in mark-ups both across countries and across sectors, with the services sector having a higher index than manufacturing. Comparing the euro area with the US, services have higher mark-ups in the euro area, while the opposite is true for manufacturing.

Borg (2009) also conducted a study of 15 industries for 22 EU countries for the period 1990–2006 (due to a lack of data, some countries were studied only for the period 1994–2005). The mark-up values range from 1.46 (Cyprus) to 1.22 (Switzerland), with most values in the range of 1.25 to 1.35, nullifying the hypothesis of perfect competition. Portugal does not stand out as it ranks 17th in the mark-ups. Looking at the individual sectors of the economy, the author concludes that the highest mark-ups are in *agriculture*, *fishing*, *publishing and printing*, *furniture*, *trade and maintenance of motor vehicles*, *hotels and restaurants* and *real estate*. The lowest mark-ups are observed in the manufacturing activities, especially in the export-oriented sectors. Overall, the average mark-ups in the services are higher than in manufacturing in all countries studied, findings that are backed up by Christopoulou and Vermeulen (2012).

Bottini and Molnár (2010) analyzed the services sector in 21 OECD countries for the period 1993–2006 and found that mark-ups tend to be higher in professional services, real estate, rentals and utilities and substantially lower in construction, computer services, wholesale and retail trade and restaurants. They also found that there are large differences between countries, with higher values for Central European members and for Italy, Portugal and Sweden, while the United Kingdom and most Scandinavian countries have lower mark-up values.

In the case of Portugal, Alves and Figueira (2019) analyzed the period 1910–2016 and also rejected the hypothesis of perfect competition. The industries with the highest mark-up are electricity, gas and water, and transport and communications, which can be explained by the fact that they are capital-intensive sectors and therefore have strong economies of scale. The lowest mark-up is in the trade sector, which consists of numerous micro-enterprises and only a few large firms. The authors conclude that regulatory reforms should be strengthened to increase competition in Portugal.

In contrast to the above studies, Polemis and Fotis (2016) found that there is no evidence of imperfect competition in most manufacturing and service industries in the Eurozone, the US and Japan in the period 1970–2007, as estimated mark-ups are generally no higher than unity. Service industries have higher average mark-ups than manufacturing and the Eurozone exhibits the lowest mark-ups. Industries that are more open to internationalization, along with those that are deregulated, have relatively lower mark-ups than industries that are less open and regulated.

Recently, some authors have been using the DLW method to determine the mark-up index. For example, Weche and Wambach (2021), who studied 17 EU countries over the period 2007–2015, showed that there was a sharp decline in average mark-ups during the crisis years of 2008 and 2009, followed by a post-crisis increase. Conversely, García-Perea et al. (2021) found that mark-ups increased during the Great Recession (2008-2013) in Spain, and that small firms had greater market power than their larger competitors in the same industry. Finally, Dai and Cheng (2018) observed that product innovation significantly increased the mark-up of Chinese manufacturing firms during the period 1998–2007.

3. Data and Methodology

3.1. Data

Our data are extracted from the Integrated Business Accounts System (Portuguese acronym, *SCIE*), administered by the Portuguese Statistical Office (INE), and produced under the project ENtRY (grant FCT No. PTDC/EGE-ECO/31117/2017). It covers all enterprises operating in the manufacturing and service industries in Portugal, except the financial sector, and education, health and cultural services, for the period 2010-2019.

After apply cleaning filters,[2] the final dataset encompassed 480,993 firms and consisted of 2,794,324 year-firm observations.

The database contains detailed input and output information required for the computation of firm-level mark-ups. The gross output was measured as the value of production and deflated by the producer price index at the two-digit industry level. Materials included the cost of materials and services purchased and were deflated by the GDP deflator index. Capital was computed by applying the perpetual inventory method to the changes in tangible and intangible assets, and book values were deflated by the GDP deflator index.

3.2. Macro-approach of Hall (1988) and Roeger (1995)

Our first approach uses the methodology developed by Hall (1988) and Roeger (1995) and extended by Polemis (2014), who adds intermediate inputs to the production function. The inclusion of this new input allows mark-ups to be defined using gross output, overcoming the upward bias that would result if value added were used instead.

Assume the production function of an *industry* that is homogeneous of degree one (returns to scale) and defined as follows:

$$Y = Af(L, M, K), \tag{3}$$

where Y represents the gross output, L, M and K are the labor, intermediate (materials) input and capital, respectively; A denotes the multifactor productivity growth (Hicks-neutral technical progress). Considering a Cobb–Douglas production function (in log form), equation (3) can be rewritten as follows:

$$y = \varepsilon_L l + \varepsilon_M m + \varepsilon_K k + \theta, \tag{4}$$

where lower-case letters denote the log of corresponding upper-case variables in (3); θ is the technical progress; and ε_f denotes factor elasticities, with $f = L, M, K$.

Under constant returns to scale and perfect market competition of product and labor, the elasticities are equal to the observed input shares. In the case of imperfect competition, the elasticities correspond to input shares and the mark-up, that is:

$$y = \mu\alpha_L l + \mu\alpha_M m + \mu\alpha_K k + \theta, \tag{5}$$

where α_f are input shares and μ is the mark-up defined by equation (2). Assuming constant returns to scale and given that $\mu = \frac{1}{1-B}$, equation (5) can be rewritten as the Primal Solow Residual:

[2] We omitted data with missing or non-positive output, employees, cost of purchased materials and services or total net assets.

$$PSR = y - \alpha_L l + \alpha_M m - (1 - \alpha_L - \alpha_M)k = B(y - k) + (1 - B)\theta, \quad (6)$$

This equation can be used to calculate B, the Lerner index, and therefore μ. However, because the term $(1 - B)\theta$ is not observable, instrumental variables become necessary to obtain consistent estimates. Roeger (1995) proposed eliminating the unobservable term by combining the primal and dual solutions, DSR, by using the cost function associated with the production function (4) as follows:

$$DSR = \alpha_L w - \alpha_M p - (1 - \alpha_L - \alpha_M)r - P = (1 - B)\theta - B(P - r), \quad (7)$$

where w denotes the wage, p, r and P are the prices of materials, capital and final product. Subtracting the equations (7) and (6), an expression for B is (adding an error term e):

$$\Delta y = B\Delta x + e, \quad (8)$$

where $\Delta y = (y + P) - \alpha_L(l + w) - \alpha_M(m + p) - (1 - \alpha_L - \alpha_M)(k + r)$ and $\Delta x = B[(y + P) - (k + r)]$.

Since there are no price series for capital, we use the approach of Hall and Jorgensen (1967):

$$r = (i - \pi_e + \delta)P_t, \quad (9)$$

where P_t is the GDP deflator, $(i - \pi_e)$ is the real interest rate and δ is the depreciation rate, which is set at 5% across all sectors. The real interest rate is the long-term interest rate minus the expected inflation rate.

3.3. Micro-approach of De Loecker and Warzynski (2012)

De Loecker and Warzynski (2012) assumes a production function with Hicks-neutral technology as a starting point:

$$Y_{it} = f_{it}(A_{it}, L_{it}, M_{it}, K_{it}), \quad (10)$$

where subscripts i and t refer to firm and year, respectively.

The firms are cost-minimizing. Therefore, their optimization problem can be written as a Lagrangian function:

$$LG(L_{it}, M_{it}, K_{it}, \lambda_{it}) = w_{it}L_{it} + p_{it}M_{it} + r_{it}K_{it} + \lambda_{it}[Y_{it} - f_{it}(.\,)], \quad (11)$$

where λ_{it} is the Lagrange multiplier.

To compute firm-level mark-ups, De Loecker and Warzynski (2012) consider labor as the baseline variable input of reference. However, given the rigidities in the Portuguese labor market, labor is a quasi-fixed input that can be associated with market power on both

the consumer and seller side (e.g., the bargaining power of workers). We therefore use the materials input as it is a more flexible input, free of adjustment costs (Dai and Cheng, 2018; García-Perea et al., 2021).

The first-order condition with respect to intermediate inputs is:

$$\frac{\partial LG_{it}}{\partial M_{it}} = p_{it} - \lambda_{it} \frac{\partial f_{it}(.)}{\partial M_{it}} = 0, \tag{12}$$

where $\frac{\partial f_{it}(.)}{\partial M_{it}}$ is the marginal productivity of intermediate input. Rearranging equation (12) and multiplying both sides by $\frac{M_{it}}{Q_{it}}$ we get:

$$\frac{\partial f_{it}(.)}{\partial M_{it}} \frac{M_{it}}{Q_{it}} = \frac{1}{\lambda_{it}} \frac{p_{it} M_{it}}{Q_{it}}. \tag{13}$$

Note that $\frac{\partial L_{it}}{\partial Q_{it}} = \lambda_{it}$ is the shadow cost, which represents the marginal cost of production for any given level of output Q_{it}, therefore mark-up can be defined as $\mu_{it} = \frac{P_{it}}{\lambda_{it}}$. Using the optimality condition (13), firm-level mark-up can be measured as:

$$\mu_{it} = \frac{\varepsilon_{it}^{M}}{\alpha_{it}^{M}}, \tag{14}$$

where $\varepsilon_{it}^{M} = \frac{\partial f_{it}(.)}{\partial M_{it}} \frac{M_{it}}{Q_{it}}$ is the output elasticity of materials, and $\alpha_{it}^{M} = \frac{p_{it} M_{it}}{P_{it} Q_{it}}$ is the share of expenditures on materials in sales revenue.

While the computation of α_{it}^{M} from the data is straightforward, firm-level estimates of ε_{it}^{M} cannot be easily obtained. Assuming that all firms within an industry share the same technology, we estimate the Cobb-Douglas production function (4) using the estimator proposed by Levinsohn and Petrin (2003).

4. **Empirical Results**

The empirical results from using the HR and DLW methodology – equations (8) and (14), respectively – are shown in Table 1.[3] The mark-ups exceed unity for both methods, except in the *rubber and plastic products* and *transport and storage* industries for the HR method.[4] Therefore, the scenario of perfect competition for the Portuguese manufacturing and service industries over the period 2010–2019 is rejected for almost all industries. The clear excep-

[3] Estimates were made using the "markupest" command of Stata/SE 16.0 software (Rovigatti, 2020).

[4] Caselli et al. (2018) documented the incidence of firms displaying mark-ups lower than unity (markdowns) for French manufacturing firms for the period 1990–2007.

tion seems to be the *rubber and plastics* industry, where the mark-up for the HR and DLW methods is almost one, indicating the presence of competitive conditions (in the case of the *furniture* industry, the result is also significantly equal to one, but only for the DLW method).

In general, mark-ups are higher for the HR method than for the DLW method – the average mark-ups are 1.815 and 1.350, respectively. This could be due to the fact that the DLW method is conducted at the firm level and can therefore better capture the market power of the firms (Rovigatti, 2020). The average HR mark-up estimated in this study is higher than the estimated mark-ups for Portugal by Alves and Figueira (2019), who reported values of 1.49 in 2012 and 1.41 in 2016, and by Borg (2009), who reported an index of about 1.25 for the period 1990–2006. In the case of the DLW method, the average mark-up in manufacturing is similar to the estimates by De Loecker and Warzynski (2012) for Slovenian manufacturing firms in the period 1994-2000, but lower than the median value of 1.84 estimated by Weche and Wambach (2021) for 17 EU countries in the period 2007-2015.

Table 1: Mark-up index by sector, 2010–2019

CAE	Industry	HR	DLW
10	Food products	1.1448	1.1571
11	Beverages	1.1954	1.1135
13	Textiles	2.1084	1.3926
14	Wearing apparel	2.9678	2.1626
15	Leather and related products	1.3176	1.6171
18	Printing and reproduction of recorded media	3.1653	1.2335
20	Chemicals and chemical products	1.9516	1.1996
22	Rubber and plastic products	0.9510	1.0565
23	Other non-metallic mineral products	1.5260	1.1980
24	Basic metals	1.2358	1.3312
25	Fabricated metal products (except machinery/equipment)	1.8311	1.1340
26	Computer, electronic and optical products	1.2892	1.2292
27	Electrical equipment	1.4685	1.1593
28	Machinery and equipment n.e.c.	1.7102	1.1932
29	Motor vehicles, trailers, semi-trailers and accessories	1.5129	1.2996
31	Furniture	2.25760	1.0179
32	Other manufacturing activities	2.27565	1.3969
33	Repair and installation of machinery and equipment	2.1687	1.4414
37-39	Sewerage, waste management and remediation activities	1.7767	1.4187
41-43	Construction	1.1393	1.3639
45-47	Wholesale and retail trade; repair of motor vehicles	2.7114	1.4798
49-53	Transportation and storage	0.7846	1.2902
58-63	Information and communication activities	1.9699	1.4989
69-75	Consultancy, scientific and technical activities	2.1179	1.5992
77-82	Administrative and support service activities	2.7937	1.7646

Notes: HR and DLW denote Hall (1988) and Roeger (1995) method and De Loecker and Warzynski (2012) method, respectively. Two-digit level of the Portuguese Classification of Economic Activities (CAE-Rev.3). At this disaggregation level there is a direct correspondence between the CAE and the classifications of both the European Community (NACE-Rev.2) and the United Nations (CITA-Rev.4).

There are significant differences across industries. According to the HR method, the highest market power is found in the *printing* industry with a mark-up of 3.165. However, this result is not confirmed by the DLW method. Borg (2009) also found that the *printing* sector has relatively high HR mark-ups in 22 EU countries.

Both methods agree that mark-ups are relatively high in *wearing apparel* and *administrative activities*—in fact, they have the highest values in the DLW method, where average mark-ups are 116% and 76% above marginal costs, respectively. In the first-mentioned industry, the high mark-ups can be explained by innovation and the export behavior of firms (Martins et al., 1996; De Loecker and Warzynski, 2012; Dai and Cheng, 2018). According to Fraga et al. (2008), the apparel industry has one of the highest shares of patented production in Portugal. Moreover, this industry is increasingly engaged in international trade, with a positive trade balance of 982.4 million euros in 2019 (source: PORDATA). In the latter industry, the explanation may be different, as there is a high and growing number of large firms.

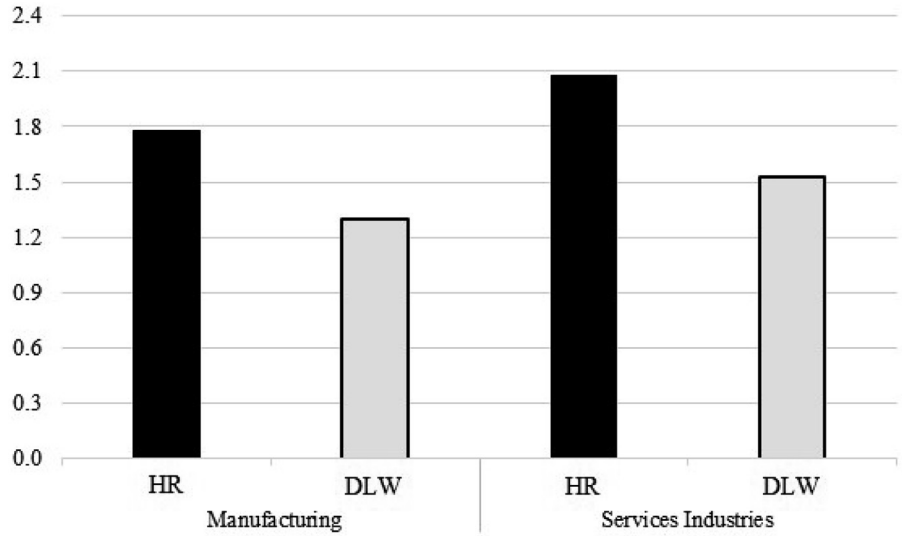
The trade industry also has one of the highest mark-ups for both methods. There are, in fact, several micro-enterprises in this industry, however, a few, but very large, firms may exercise market power. Borg (2009) also found a high mark-up for trade, in contrast to the low mark-ups found by Bottini and Molnár (2010) and Alves and Figueira (2019).

The *consultancy and scientific* and *information and communication* sectors also have one of the highest mark-ups, but only for the DLW method. The high market power in the latter could be due to the telecommunications sub-sector. Indeed, there is a lack of competition, resulting in high prices in this sector, with three operators accounting for almost all the market share (OECD, 2021). Alves and Figueira (2019) also reports high market power in the *communication* sector.

According to the two methods, mark-ups are low in the *food* and *beverages* industries – mark-ups are 14/16% (HR/DLW method) and 20/11% above marginal costs, respectively. These two industries – as well as the *rubber and plastics* industry, which was considered competitive – face strong foreign competition on the domestic market (the trade balance is negative; source: PORDATA).

Finally, Figure 1 compares the average mark-ups of the manufacturing and services industries according to the two methods. Mark-ups are higher in the service sector than in the manufacturing sector as found in almost all the studies discussed in Section 2.2.

Figure 1: Average mark-ups of manufacturing and services industries



Note: HR and DLW denote Hall (1988) and Roeger (1995) method and De Loecker and Warzynski (2012) method, respectively.

5. Concluding Remarks

This study analyzed the extent of market power of the manufacturing and services industries in Portugal over the 2010-2019 interval. We used two different methodologies: the macroeconomic (i.e. industry-level) model of Hall (1988) and Roeger (1995) and the microeconomic (i.e. firm-level) model of De Loecker and Warzynski (2012). The empirical analysis was conducted at the two-digit level, which allowed for the examination of differences across industries.

Estimated mark-ups are higher than unity in almost all industries, suggesting that Portuguese firms in the manufacturing and services industries exercise market power. Mark-ups are heterogeneous across industries, with services having higher mark-ups on average than manufacturing, which is in line with the findings of previous studies. Both methods agreed that the *apparel* industry and *administrative activities* have the highest levels of market power; the *food* and the *beverages* have the lowest; and the *rubber and plastics* industry seems to operate under competitive conditions. The *printing* industry also has a high murk-up, according to RH method, but this is not confirmed by the DLW method.

The number of firms operating in each industry is not the only factor explaining these different levels of market power. Size, regulatory regime, degree of openness to international

competition, and product differentiation, among others, can also be important factors in explaining market power. Thus, there is room for the government, and regulators especially, to improve competition in product markets. For the future, it would be important to study the explanatory factors of market power more thoroughly in the different industries and their evolution over the past decades.

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