DISCUSSION PAPER

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TRADE AND COMPETITION: MARK-UPS, CONCENTRATION, AND INTERNATIONAL ORIENTATION – DISCUSSION AND EMPIRICAL TESTS FOR BRAZILIAN MANUFACTURING SECTORS

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ABSTRACT

This paper discusses the relation between trade and competition, revising the literature and using indicators, build with Brazilian industrial survey (PIA/IBGE) and foreign trade (Comtrade) data. The premise is that the structure of domestic competition is explained by concentration indices, such as CR4 and HHI, which show positive correlation with profit margins of the Brazilian manufacturing sector. Other indicators exert negative effects on the dependent variable – the mark-up –, prices in excess to costs (PCM), among of which stand out import penetration and the export orientation of sectors. In addition to these, investment propensity (entry) and the labor factor wield negative effects on the dependent variable. The exercise is based on a recent literature relating mark-ups, market concentration and globalization processes (investment, trade) in the world economy. Our purpose is to extend these discussions and findings to the Brazilian case. Empirical results show relevant statistical significance of explanatory variables in different estimation methods (OLS, Fixed and Random Panel, GMM). Though there are empirical regularities, some methodological limitations suggest the application of instrumental variables, build with UNCTAD data. The fundamental goal is to indicate possible methodologies and discussions for evaluating trade and competition policies in the context of the Brazilian economy.

Keywords: competition indicators; market structure; competition defense; empirical tests; international competition; investments.

SINOPSE

O trabalho discute o emprego de indicadores construídos com dados de setores industriais (Pesquisa Industrial Anual – PIA/Instituto Brasileiro de Geografia e Estatística – IBGE) e de comércio exterior (Banco de Dados das Estatísticas do Comércio Internacional das Nações Unidas – Comtrade), além de sua aplicação na discussão de políticas públicas, em especial nas políticas de concorrência e de comércio exterior. A premissa básica é que a estrutura da competição doméstica, manifestada em índices de concentração, como o CR4 e o HHI, tem correlação positiva com a variável dependente – a margem de lucro, ou *mark-up* –, preços em excesso aos custos. Outros indicadores teriam a capacidade de afetar negativamente a lucratividade, entre os quais se destacam as variáveis relacionadas à competição internacional, como a penetração das importações e o coeficiente de exportações. Portanto, o trabalho se propõe a verificar qual o impacto da concorrência internacional na margem de lucro doméstica. Adicionalmente, o nível de investimento (entrada) e o conteúdo de fator trabalho afetam negativamente o lucro. Os resultados empíricos demostram significância estatística, em diferentes métodos de estimação (mínimos quadrados ordinários – MQO, painel de efeitos fixos e efeitos aleatórios, método generalizado de momentos – GMM). O exercício baseia-se em literatura recente relacionada a aumento dos lucros, da concentração setorial e dos processos de globalização (investimento, comércio exterior) na economia global, visando aplicá-los ao caso e aos dados brasileiros. Regularidades empíricas são observadas, guardadas limitações metodológicas que sugerem a aplicação de variáveis instrumentais (dados da Conferência das Nações Unidas sobre Comércio e Desenvolvimento – UNCTAD). O objetivo fundamental é indicar possíveis metodologias e discussões para avaliação de políticas de comércio exterior e de concorrência, no intuito de aumentar a eficiência produtiva da economia brasileira.

Palavras-chave: indicadores de concorrência; estrutura de mercado; defesa da concorrência; testes empíricos; competição externa; investimentos.

1 INTRODUCTION[1]

Developed by the economic theory and adopted by government authorities to monitor public policies, indicators are policy tools in competition, trade and investment analysis. This work reviews the literature and performs empirical tests aiming to discuss the adoption of such indicators to evaluate competition and market power in the Brazilian context, as well as to guide public policies. Recent literature on the contemporary global economy has highlighted an increase in market power and concentration. This paper analyzes a policy literature on antitrust and trade and builds and applies domestic indicators in order to evaluate the Brazilian experience vis-a-vis these global trends.

The main indicator is the price-cost margin (PCM), the dependent variable to be explained, extensively used in the literature as a market power indicator. Concentration, import penetration, export orientation and "barriers to entry", among others, are explanatory variables. These variables are gauged in econometric models in ordinary least squares (OLS), fixed (FE) and random effects (RE) panels, and generalized method of moments (GMM), with data from Brazilian industrial surveys (PIA/IBGE) and from Comtrade/UN, for the years 2007 to 2018. The period after the 2008 subprime financial crisis is characterized by deepening globalization and by a process of increasing economic concentration and, therefore, competition retreating in several countries, with impacts on inequality and productivity, according to many authors. The impact of these recent processes on the domestic structure of the Brazilian economy deserves greater scrutiny, especially due to the low international trade participation of the country. The study aims to fill this void, and it also touches the issue of economic fairness due to the current situation of global pandemic.

The modern theory of international trade indicates that liberalizing the domestic economy to trade and investment diminishes the market power of incumbent firms in sectors with oligopolist or monopolistic structures. Thus, this research wishes to untangle these international competition effects: how trade participation of domestic manufacturing sectors may affect their margins. The basic premise is that sectors with greater exposure to international competition have smaller mark-ups. Measures of *entry*, that is, the easiness of establishing new companies, would also change market power and profits of incumbent firms. Finally, sectors with higher intensity of the labor factor, in an open economy, often display lower profit margins. In order to emphasize a more practical aspect, this paper indicates the possible applications for trade and investment policies

1. This work had the support of Felippe Bispo and Cauan Cardoso in the preparation of the database. This is an extension, with a Brazilian database and additional estimation methods, of the working paper from the Department of Economic Studies of the Administrative Council of Economic Defense (DEE/CADE) (Oliveira, 2017).

and suggesting the disciplinary power of international competition for the Brazilian economy, in an international framework marked by market concentration and globalization.

On the methodological side, the literature of empirical industrial organization challenges market structure explanations, due to the problem of the direction of causality between concentration and profit. Hence, this paper suggests some empirical regularities and proposes the use instrumental variables – factors of production (capital, human capital, natural resources) – in the empirical exercises. The exogenous variables are evaluated according to classical trade theory models (Heckscher-Olin, henceforth H-O), which assume constant factor content of products across countries. Hence, there is an optimal basket of inputs that correlates with the concentration structure, but do not relate to the price-cost margin (PCM). These assumptions will be further explained.

We seek to combine Brazilian industrial surveys (PIA/IBGE) with international data (Comtrade/UNCTAD), in order to compare the Brazilian case with the current economic discussion regarding mark-ups and concentration in world markets. The rather recent time span (2007-2018) also allows for contemporary discussions.

Results are partially robust – they indeed suggest that less concentrated industrial sectors and those subject to entry would tend to have lower profit margins. Along these lines, labor share also has a negative relationship with profit. However, in broader specifications, empirical exercises found inconclusive results regarding profit margins and trade variables. Hence, more parsimonious models – keeping just concentration and trade indicators – are tested and the statistical validity of international competition variables is visible; in these, trade exposure has a strong negative correlation with PCM. In most specifications, the estimates are robust with the introduction of instruments for HHI and CR4. There is a decrease in the explanatory power in the presence of weak instruments, but the instrumental variables pass the test of validity. Econometric models are estimated with ordinary least squares (OLS), fixed (FE) and random (RE) effects panel data, with and without instrumental variables, and the Generalized Method of Moments (GMM) for the period 2007 to 2018.

In addition to this introduction, the second section presents the theoretical motivation and a review of the academic and applied literature (antitrust/trade policy). The third section presents the indicators that will be used in the empirical exercise. Section four describes data sources, discusses the empirical strategy of the econometric exercise and present results. Discussions regarding competition, foreign trade and investment aspects, such as in the detection of cartels and anti-dumping, are presented and discussed in the sections. The last section retrieves the discussions, summarizes the findings and concludes.

2 LITERATURE REVIEW AND CONCEPTUAL DISCUSSION

Economic science in the field of industrial organization has discussed sectoral indicators as a way to measure market structure (Bain, 1956; Stigler, 1968; Schmalensee, 1989). Conversely, an applied literature discussed their effectiveness in competition policy (Hovenkamp, 2005; Polder et al., 2009; Schiersch and Schmidt-Ehmcke, 2010). Recently, several studies have observed the relation between domestic competition and globalization (trade and investment) (De Loecker and Biesebroeck, 2016; De Loecker and Eeckhout, 2017; Gradzewicz and Mućk, 2019; Weche and Wambach, 2018). The antitrust literature has traditionally used competition indicators to assess mergers and acquisitions, as well as anti-competitive conducts, and their effects on markets. Indicators also seek to improve the impact of competition policies and institutions on economic performance, such as factor productivity and economic growth (Besley, Fontana and Limodio, 2021; Buccirossi et al., 2011). The competition measures also evaluate policy outcomes, such as the number of mergers judged, and cartels convicted.

Adequate structural conditions, such as less concentrated markets and with absence of barriers to entry and exit, create incentives for companies to compete. Therefore, allocative and productive efficiencies and technical progress are enhanced in the presence of a competitive economic environment (Stigler, 1968). In this situation, the well-being of consumers would be maximized.[2] There is a strong relationship between economic concentration and market power. Economic theory shows how monopolies and oligopolies restrict production and increase prices, undermining economy efficiency and consumer welfare. Thus, concentrated structures tend to lead to market power – expressed in the ability of firms to price in excess to costs. Therefore, market concentration is an aspect that stands out in competition analysis: both academic economists and policymakers assess that, given certain conditions, excessive concentration causes harm.

This debate was revived after the *sub-prime crisis* of the late 2000s and, allegedly, there is an increase in *mark-ups* and concentration in domestic economies, despite the process of competition brought by globalization. Increasing market power associated with higher concentration and profit rates seems to be an ubiquitous characteristic of the contemporary capitalist economy, especially documented in the U.S. case (Grullon, Larkin and Michaely, 2019).

2. It is important to highlight the differences between productive efficiency and allocative efficiency. The first refers to a decrease in production units, for example, due to technological improvement that eliminates costs. Allocative efficiency is a theoretical concept referring to the maximum general well-being of a society – a result that makes at least one person better without harming any other – a superior Pareto result (Hovenkamp, 2005).

The Theory of *Structure-Conduct-Performance* (SCP) argues that there is a one-way causality going from the structure (concentration) to the conduct (prices) and to the performance (profits, innovation, growth) in economic sectors. It claims that high concentration would lead to higher prices and profits, with dubious results in relation to innovation (Carlton and Perloff, 2005; Davis and Garcés, 2010; Ellickson, 2015). In complete market models, such as perfect competition or monopoly models, the structure determines conduct – the rules of behavior followed by buyers, sellers and potential entrants. Hence, performance can be estimated by comparing the results of conduct in an ideal model *(first best).* For example, sectors with higher concentration, not only would have higher prices, but also a tendency to collusion through cartels. Sectors with low probability of entry and high economies of scale (ex. chemicals, steel, cement, mining) are naturally susceptible to collusive practices.

According to Carlton and Perloff (2005), SCP studies adopt the following methodology: first, they obtain performance and structural measurements; hence, they perform cross-section econometric estimates comparing economic sectors. Two types of performance measurements try to assess directly or indirectly how sectors are close to the competitive benchmark: i) *rate of return* (profits) – the ratio of earned profits by invested amount; and ii) *price-cost margin* (PCM) – the difference between prices and marginal cost (or variable cost), also known as *mark-up.*

In order to assess the structural conditions of the economy, scholars and policymakers have been applying indicators. Among those, concentration measures stand out. For instance, the market share of the four (CR4) or eight (CR8), large companies or the Herfindahl-Hirschman index (HHI), and the number of companies. They have been used as explanatory variables.

Recent studies emphasize *changes* rather than *levels* of concentration as a mechanism to gauge market structure for competition enforcement (Nocke and Whinston, 2020). This recent work examines filters for evaluating horizontal mergers employed by the U.S. authorities (Department of Justice – USDOJ; The Federal Trade Commission – FTC), emphasizing two specific points: first, there is theoretical and empirical justification for basing decisions on mergers observing only the *change* of HHI, ignoring the *level*, without harmful effects; secondly, the alleged level in which there is absence of harm to consumer is currently very lenient, especially with regard to the guarantees of a minimum non-harmful concentration standard (called *Safe Harbor*, by the U.S. authorities).

Indicators can also provide insights about the contemporary world economy. In the atomized environment of perfect competition, companies offer similar and homogeneous goods and have the same information, which makes them *price-takers*. The equilibrium of price and quantity is given by interactions between supply and demand and within firms when price equals marginal cost. Yet, imperfect competition is the most ubiquitous scenario, with a tendency to concentration

due to the presence of economies of scale, transaction costs, strategic behavior, cutting edge technologies and factors intensity in production, among others. Companies that hold market power can influence the final prices of their products, which makes them *price-makers*, and they may also be able to price discriminate among different consumers, depending on elasticities of substitution. Thus, concentration is not always sufficient to characterize the lack of competition in markets, as in the case of innovative companies with high intensity of Research and Development (R&D), which may acquire temporary monopoly power due to intellectual protection legislations (Park, 2009). Similarly, the decrease in concentration when a collusion agreement is discovered may remove companies from the market, not necessarily making it less competitive (Boone, van Ours and van der Wiel, 2013).

Recent studies have sought to understand the micro and macroeconomic forces responsible for developments in the contemporary economy, especially since the *sub-prime* financial crisis of the late 2000s. The dominant position confirms the trend towards higher *mark-ups* and market concentration, in an economic structure characterized by technological innovations and increased globalization. Using a methodology that estimates the *mark-ups* computed with elasticities of demand for production inputs and with micro data from firms, this literature also verifies that increasing productivity and decreasing market power are associated with greater economic openness (De Loecker and Biesebroeck, 2016; De Loecker and Eckhout, 2017). International competition effects come from import share in domestic consumption, also associated with integration in global value chains, which exercise a negative effect on domestic *mark-ups* (Gradzewicz and Mućk, 2019). There are, however, heterogeneous effects with the same type of data from European firms, which verify pro-competitive effects of competition with imports but show no conclusive effects of foreign direct investment on domestic mark-ups (Weche, 2018; Weche and Wambach, 2018).

The verticalization of production chains may be associated with greater competition and productive efficiency, even if there is a greater concentration in domestic markets. Thus, concentration does not necessarily increase market power, following the tradition of a school of antitrust policy, which was prevalent in economic policy circles in the U.S. in recent decades. According this strand, empirical evidence on the increase of mark-ups and market power is unconclusive (Berry, Gaynor and Morton, 2019). There is also the macroeconomic explanation to which the higher returns of the capital in relation to the labor factor would explain the recent increase in mark-ups in the United States, also related to productivity gains (Basu, 2019; Syverson, 2019). On the other hand, other studies suggest that concentration indicators exert unambiguous competitive effects on mark-ups and the recent period is associated with disproportionate returns of the capital share in relation to the labor share as factors of production (Stansbury and Summers, 2020).

The current work does not observe directly the issue of productivity, however, it maintains the premise of the positive effects of concentration and negative effects of globalization on *mark-ups*, as it attempts to study the Brazilian case. Empirical results point to this direction. Hence, this article aims to discuss and test some models with selected indicators, described in the next section.

On the strong hypothesis that, in the presence of free trade, the productive conditions between countries would be the same – the hypothesis of equalization of the prices of factors of production, proposed by the Heckscher-Ohlin Theorem (H-O). According to the H-O framework, production factors are immobile, so each product carries a certain optimal level of inputs and markets would efficiently allocate production factors. Economic openness would have different impacts on different sectors and would improve the efficient allocation of factors of production. According to the level of factor composition of each economic sector and the total composition of the domestic economy, there would be greater or lower gains derived from trade liberalization, but the result would bring general welfare gains for both domestic and international economy. For example, if a country is endowed with natural resources and predominantly agrarian, integration to the international economy would benefit those domestic sectors with the highest content of natural resources (land). Specialization would ensue and lead to higher exports to world markets at better prices, benefiting the world economy.[3]

International economics theory has also developed robust models in which the factors of production are mobile; therefore, in a free trade structure, the optimal level of production would be achieved through a flow of production factors between different sectors, so that trade opening would reinforce different trends of productive specialization, with clear variations between sectors and countries. The degree of market power and concentration between different sectors also affects where such resources would be applied. The labor factor is often more mobile when compared with the capital factor. Differences in aggregate value among sectors would be defined by this possibility of flow (Feenstra, 2004; 2018). Finally, a modern theory of international trade strand discusses the heterogeneity between firms with different contents of productive specialization directly affected by the degree of trade openness: firms closer to the optimal production frontier would benefit from free trade due to the expansion of the market and scale effects. The competitive advantage would be directed to sectors with a higher level of productive innovation in monopolistic competition setting with product differentiation (Mayer, Melitz and Ottaviano, 2016; Melitz and Ottaviano, 2008). The gains derived from trade openness are related to the capacity for innovation and creative destruction of firms. Market size expansion leads to productivity gains and such expansion would also be expressed in greater *mark-ups*. Hence, in that case market power and concentration may lead to more competition.

3. This is an established and empirically tested theory, but still subject to criticisms that this article does not deepen (Baldwin, 2008).

The models described here are discussed in the results of empirical tests. However, the initial framework (H-O) is predominant in the analysis. We attempt to highlight the complex relationship between productive concentration, market power and domestic and international competition. Therefore, the empirical exercise proposed here is quite objective and aims to seek some empirical regularity, in view of the existence of alternative models and the recent evolution of the literature.

Our aim is to pin down the Brazilian case in face of a global trend. The figures A.1-A.3 in the appendix A show the recent evolution of the dependent variable, the mark-up (PCM) and the concentration variables (HHI, CR_4) in the Brazilian manufacturing industries, with data from the PIA-IBGE/Rais. A sharp increase in concentration over the years is noticeable, although there is no trend in the *mark-up.* The evolution of PCM in Brazil bears similarity with recent studies using data from *Compustat* and *Thomson Reuters* (Diez, Leigh and Tambunlertchai, 2018), who support there is a positive correlation between mark-ups and concentration in the contemporary world economy. In that study, Latin America emerging markets countries are the only exception among other regions and countries, lacking a clear trend in mark-ups from 2000 on. Hence, the data for Brazil fits that analysis.

Summing up, sectoral indicators are instruments to support competition and trade policies, based on market structure and international trade theories. The methodological set up encompass cross-sectorial analysis, which have been added to the policy toolkit of antitrust authorities to gauge the overall competition in a market economy. That said, these methodologies were contested by the theory of industrial organization and by more recent theories of international trade due to problems of estimation and comparison, as well as due to theoretical expansions based on contemporary economic processes. Schmalensee (1989), however, defends the importance of this research agenda by seeking empirical regularities in the comparison between different industries (inter-sectoral). Especially in trade policy, the regularity between competition with imports and the decrease in domestic margins seems to be robust, as the empirical part of this paper will attempt to measure using the Brazilian data. Hence, although less used than in antitrust, competition indicators may be instruments to support broader competition policies, such as trade and investment. Next section, we identify the indicators used in the empirical tests.

3 INDICATORS AND APPLICATION IN DOMESTIC AND INTERNATIONAL COMPETITION

This section aims to present and describe the methodology for assembling some indicators of competition to be used in the empirical exercise. The main indicator in this literature, the dependent variable and the most used indicator of market power, the price-cost margin (PCM), reflects ability to maintain the price above the marginal cost. There are several methods used to build this indicator

depending on the availability of data. In this work, we built it with the difference between sales revenue Y_{it} and marginal costs (MgC), which is not observable, hence, the MgC is compound with the average variable cost (Labor Factor L; consumption of *intermediates* – energy, materials and services, E + *M* + *S*). The formula is given by:

$$PCM_{it} = \frac{Y_{it} - (L_{it} + E_{it} + M_{it} + S_{it})}{Y_{it}}, \quad (1)$$

where, PMC_{it} – Price-Cost margin, Y_{it} – output/revenue from sales, L_{it} – wage costs (labor), E_{it} – energy costs, M_{it} – intermediate costs, S_{it} – service costs.[4] The mark-up, or PCM, may be obtained by the so-called Lerner index, which accurately reflects the difference between price and marginal cost over the price:

$$\frac{P - MgC}{P}. \quad (2)$$

In the absence of marginal cost, other types of costs are used. Elasticities of input use are also used to compute marginal costs and the final mark-up. In this work, the PCM is built with IBGE data, sales revenues in relation to the cost of production of sector *j*. This indicator therefore reflects the price, because revenues are obtained by prices *P* multiplied by the quantity sold *Q*. In the absence of revenue data, domestic production can provide an approximation for the indicator.

Regarding concentration indices, an indicator of market share is the $CR_{n,}$ is the portion dominated by the *n* largest firms. A CR_4 of 90 means that the four largest firms dominate 90%, while the remaining firms have only 10% of the market.

$$CRn_{jt} = \sum_{i \in j} s_{it}, \quad (3)$$

where CRn_{jt} is the group of *n* firms *i* with the largest market share (*s*) in industry *j*, in period *t*.

The Herfindhal-Hirschman index (HHI) also indicates the number and size of firms in a sector or market. It is defined as the sum of market parcels (*s*) squared. According to the formula:

$$HHI_{jt} = \sum_{i \in j} \alpha_{it} \, s_{it}^2, \quad (4)$$

4. Alternatively, following the methodology of Ghosal (2000; 2002), the PCM can be measured with accounting data, with the ratio between the added value and the sum of employment costs plus costs with capital stock, as specified: $PCM_{j,t} = \frac{Value\ Added_{\ j,t}}{Employment\ costs_{j,t} + Capital\ Share_{\ j,t}}$.

where α_{it} is the sample weight of firm *i* in period *t,* in which it owns the market share (*s*) in industry *j.* A market with only one firm has a HHI of 1, while HHI close to 0 indicates many firms with low *market shares.* HHI is widely adopted by antitrust authorities but is subject to criticism related to the entry of firms. Both the *CRn* and the *HHI* can be built with sales revenue, production value, and even number of employees, depending on the availability of data.

The import penetration indicates the supply of goods and services from foreign firms in a domestic market. It can be calculated with the value of imports to domestic sales revenue in the case of a *tradable* good. In the absence of sales data, the ratio of imports to domestic output is used. The ratio is given by:

$$IMPSh_{jt} = \frac{IMP_{jt}}{Y_{jt}}, \tag{5}$$

in which IMP_{jt} are imports of *and* Y_{jt} are domestic sales (or production) of sector *j* in time *t*. The use of this indicator in the empirical tests assumes a previous trade policy, therefore, exogenous to the contemporary market structure. This hypothesis is strong and discussed in the results of the empirical tests.

Competition is also manifested by the ability of domestic sectors to participate in international markets. The literature mentioned above discusses the effects on mark-ups and productivity of domestic firms in the international economy. An indicator for assessing this participation is the export coefficient, given for the following ratio:

$$Coex_{jt} = \frac{Exp_{jt}}{Y_{jt}}, \tag{6}$$

where Exp_{jt} *is the* value exported in proportion to the domestic output of sector *j*, Y_{jt} in each year *t*.

The *labor-income* ratio indicates the share of wages to net value added:

$$LINC_{it} = \frac{L_{it}}{NVA_{it}}. \tag{7}$$

It does not mirror market power specifically, however, it indicates the competitive pressures exerted on some sector or firm due to labor costs. The indicator *LINC* provides a measure of labor intensity, as it reflects the labor content in proportion to the net value added NVA_{it}. Again, for the aggregate sector, firm *i* data may be replaced by sector *j*. *LINC* can also serve as a *proxy* for "barriers to entry" as sectors with higher value added tend to have higher fixed and sunken costs, while labor-intensive sectors are easier to accommodate. The question of asset specificities determines

the competitive advantage between sectors. Assuming that *low-skill* is a less specific factor compared to capital or natural resources, *low-skill* labor-intensive sectors would have lower difficulties in entry, and indirectly lower profit rates (Berlingieri, 2013; Feenstra, 2004). Conversely, models of endogenous growth and international trade models highlight the interaction of *skilled work* (greater value added in relation to the labor content) with technology and economic openness, as a measure to get temporary monopoly power in high-end products, hence, with higher profits. Therefore, this variable may be difficult to interpret.

"Barriers to entry" is related to the probability of a sector to attract new investments, both by incumbent firms and of eventual "entrants" (green field). This is the ratio between improvements and the stock of capital - fixed assets. If an economic activity offers opportunity for profits, it tends to attract new participants and capital – considering the perfectly competitive market with zero economic profit in the long run (Carlton and Perloff, 2005; Motta, 2004). The effect of this variable is expected to be negative on the *mark-ups.* Moreover, this indicator would also serve as a *proxy* for productivity, since more dynamic sectors present greater returns on invested capital.[5] The variable is constructed with PIA/IBGE data deflated by the sector's producer price index (IPA), correcting fixed assets. The ratio is given by:

$$INV_{jt} = \frac{INVN_{jt}}{INVF_{jt}}\ , \qquad (8)$$

in which $INVN_{jt}$ are the new investments and $INVF_{jt}$ *the* fixed assets (capital stock) in sector *j* in period *t*. The higher the value, the greater the proportion of new investments in relation to existing fixed capital. Therefore, the greater the probability of entry, because the initial capital would not be so large in proportion to improvements. On the other hand, in sectors with a small ratio, capital stock is high, favoring incumbent firms and making it difficult for entrants. This variable is also a good proxy for the dynamism of the sector, correlated with the rate of entry.

Finally, "price" indicators tend to have an immediate application in monitoring competition. Sectors with higher average prices compared to the economy as a whole – or sectors with price stability at a high level – may indicate evidence of collusive practices (Harrington, 2008). It is also interesting to measure the average prices of the sector before and after mergers that greatly increase the CR_n and/or the HHI, or structural breaks due to cartel destabilizations. In the current exercise, however, no direct price indicator will be used.

5. For a recent review of the relationship between "competition" and "productivity" (Backus, 2019; Holmes and Schmitz, 2010). For an empirical discussion on developing countries (Sekkat, 2009), for the Brazilian case (Lucinda and Meyer, 2013; Feijó and Cerqueira, 2013).

Indicators does not come out of criticism. Boone, van Ours and van der Wiel (2013) argue that the elasticity of *profit (PE)* is a better marker for profits, as it avoids methodological problems (reverse causation) of the PCM. Profit elasticity describes the relationship between the firm's profits and its marginal costs. From another methodological point, the literature of empirical industrial organization shows that the degrees of concentration and mark-ups in the industrial sectors are very stable over the years, indicating the limitations of the cross-sectional approach. Thus, the empirical industrial organization suggests models of strategic behavior among firms in a given relevant market as the best way to evaluate market power (Berry, Gaynor and Morton, 2019; Einav and Levin, 2010). Recent studies additionally question the statement that mark-ups have increased recently, arguing that the trend relates to productivity and capital factor accumulation in relation to the labor share (Basu, 2019).

In order to propose a solution to methodological issues regarding the relationship between performance (PCM) and the structure/concentration (HHI, CR4) this work proposes instrumental variables related to factors of production (McLaren, Saygili and Shirotori, 2018; Shirotori, Tumurchudur and Cadot, 2010). Instruments would be related to concentration, but not with profits. Although results are mixed, they present an alternative to deal with endogeneity.

In brief, the next section discusses an empirical strategy that aims to capture both the sectoral concentration, as well as the degree of international competition. Given the results, we believe there is a degree of certainty to assess the competition exposure of the Brazilian manufacturing sector, expressed by the mark-ups.

4 DATA, EMPIRICAL STRATEGY, RESULTS

4.1 Data sources and panel construction

The data comes from different sources for the period 2007 to 2018. The manufacturing data was originally assembled by Kannebley Júnior, Remédio and Oliveira (2020; 2021), who also compile import and export values are from Comtrade,[6] these are converted with the average exchange rate (Real/U.S. Dollar) of the current year, obtained from Ipeadata.[7] Trade indicators follow the methodology of the Foundation for Foreign Trade,[8,9] summarized in documents from

6. Available at: <https://bit.ly/3oyhZj1>.

7. Available at: <https://bit.ly/3Jhioyw>.

8. Available at: <https://bit.ly/34OiSgF>.

9. Data is at the level of the four-digit CNAE class: there are 253 classes in total, but observations regarding each variable may vary.

the National Confederation of Industry – CNI.[10] Imports are measured both by absolute volume in U.S. dollars and by the ratio between imported and domestic consumption. Similarly, exports, also by the volume and by the ratio between exported share and domestic output in each sector.

Industrial survey firm data from the Brazilian Statistical Bureau (IBGE) identifies the basic structural characteristics of the manufacturing sector, according to the National Classification of Economic Activities (CNAE 2.0). Information from industrial firm-based survey (PIA-Empresa) is disaggregated annually, under industrial classification of 5 digits. PIA-Empresa data was used to assemble import and export ratios (IMPSH, COEX), and variables for labor intensity (LINC) and entry (INV).[11]

For industrial prices deflator, we use producer price index (IPA-FGV), which records monthly price variations of agricultural and industrial products in cross-company transactions.[12] Industrial concentration indicators were assembled by the Department of Economic Studies of the Brazilian Competition Enforcement Agency (DEE-CADE) with data from the Annual Social Information Report (Rais) for the years 2006 to 2012. CR4 and CR8 concentration measures are for the four and eight biggest firms in terms of employment in each CNAE class. The Herfindahl-Hirschman index (HHI) is from the same source and period. In the statistical exercise, due to an interpolation with the average of the last year, concentration information is extended up to 2016.

The panel consists of two dimensions, namely: the five-digit CNAE class (dimension *i*), and the year (dimension *t*), respecting the compatibilization by sectoral aggregation. In order to make the analyses compatible and homogeneous, 2007 is the first year of the panel and 2018 the last. Yet, the variables from Rais are limited to 2016. Trade and industrial variables advance up to 2018. With the compatibilization between the bases PIA, Rais and Comtrade, there is a panel of 12 years (2007 to 2018) by 239 classes CNAE comprising 2868 observations maximum, depending on the variable. Finally, instrumental variable data come from the *Revealed Factor Intensity Indices at the Product Level* from UNCTAD (McLaren, Saygili and Shirotori, 2018; Shirotori, Tumurchudur and Cadot, 2010). These indexes measure the content of factors of production (physical capital in

10. Recent methodologies are described in the following documents of the National Confederation of Industry: *Coefficients of trade openness – methodology*. Version 4.0. (available at: <https://bit.ly/3Lr8r3n>; accessed on: May 28, 2021); *Reformulation of the methodology of trade openness coefficients* (available at: <https://bit.ly/3uQ48Zk>; accessed on: May 28, 2021).

11. PIA's information underestimates the revenue from industrial class to 4 digits. Thus, an approximation was made using the ratio of the 3-digit revenue variable from the two editions of the survey.

12. Producer price indices have data with monthly periodicity and level of disaggregation up to 5 digits, depending on the possibility of disclosure of information due to confidentiality problems.

U.S. dollars, human capital in years of formal education, natural resources in hectares) of goods classified in the Harmonized System (HS). The physical capital index in dollars is deflated into real values. Compatibilization between production factors-UNCTAD and foreign trade-Comtrade at HS (6 digits), and PIA-CNAE (5 digits) uses the IBGE translator.

UNCTAD's base uses a basket of optimal production factors, which varies between different products throughout the *Harmonized System* (HS) and *the Standard Trade and Industrial Classification* (STIC) but is constant among the different countries on the base. UNCTAD also considers that the allocation of factors may vary over time, as countries can increase their physical capital and level of formal education. Ultimately, the data relates to comparative advantages and geographical factors, therefore, exogenous. However, international trade models consider several other possibilities, such as mobile production factors and trade between countries with similar factor endowments, in the lines of intra-industry trade. Production factors bear relation with the concentration structure due to economies of scale and technology. For example, industries that produce land-intensive goods, such as *food* industries, tend to be more fragmented compared to a capital-intensive, such as the steel industry. These factors (capital, labor, land) naturally lead to a higher or lower concentration. A country with natural resources, such as fertile land or mineral deposits, for instance, will specialize in the production of agricultural products and mineral extraction. Hence, the UNCTAD database allows a comparison between countries, and a benchmark for indirectly measuring profits.

Table B.1 in the appendix shows descriptive statistics. The matching between different databases creates inconsistencies, so the final panel is not balanced, as observations are missed when converting and merging the data. For example, international trade originally in Harmonized System (HS-6 digits) has more than 10,000 product classifications. In the conversion to industrial data observations are eliminated, so that the final database has 239 CNAE classes in the trade variables, whereas only 161 sectors in factors of production – Human Capital (RHCI), Physical Capital (RCI) and Natural Resources (LAND). The temporal dimension ranges from 2007 to 2018, but with gaps, thus, variables vary from 1145 to 1924 total observations in the panel dimension. In order to avoid biases in the empirical exercise, we restrict the panel to observations that trade-industrial match factors of production (table B.2). Besides, in the empirical tests, missing observations are dropped. Therefore, the models are estimated with a range of 1041 to 1513 observations.

4.2 Empirical strategy

We apply a parsimonious model to discuss the impact of structural characteristics of domestic industrial sectors in Brazil on their own mark-ups, attempting to gauge the role of domestic and foreign competition. Yet, the model presents somewhat weak results, depending on the specification,

with insignificant coefficients, especially the trade variables. The exercise is then conducted with instrumental variables to tackle the problem of endogeneity. Factors of production are used as instruments for concentration. The hypothesis is that the causal relationship between PCM and the instruments, by definition, is mediated by the structure, and by other characteristics, such as entry capacity, competition with imports and export orientation. That is, the influence of sectors on PCM only occurs through concentration (HHI, CR4), with no direct effect. The exogenous nature of instruments is verified with robust results, reported in the appendix and in the comments.

In the model below, the PCM is regressed against concentration (HHI or CR_4), number of firms (FIRM), labor factor intensity (LINC), competition with imports (IMP and IMPSH – volume and import penetration, respectively), investment (INV) – the proxy for entry – and export orientation (EXP and COEX, volume and export orientation), plus sector and year dummies. All variables are transformed in natural logarithm in order to circumvent the large-scale differences. Initially, equation (9) is estimated by ordinary least squares (OLS) with *pooled* data. Next, an estimation with instrumental variables in two-stage least squares (2SLQ) is applied. Instrumental variables are those related to production factors, Human Capital, Capital, Natural Resources (RHCI, RCI, LAND), and are regressed against CR_4-HHI. Subsequently, we run a panel model with fixed effects (FE) and with fixed effects and instrumental variables (FE/IV) and a panel with random effects (RE) and with random effects and instrumental variables (RE/IV). In the OLS and 2SLS estimations, the dummy sector is built using sector CNAE 3 digits, thus with higher level of aggregation than the panel specific effects. This sector dummy is dropped in panel specifications. Finally, in order to account for the non-linearities in the data and to look for a more robust estimator, based on the moment's conditions, a GMM estimation, in which the endogenous estimators are the concentration variables (HHI, CR4). Hence, the baseline equation is given by:

$$\begin{aligned} ln\, PCM_{i,t} = {} & \alpha_i + \beta_1 lnCR_4HHI_{i,t} + \beta_2 lnFIRM_{i,t} + \beta_3 lnIMPSH_{i,t} + \beta_4 lnIMP_{i,t} + \\ & \beta_5\ lnEXP_{i,t} + \beta_6\ lnCOEX_{i,t} + \beta_7 lnINV_{i,t} + \beta_8 lnLINC_{i,t} + DumYr_t + u_{i,t}. \end{aligned} \tag{9}$$

Due to the correlation between concentration variables (HHI and CR_4), these are included separately in different estimates, with FIRM, also a concentration variable not directly reflecting market power. Dummy variables for the years wish to capture macroeconomic conditions and non-observable shocks. Similarly, dummies at the three-digit CNAE classification control for idiosyncratic effects of sectors. The concentration structure varies according to the technological characteristics and production scale of each sector. The inclusion of *dummies* corrects the effects of the other explanatory variables on the dependent variable. The variance of residues in the OLS estimation was tested, and heteroscedasticity was observed, thus we opt for a variance robust errors model. Subsequently, identification tests were conducted.

If CR_4 and HHI were exogenous regressors, the OLS method would provide the best linear unbiases estimator (BLUE) and stochastic error term would meet the classical hypotheses properties, that is, normal distribution – zero mean and constant variance – and the covariance between the error term and concentration indicators would be zero – the hypothesis of exogeneity. Hausman test of exogeneity of regressors was, then, conducted on CR_4 and HHI to verify endogeneity (omitted variable, bias, measurement error, or reverse causality). Such characteristics were detected in both variables. Thus, instrumental variables – RCI, RHRI, LAND – were included, and regressed against concentration indices. Further tests show that the instruments are valid.[13] Yet, we opt for a more restricted model, in the econometric sense, in view of the exploratory objective of the exercise.

Concentration might be related to the level of production factors. Although conditioned by other factors, it is expected that the correlation between production factors (capital, human capital and natural resources) and concentration indicators is significant. Causality would go from production factors intensity to structure of the sector, not the other way around. Conversely, the mark-up (PCM) would not be directly influenced by the factor endowment of sectors, being affected by structure (HHI, CR_4) and the other intervening variables. That said, however, this hypothesis is strong, if the stock of factors of production might affect the import penetration or exporting orientation, due to comparative advantage, for example. Thus the profit rate would be affected, violating the exclusion restriction. We report first stage regressions in the appendix in which concentration variables are regressed against the instruments and the dummy of years.

As indicated, the Kleibergen-Paap *F* statistics for weak identification tests for the significance shows that the instruments are valid, and it is possible to reject the null hypothesis that all coefficients would be equal to zero. Yet, in *F* tests carried out separately, only capital (RCI) was robust. Hence, regressors can generate contradictory effects, which is perceived in the use of different models. The econometric literature has discussed the choice of weak instruments in regressions of instrumental variables (Staiger and Stock, 1997).[14]

13. The under-identification test reports a Kleibergen-Paap LM statistic of 94.519, with p-value significant at 1%, which means that we accept the null that the model was correctly specified. Table B.3 in the appendix B also report a weak-identification test with a Wald *F* statistic of 2056, hence, far above the Stock-Yogo weak ID critical values and we accept the null hypotheses that instruments are valid. Also, the Hansen J statistic test of overidentification tests of all instruments accept the null only at 5% level. Finally, the endogeneity tests reject the null that the regressors (HHI, CR4) are exogenous, though, again, at a 5% level.

14. Staiger and Stock (1997), as a pocket rule to overcome the problem of weak instruments maintain that in the estimation by two stages least squares (2SLS), *F* statistic of the first stage estimation should be at least greater than 10.

Alternatives to provide greater robustness to the estimation include models with panel data and GMM estimations. In fixed-effect panel data models (FE), the intercept α_i is treated as an unobservable random variable that can be correlated with regressors x_{it}. Initially, we opted for fixed effects to capture the sectoral specificities of each CNAE class and to reduce the problem of endogeneity of the instruments observed in the regressions by OLS and 2SLS. In short temporal dimension panels, as in the current study, fixed effects estimation (FE) can lead to inconsistency of parameters. Thus, *N* incident parameters and individual intercepts α_i cannot be consistently estimated if *T* is small. This inconsistent intercept estimation can also make the vector estimation β inconsistent.

Due to these problems, random effects panel models were also tested, with results more appropriate to the hypothesis of the work. The logic behind the random effects is that, unlike fixed effects, the variation between *individuals i* is assumed to be random and uncorrelated with the independent included predictive variables. This hypothesis, in the case of manufacturing sectors is plausible, because, although many of these have similar productive structures, among the 161 CNAE sectors there is a considerable difference in terms of cost structure, demand elasticities, price formation, among others. Therefore, from the econometric point of view, we also chose to test random effects with and without instrumental variables.[15] Having said that, Hausman tests indicate that fixed-effect panel models would be preferable to random effects.

In general, the expected effects of the structural variables (HHI, CR_4) on the PCM remained the same and are positive and significant, except for the fixed effect panel data estimation methods. In relation to the other explanatory variables, most of them remained with the expected effects, although some with insignificant coefficients, especially those related to the trade variables.

15. Choosing panel data models with fixed or random effects is not trivial. When only a few observations are available, it is important to make more efficient use of the data. The appropriate interpretation should consider that the fixed effects approach is conditional on the values of α_i, the intercept, which is specific to every observation in the data. This approach considers the distribution of y_{it}, the dependent variable, given α_i, in which α_i represents a firm, or industry, as in this study. One way to formalize this is to note that the random effect defines that:

$$E(y_{it} / x_{it}) = x'_{it}\, b\,,$$

while the fixed effects model estimates:

$$E(y_{it} \;/\; x_{it}, \alpha_{it}) = x'_{it}\, \beta + \alpha_{it}$$

The coefficients of βs in these two conditional expectations are the same only if $E(\alpha_{it} / x_{it}) = 0$

In the regressions of this work, Hausman tests are performed between the specifications by fixed and random effects, indicating that the former would be more suitable (Verbeek, 2004).

In order to tackle these issues, we use a GMM specification. The generalized method of moments (GMM) is a method for generating estimators. GMM uses assumptions about specific moments of the random variables instead of assumptions about the full distribution, which makes GMM more robust than Maximum Likelihood estimators, for instance, at the cost of some efficiency. GMM generalizes the method of moments (MM) by letting the number of moment conditions to be greater than the number of parameters. When there are more moment conditions than parameters, the estimator is supposed to be overidentified. GMM can efficiently use the moment conditions when the estimator is overidentified, which is the case here given the endogeneity tests (Cameron and Trivedi, 2010).

One of the main objectives of the trade indicators is to gauge the foreign competition assumption, that is, exposure to trade would discipline domestic profits. Hence, in order to discuss these conjectures, we use a more restricted model, only with the variables of structure and trade. The estimations are performed with all methods described before: ordinary least squares (OLS), two-stage ordinary least squares (2OLS), fixed effects (FE) and random effects (RE) panel data, and instrumental variables fixed effects (FE-IV), random effects instrumental variables (RE-IV) and GMM. According to the equation (10) below. In these models, again, concentration variables (HHI-CR4) are instrumentalized by the factor content variables (RHI, RHCI, LAND) and year dummies.

$$ln\, CR_4HHI_{i,t} = \alpha_i + \beta_1 lnRCI_{i,t} + \beta_2 lnRHCI_{i,t} + \beta_3 lnLAND_{i,t} + DumAno_t + u_{i,t}. \qquad (10)$$

In alternative tests not reported, we also treat IMPSH and COEX as endogenous and apply instrumental variables to them. As before, we apply significance and endogeneity test on the instrumental variables of trade indicators (IMPSH and COEX) and we verify weak identification tests, rejecting the null hypothesis that regressors would be valid.[16] Similarly, we accept the null hypothesis that regressores are exogenous. Therefore, only the specifications with HHI and C4 as endogenous regressors are reported in the baseline equation (10).

16. For instance, in the weak identification test in the GMM model, performed with just IMPSH (import penetration) as endogenous variables, and CR4 as the concentration variable. The Kleibergen-Paap Wald *F* statistic) of 3.238 indicates that the null hypothesis that the variable is a weak instrument can not be rejects, and this number is smaller than the Stock-Yogo weak ID test critical values. The same pattern remains for COEX (export orientation) and using HHI as the concentration variable.

4.3 Discussion of results

Tables 1 and 2 display results for the several models (OLS, 2SLS, FE, FE-IV, RE, RE-IV, GMM). Results are relevant and toward empirical regularities. Despite inconsistencies in some specifications, there is statistical significance, even in the models with instruments. In tables 1 and 2 concentration variables (HHI and CR4) present the expected positive correlation with the mark-up (PCM) in OLS and 2SLS specifications, with a degree of relevant statistical significance (5% and 1%). However, FE and IV-FE panel models do not display statistical significance in the regression with HHI, and, in fact, the FE specification with CR4 presents an inverse signal, that is, less concentrated sectors lead to smaller profits, though at the 10% statistical significance. In estimates with instrumental variables, the effect of concentration variables on PCM is not statistically significant only in the FE and IV-RE, with HHI, and in in FE-IV, with CR4. All the other results display a positive and significant coefficient. The econometric literature mentions how choosing weak instruments can bias results. Thus, that is what may be happening with C4 in the FE model. Yet, we have tested for the validity of instruments, and they proved to be consistent. Hence, this result may be related to low time variation of instrumental variables, that may affect the correlation between the errors of the first stage estimation and fixed effects *i*. In fact, given that structural variables tend to vary little along time, the variation occurs only on the cross-sectional level. Yet, the overall picture tends to point to empirical regularities as presented in the GMM model, in which results are more significant.

TABLE 1

Dependent variable – PCM; structural variable – HHI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	2SLS	FE	FE-IV	RE	RE-IV	GMM
HHI	0.157***	0.172***	-0.06	0.175	0.101***	0.149***	0.173***
	(0.017)	(0.018)	(0.082)	(0.166)	(0.027)	(0.031)	(0.017)
FIRM	-0.029***	-0.027***	-0.033	-0.001	-0.036*	-0.031*	-0.028***
	(0.01)	(0.01)	(0.045)	(0.033)	(0.022)	(0.016)	(0.01)
LINC	-0.52***	-0.534***	-0.642***	-0.684***	-0.676***	-0.675***	-0.631***
	(0.128)	(0.124)	(0.092)	(0.067)	(0.097)	(0.052)	(0.114)
IMP	0.031	0.021	0.019	0.006	0.015	0.014	0.021
	(0.025)	(0.02)	(0.034)	(0.035)	(0.033)	(0.017)	(0.019)
IMPSH	-0.026	-0.018	-0.018	-0.005	-0.013	-0.012	-0.018
	(0.023)	(0.019)	(0.033)	(0.035)	(0.03)	(0.016)	(0.018)
INV	-0.008**	-0.009**	-0.002	-0.002	-0.002	-0.003	-0.007*
	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)

(Continues)

(Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	2SLS	FE	FE-IV	RE	RE-IV	GMM
EXP	0.008	0.014	0.000	-0.013	0.004	0.002	0.013
	(0.017)	(0.015)	(0.028)	(0.022)	(0.02)	(0.015)	(0.014)
COEX	-0.019	-0.026	-0.018	-0.009	-0.02	-0.017	-0.024
	(0.022)	(0.018)	(0.025)	(0.023)	(0.027)	(0.017)	(0.018)
Observations	1091	1091	1091	1091	1091	1091	1091
R-Squared	0.413	0.403	0.180	0.124	0.172	0.127	0.401
Dummy sector	Yes	Yes	No	No	No	No	Yes
Dummy year	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Author's elaboration.

Obs.: 1. Variables in natural logarithms. Constant omitted.

2. Robust standard errors in parentheses.

3. *** p < 0.01, ** p < 0.05, * p < 0.1.

TABLE 2

Dependent variable – PCM; structural variable – CR4

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	2SLS	FE	FE-IV	RE	RE-IV	GMM
CR4	0.264***	0.374***	-0.133*	0.003	0.087*	0.462***	0.369***
	(0.048)	(0.05)	(0.07)	(0.195)	(0.048)	(0.091)	(0.046)
FIRM	-0.033***	-0.031***	-0.032	-0.012	-0.047***	-0.048***	-0.029***
	(0.01)	(0.01)	(0.031)	(0.031)	(0.016)	(0.017)	(0.01)
LINC	-0.57***	-0.579***	-0.341***	-0.345***	-0.392***	-0.41***	-0.745***
	(0.162)	(0.156)	(0.038)	(0.04)	(0.038)	(0.039)	(0.106)
IMP	0.03	0.021	0.046	0.03	0.044*	-0.015	0.023
	(0.023)	(0.019)	(0.036)	(0.032)	(0.026)	(0.02)	(0.018)
IMPSH	-0.026	-0.018	-0.064*	-0.051	-0.057**	0.002	-0.02
	(0.022)	(0.018)	(0.036)	(0.032)	(0.025)	(0.02)	(0.017)
INV	-0.019***	-0.019***	-0.005	-0.005	-0.006**	-0.005*	-0.017***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
EXP	0.005	0.009	-0.02	-0.029	-0.013	0.027	0.006
	(0.017)	(0.014)	(0.032)	(0.024)	(0.021)	(0.017)	(0.013)

(Continues)

(Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	2SLS	FE	FE-IV	RE	RE-IV	GMM
COEX	-0.022	-0.025	-0.006	-0.002	-0.005	-0.049**	-0.021
	(0.021)	(0.018)	(0.033)	(0.024)	(0.023)	(0.019)	(0.017)
Observations	1425	1425	1425	1425	1425	1425	1425
R-Squared	0.429	0.416	0.124	0.077	0.116	0.043	0.410
Dummy sector	Yes	Yes	No	No	No	No	Yes
Dummy year	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Author's elaboration.

Obs.: 1. Variables in natural logarithms. Constant omitted.

2. Robust standard errors in parentheses.

3. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The more concentrated the CNAE class, the greater the positive effect on the PCM. The concentration structure tends to be stable over time and influenced by technology-related aspects. For example, sectors with larger production scales or with more technology-intensive use tend to have an oligopoly structure, with competition standards based on strategic behaviors: firms define quantities (*Cournot*) or prices (*Bertrand*). The perfect competition model is supposed to bring the better outcome to the economy overall, but there is some degree of competition in these intermediary models. The differentiation by technology generally increases the well-being of the economy, with a strong increase in productivity, according to the recent literature on *star firms* (Autor et al., 2020). To our understanding that is what might be happening with the variable INV, which may be a valid proxy for the dynamism in the sector. Hence, the more dynamic is a sector, the smaller are the profits relative to other sectors.

However, the literature also acknowledge that star firms may exert market power, due to monopolistic differentiation of products. In fact, oligopolies bring greater propensity to cartel formation, or a higher incidence of anti-dumping measures, for instance. Thus, policy tools should monitor the pattern of profitability in these sectors. The increase in concentration in recent decades in several countries, including the United States, for example, has caused apprehension in analysts, due to decreasing content in labor share and a possible decrease in productivity (Furman and Orszag, 2015). These results of empirical exercises indicate a similar trend for Brazil, as figures in the appendix report a strong tendency of concentration, albeit with a less noticeable trend in the PCM.

On the other hand, many technological innovations have been created by small businesses in unconcentrated sectors. In the contemporary economy, characterized by knowledge and innovation, more dynamic sectors employ both physical capital (precision equipment, aeronautics,

armaments, electronics and fine chemistry) and human capital and are less concentrated than traditional sectors. Ellickson (2015) and Sutton (2007), indicates that in sectors with knowledge economics, concentration is related to product differentiation conditioned by innovation and new technologies, and they also suggest more fragmentation (Ellickson, 2015; Sutton, 2007). In fact, there is a high correlation between human capital (RHCI) and capital (RCI). The database used in this work may be capturing partially these trends related to concentration and high-tech sectors in Brazil. Results of the first stage estimates relating human capital (RHCI) and capital (RCI) with concentration (HHI-CR4), box B.1 and table B.4 in the appendix, report a significative negative correlation with concentration indices and those capital endowment variables, also with LAND, with HHI in the OLS estimation, albeit the models are plagued with the problem of collinearity in the fixed effect estimations. Yet, this exercise does not differentiate in terms of technological content of sectors. So, results should be read carefully.

Returning to tables 1 and 2, the other explanatory variables exert mixed effects. FIRMS is significant at 1% level and has an expected negative effect on the mark-up in all specifications but those with fixed effect panel data. Yet, the effect of FIRM and CR4 on PCM is significant only at a 10 level in the RE specifications. In general, results indicate that sectors with more firms have lower profits on average. This variable may also account for rate of entry, as the number of firms vary all over the years.

The import volume (IMP) displays non-significant results all over. In theory, there should be a positive relationship with imports and PCM interpreted as internationalized sectors with greater presence in global value chains, although the data does not specify whether intra-industry trade happens in sectors with higher import content (reflecting imported value added, for example). Yet, from the macroeconomic point of view, higher imports are related to greater economic activity in world markets with higher demand, so higher profits accrue in internationalized sectors (Ghosal, 2002). These effects can be observed in results of tables 3 and 4, the more restrictive model (10), however, they do not hold for tables 1 and 2, with the exception of the model for RE, in which imports exert a negative effect at 10% significance level.

The variable IMPSH, in turn, may gauge more accurately the competitive pressure of imports, as it depicts the ratio between imports and domestic consumption. The higher this ratio, the lower the profits. The literature has verified how imports reduce market power of domestic oligopolies, especially in consumer goods (the China effect). Trade liberalization is still an important resource against domestic market power, suggesting the need for dialogue between competition policies (advocacy and antitrust) and trade liberalization policies (Wooton and Francois, 2010). Again, this variable is not significant in several specifications of tables 1 and 2, except for the RE model, with CR4, in which it exerts the expected negative effect on PCM, with a 5% level of statistical significance.

Indicators for exports and export orientation (EXP and COEX) have a similar interpretation of imports: the volume would capture scale and integration effects, so that the sector open to exports would achieve higher profits; whereas higher export orientation – the domestic supply serves the foreign market – the lower PCM indicates the competitive pressure from the external environment. On the other hand, export participation may expand profits in selected sectors, as trade integrations improves the size of plants – scale and technological effects (De Loecker and Warzynski, 2012). These variables, however, do not present robust results in the different specifications, except for the RE-IV model, in which COEX exert a 5% negative effect on profits, with a statistical significance of 5%, again with CR4.

"Entry" has an inverse relationship with mark-ups. INV is the ratio between capital improvements, or new investments, in relation to the capital stock in a sector. As discussed, this variable may capture the dynamism of a sector. Hence, the higher the absolute number, the easier the possibility of investment. Results show an inverse and statistically significant (1%) correlation between INV and PCM, indicating that sectors with greater probability of entry exert a negative effect on profits, and market power would be easily disciplined. Recent studies indicated not only the decreasing share of the labor input in the total output of the sectors, but also the decreasing power of labor to extract rents from society due to, among others, new technologies and, to a lesser extent, the globalization of competition (Stansbury and Summers, 2020). In labor-intensive sectors, which is expressed in the variable LINC, there is a clear negative effect on profits, with significant and robust effects on all specifications. In fact, in all specifications, this is the most significant variable of the model.

Due to the mixed effects of the model specified in equation (9), a more parsimonious version was sought, including variables of market structure and international trade only, as specified in equation (10). This model aims to isolate the effect of imports and exports on profit, in addition to the concentration/structural variables and the dummies for years and sectors. Tables 3 and 4 indicate more robust results in line with the literature previously discussed. Again concentration/structural variables (HHI-CR4) are regressed against exogenous variables RCI, RHCI and LAND. Import (IMP and IMPSH) and export variables (EXP and COEX) are estimated in separated models, with the same previous methods, OLS, 2SLS, panel data with fixed and random effects, and with instrumental variables, and GMM. Effects of the dependent variables on the mark-up and greater statistical relevance with the predicted signs is noticeable. Both HHI and CR4 exert positive pressure on mark-ups, but the former is more robust in the different specifications. There is though contradictory results and a change in the expected positive signal, both from HHI and CR4, with statistical significance at 5% level, in the estimation by FE-IV, probably due to the problem of collinearity among dummies.

The trade orientation variables are statistically significant (1% and 5%) and have negative signal in all specifications, relevant to 10% in the specifications by fixed effect with COEX. Both import penetration and the export orientation have a strong pro-competitive effect, reducing *mark-ups* in sectors subject to international exposure, albeit the absolute effect may be small.[17] Yet, the small R-squared results, especially in the panel models, also indicates that many other factors may explain the PCM, as there are non-observables captured by specific panel effects.

Overall, results regarding IMPSH are important, as they show a consistent pattern of smaller profits in sectors exposed to international competition. The result of the export orientation (COEX) may be more difficult to interpret, as it may indicate that, due to the greater elasticity of foreign market demand, the disciplinary power over profits can be a plausible hypothesis. However, the interpretation of these results must be cautions as the volume of exports may bear some influence on these export orientation coefficients, hence, the year dummy variables wish to capture macroeconomic shocks not visible in the data, while the COEX variable may reflect structural characteristics of the sectors. For example, manufacturing industries related with aircraft have a structural propensity to export, if compared with the automotive vehicles, more oriented toward domestic markets, which may suffer more with the domestic macroeconomic situation of the year. Besides, Brazil has a comparative advantage in the export of commodities which may face higher elasticity of demand in international markets, exerting an influence for smaller profits. The result of the Brazilian case shows a clear difference with the work of De Loecker and Warzynski (2012).

The relation between PCM, concentration and the capacity to enter new external markets may be complex but competition indicators can become an important public policy tool, to guide long-term policies, such as of export-subsidies, for instance. This study aims to seek the empirical regularities that would support such policies.

Regarding international exposure, recent literature associating globalization and mark-ups consistently shows that trade flows contribute to greater competition – import penetration decrease the profit of domestic companies. Lower barriers to entry and easiness of investment also improve competition, but not necessarily attract foreign investment. Yet, profits may be associated not only with income extraction but also with innovation capacity and greater productivity, so this literature also understands that mark-ups would be positively associated with well-placed firms in the globalization process. Hence, export-oriented firms may have higher profits. The results reported here with the Brazilian data suggest an interpretation in line with the recent literature, i.e., competition

17. As a log-log specification regression, the coefficients of the variables are partial elasticities, hence, a 1% decrease in the import penetration, results in a 0.041% decrease in the mark-ups in the GMM model with HHI as the concentration variable for example. Conversely, in the same specification, 1% increase in the HHI measure is associated with 0.25% increase in the mark-up.

with imports, ease of entry due to investments, labor-intensive sectors, and export orientation are structural factors with negative impact on domestic *mark-ups.* Concentration, in turn, wields positive relationship with the profit rate. The empirical exercise may also allow to conclude about innovating firms or technological sectors in the Brazilian economy, as the factor endowment variables (RHCI) displayed significant negative results on concentration, in the first-stage regressions. Yet these conclusions deserve a study on its own.

Results found in the various specifications are in line with empirical work to measure the effect of structure on performance indicators. Ghosal (2000; 2002), for example, with more extensive U.S. data in terms of years and robust empirical estimates, suggests similar results. The author's conclusions indicate that foreign competition has a crucial role in antitrust enforcement against concentrated industries, exerting diminishing effects on margins. Lower profits in labor-intensive sectors are also an empirical regularity confirmed in the Brazilian data, in line with the work of Furman and Orzag (2015) and Stansbury and Summers (2020). In common with the recent literature, the Brazilian results depict an increasing concentration over the last years (Diez, Leigh and Tambunlertchai, 2018). More recent work also confirm the importance of antitrust policy in market discipline (Besley, Fontana and Limodio, 2021). PCM indicators may also support the position of the authority in cases of anti-competitive practices as cartels or unilateral conduct: profits above normal market benchmarking may be an indicative of a collusive agreement. There is a consolidated literature about structural and behavioral approaches in identifying collusive agreements, which this paper did not discuss, though it is worth emphasizing the importance of market monitoring (Harrington, 2008). Additionally, estimation results may also be relevant for trade defense policy (antidumping – AD), which creates temporary competition exceptions due to alleged damage caused by predatory practices from foreign firms in domestic markets (Konings and Vandenbussche, 2005). It is important to assess whether AD petitioning sectors exhibits above-average mark-ups. Recent studies show a relationship between higher domestic mark-ups and anti-dumping protection, but with divergent effects before and after the WTO Uruguay Round (Rovegno, 2013).

TABLE 3

Dependent variable – PCM; structural variables – HHI and trade

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	OLS (IMP)	OLS (EXP)	2SLS (IMP)	2SLS (EXP)	FE (IMP)	FE (EXP)	FE-IV (IMP)	FE-IV (EXP)	RE (IMP)	RE (EXP)	RE-IV (IMP)	RE-IV (EXP)	GMM (IMP)	GMM (EXP)
HHI	0.203***	0.195***	0.216***	0.213***	-0.146	-0.134	-0.276**	-0.016	0.105***	0.1***	0.126***	0.133***	0.223***	0.216***
	(0.016)	(0.016)	(0.016)	(0.017)	(0.095)	(0.091)	(0.121)	(0.088)	(0.033)	(0.033)	(0.033)	(0.033)	(0.015)	(0.016)
IMP	0.048***	-	0.044***	-	0.079**	-	0.067***	-	0.047**	-	0.024**	-	0.044***	-
	(0.007)	-	(0.007)	-	(0.032)	-	(0.019)	-	(0.019)	-	(0.011)	-	(0.007)	-
IMPSH	-0.043***	-	-0.04***	-	-0.08***	-	-0.072***	-	-0.049***	-	-0.029***	-	-0.041***	-
	(0.008)	-	(0.008)	-	(0.027)	-	(0.02)	-	(0.017)	-	(0.011)	-	(0.007)	-
EXP	-	0.025***	-	0.025***	-	0.038	-	0.023	-	0.019	-	0.016*	-	0.025***
	-	(0.005)	-	(0.005)	-	(0.029)	-	(0.015)	-	(0.013)	-	(0.01)	-	(0.005)
COEX	-	-0.043***	-	-0.041***	-	-0.052*	-	-0.039***	-	-0.034**	-	-0.031***	-	-0.041***
	-	(0.008)	-	(0.007)	-	(0.027)	-	(0.015)	-	(0.015)	-	(0.011)	-	(0.007)
Observations	1135	1142	1135	1142	1135	1142	1135	1142	1135	1142	1135	1142	1135	1142
R-squared	0.351	0.341	0.337	0.331	0.054	0.044	0.0146	0.0091	0.0351	0.0285	0.0001	0.0002	0.337	0.331
Dummy sector	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
Dummy year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Author's elaboration.

Obs.: 1. Variables in natural logarithms. Constant omitted.

2. Robust standard errors in parentheses.

3. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

TABLE 4

Dependent variable – PCM; structural variables – CR4 and trade

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	OLS (IMP)	OLS (EXP)	2SLS (IMP)	2SLS (EXP)	FE (IMP)	FE (EXP)	FE-IV (IMP)	FE-IV (EXP)	RE (IMP)	RE (EXP)	RE-IV (IMP)	RE-IV (EXP)	GMM (IMP)	GMM (EXP)
CR4	0.387***	0.358***	0.48***	0.484***	-0.137	-0.131	-0.169	0.046	0.073	0.081	0.281***	0.335***	0.547***	0.52***
	(0.048)	(0.048)	(0.045)	(0.048)	(0.114)	(0.111)	(0.151)	(0.116)	(0.076)	(0.073)	(0.087)	(0.084)	(0.04)	(0.042)
IMP	0.051***	-	0.045***	-	0.053**	-	0.035**	-	0.035**	-	0.011	-	0.045***	-
	(0.007)	-	(0.007)	-	(0.026)	-	(0.017)	-	(0.016)	-	(0.011)	-	(0.007)	-
IMPSH	-0.047***	-	-0.043***	-	-0.062***	-	-0.05***	-	-0.048***	-	-0.025**	-	-0.044***	-
	(0.007)	-	(0.007)	-	(0.021)	-	(0.017)	-	(0.014)	-	(0.011)	-	(0.007)	-
EXP	-	0.027***	-	0.026***	-	0.03	-	0.004	-	0.015	-	0.008	-	0.027***
	-	(0.006)	-	(0.005)	-	(0.025)	-	(0.014)	-	(0.014)	-	(0.01)	-	(0.005)
COEX	-	-0.05***	-	-0.047***	-	-0.045**	-	-0.023*	-	-0.028**	-	-0.02**	-	-0.049***
	-	(0.008)	-	(0.008)	-	(0.021)	-	(0.013)	-	(0.013)	-	(0.01)	-	(0.008)
Observations	1506	1513	1506	1513	1506	1513	1506	1513	1506	1513	1506	1513	1506	1513
R-Squared	0.324	0.318	0.309	0.306	0.048	0.043	0.010	0.002	0.041	0.0367	0.0002	0.0000	0.305	0.302
Dummy sector	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes
Dummy year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Author's elaboration.

Obs.: 1. Variables in natural logarithms. Constant omitted.

2. Robust standard errors in parentheses.

3. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5 CONCLUDING REMARKS

This study discussed indicators to support the practice of public policies. The economic theory behind indicators is the paradigm of Structure-Conduct-Performance (SCP), which has been criticized by the literature of empirical industrial organization. However, new literature backs some conclusions of that theory and verify empirical regularities that might apply in competition policy, as well as in trade and investment policy. We sought to present a review of this literature, a construction of selected indices and apply robust methodological solutions to the measurement of competition conditions for the Brazilian economy. In this line, the use of econometric models with instrumental variables seeks to correct the effects of endogeneity common in sectoral studies with *cross-section data.*

Using industrial survey data from PIA/IBGE, we verified a trend towards increasing market power, the study found a positive relationship between profit margins and market concentration in Brazil, akin to the revised international experiences. In addition, the proportion of imports in consumption, the ease of entry of firms and competition in foreign markets contribute to disciplining excess profits. The exogenous variables had a modest effect on the overall calculation on the original model. A more parsimonious version presented better outcomes. The study sought originality by using data factors of production, predominantly applied in international trade studies, to discuss domestic market structure. The use of production factors by economic sectors is constant among different countries, according to international trade theory (H-O assumptions), despite the existence of more recent alternative models. The use of a conversion methodology between different classification of economic activities is also an interesting exercise to be replicated and improved. Although the results estimated with instruments are statistically less robust, the methods of assembling indicators and exogenous variables can be tested with industrial data from other countries. Thus, in general, the primary objective of the study is to stimulate the creation of competition indicators to subsidize public policies in Brazil. Hence, this work may be added to the academic works on industrial concentration, profit margins, and external competition of the country.

In its policy dimension, this study wishes to propose a closer relation between trade, investment and competition policies in order to grasp the different characteristics of domestic and international market forces, to which the Brazilian manufacturing sector is exposed to. Results of the empirical exercise remark the complex interconnections between factor endowments, investment propensity, and labor intensity, leading to smaller profits, as well as sectors with more firms and more dynamism have constrained market power. Therefore, in a post pandemic economic environment, in which active support policies for faulty economic activity may be required, such indicators can provide some guidance to policies that may enhance the economic well-being of citizens. In this

picture, sectors that employ the most, that they are already exposed to more competition, and those that are more dynamic even in difficult times, may have some preference. However, this exercise has a broad cross-section nature, and more focus-oriented studies should be carried out to support policies.

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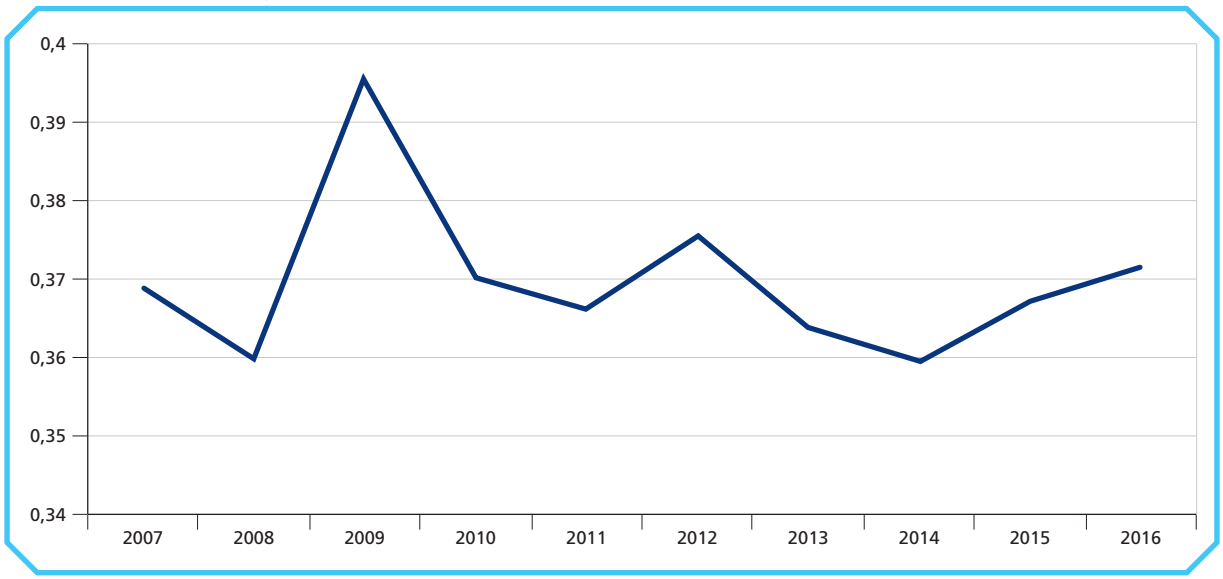
APPENDIX A

INDICATOR TRENDS FOR BRAZIL

FIGURE A.1

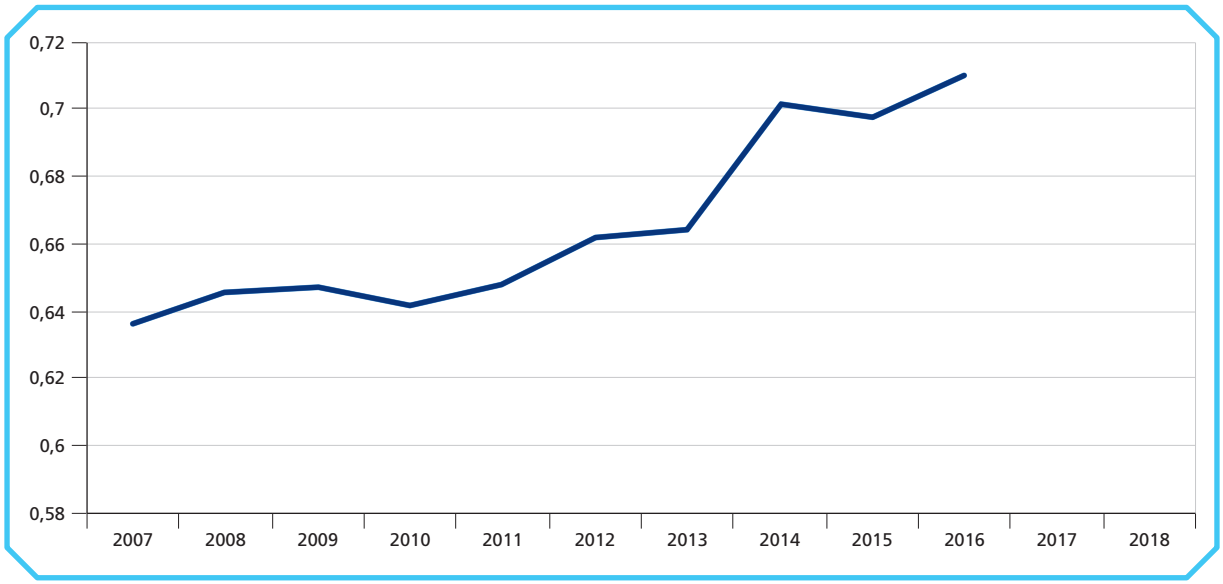
Price-cost margin – PCM (2007-2016)



Sources: Annual Survey of Industries (PIA)/Brazilian Institute of Geography and Statistics (IBGE) (available at: <https://bit.ly/3w72Bia>); and Annual Social Information Report (Rais) (available at: <https://bit.ly/35R6lKb>).

FIGURE A.2

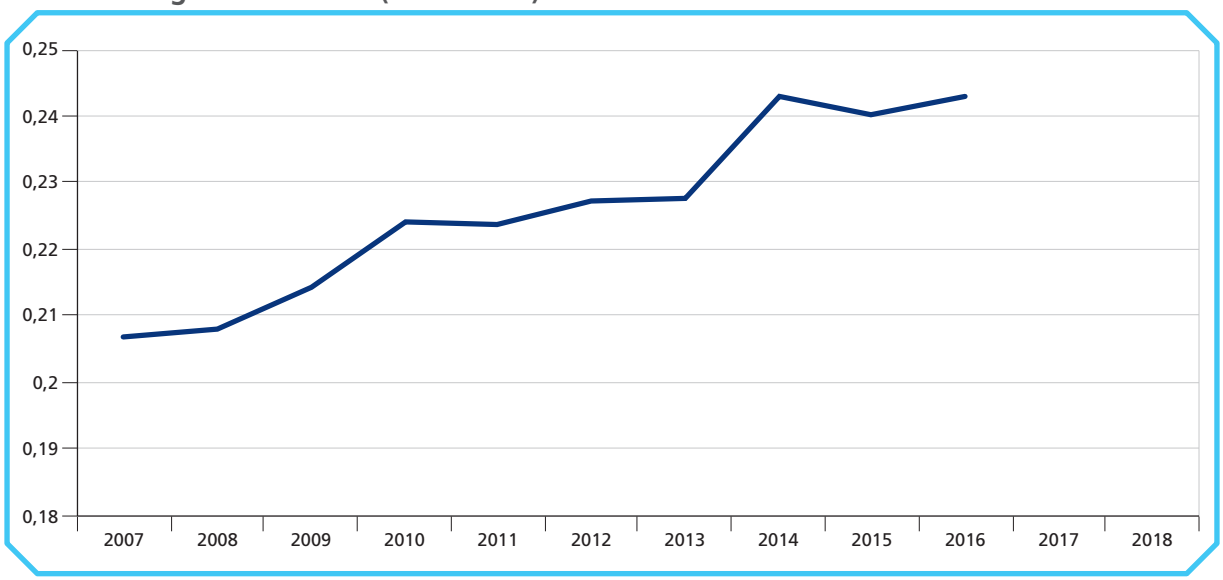
Herfindahl-Hirschman index – HHI (2007-2016)



Sources: PIA/IBGE (available at: <https://bit.ly/3w72Bia>); and Rais (available at: <https://bit.ly/35R6lKb>).

FIGURE A.3

Four largest firms – C4 (2007-2016)



Sources: PIA/IBGE (available at: <https://bit.ly/3w72Bia>); and Rais (available at: <https://bit.ly/35R6lKb>).

APPENDIX B

TABLE B.1
Descriptive statistics

Variable	Obs.	Mean	Stand. dev.	Min.	Max.
Price-cost margin (PCM)	1519	0.369	0.136	-0.162	0.963
Herfindahl Hirschman index (HHI)	1145	0.199	0.19	0.06	0.829
Four largest firms (CR4)	1569	0.665	0.21	0.351	1
Imports (IMP) (R$ million)	1924	526	1,127	0	10,710
Exports (EXP) (R$ million)	1924	630	2,190	0	41,820
Import penetration (IMPSH)	1516	166	621	0	10539
Export orientation (COEX)	1516	0.005	0.024	0	0.755
Investment (INV)	1528	0.019	0.047	0	0.999
Salaries by added value (LINC)	1519	0.408	0.23	-5.673	3.012
Number or firms (FIRMS)	1568	144	326	1	4155
Human capital (RHCI)	1924	7.475	1.204	4.374	8.666
Capital (RCI) (US$)	1924	112,823	31,368	35,556	140,462
Natural resources (LAND) (Hectare)	1924	0.594	0.107	0.447	0.891

Sources: Shirotori et al. (2010); McLaren et al. (2018); Kannebley Júnior, Remédio and Oliveira (2020; 2021); Rais; IBGE; Comtrade.
Author's elaboration.
Obs.: INV, LINC, COEX, IMPSH are ratios in units. "Imports" and "Exports" in R$ million, "Physical capital" in US$ dollars, all corrected to constant values, "Human Capital" in years of instruction, "Natural Resources" in hectares.

TABLE B.2

Descriptive statistics – Panel

Variable		Observations	Mean	Stand. dev.	Min.	Max.
PCM	Total	1519	0.368	0.136	-0.162	0.963
	Transversal	158	-	0.124	0.118	0.849
	Temporal	10	-	0.053	0.066	0.721
HHI	Total	1145	0.199	0.190	0.060	0.829
	Transversal	119	-	0.197	0.066	0.790
	Temporal	10	-	0.014	0.142	0.270
CR4	Total	1569	0.665	0.210	0.351	1.000
	Transversal	161	-	0.209	0.391	1.000
	Temporal	12	-	0.036	0.577	0.808
IMPORTS (R$ million)	Total	1924	5,26e+08	1,13e+09	0,000	1,07e+10
	Transversal	161	-	1,05e+09	0,000	6,44e+09
	Temporal	12	-	4,18e+08	0,000	4,79e+09
EXPORTS (R$ million)	Total	1924	6,30e+08	2,19e+09	0,000	4,18e+10
	Transversal	161	-	1,94e+09	0,000	2,06e+10
	Temporal	10	-	1,02e+09	0,000	2,19e+10
IMPSH	Total	1516	166	622	0.000	10539
	Transversal	158	-	565	0.068	5669
	Temporal	10	-	307	0.000	5036
COEX	Total	1516	0.005	0.024	0.000	0.755
	Transversal	158	-	0.016	0.000	0.139
	Temporal	10	-	0.019	0.000	0.621
INV	Total	1528	0.019	0.047	0.000	0.999
	Transversal	158	-	0.025	0.000	0.198
	Temporal	10	-	0.041	-0.178	0.819
LINC	Total	1519	0.408	0.230	-5673	3012
	Transversal	158	-	0.116	0.066	0.818
	Temporal	10	-	0.198	-5331	2790
FIRMS	Total	1568	144297	326	1	4155
	Transversal	161	-	321	1	3654
	Temporal	10	-	36	1	645

(Continues)

(Continued)

Variable		Observations	Mean	Stand. dev.	Min.	Max.
RHCI	Total	1924	7.475	1.204	4.374	8.666
	Transversal	161	-	1.215	4.374	8.666
	Temporal	12	-	0.000	7.475	7.475
RCI (US$)	Total	1924	1,13e+05	31,368	35,556	1,40e+05
	Transversal	161	-	31,707	35,556	1,40e+05
	Temporal	12	-	0,000	1,13e+05	1,13e+05
LAND	Total	1924	0.595	0.107	0.447	0.891
	Transversal	161	-	0.109	0.447	0.891
	Temporal	12	-	0.000	0.595	0.595
ANO	-	12	-	-	2007	2018
CLASSE	Total	1924	-	-	7103	30997

Sources: Shirotori et al. (2010); McLaren et al. (2018); Kannebley Júnior, Remédio and Oliveira (2020; 2021); Rais; IBGE; Comtrade.

Author's elaboration.

Obs.: INV, LINC, COEX, IMPSH are ratios in units. "IMP" and "EXP" in R$ million, "RCI" in US$ dollars, all corrected to constant values, "RHCI" in years of instruction, "LAND" in hectares.

TABLE B.3
Correlation matrix

	MPC	HHI	CR4	IMP	EXP	IMPSH	COEX	INV	LINC	FIRMS	RHCI	RCI	LAND
PCM	1,000												
HHI	0.241	1,000											
CR4	0.289	0.817	1,000										
IMP	0.112	0.276	0.062	1,000									
EXP	0.130	-0.076	-0.095	0.080	1,000								
IMPSH	-0.092	0.053	-0.070	0.253	-0.112	1,000							
COEX	-0.080	-0.103	-0.146	-0.042	0.166	-0.210	1,000						
INV	-0.036	0.037	-0.018	-0.035	0.038	0.039	-0.019	1,000					
LINC	-0.425	0.004	-0.020	-0.064	-0.161	0.095	0.064	0.050	1,000				
FIRMS	-0.055	0.243	0.218	0.074	-0.018	-0.059	-0.109	0.001	0.135	1,000			
RHCI	-0.254	-0.651	-0.636	-0.032	0.026	0.051	0.054	0.008	0.033	-0.153	1,000		
RCI	-0.159	-0.728	-0.657	-0.006	0.132	0.001	0.095	-0.023	-0.133	-0.250	0.899	1,000	
LAND	-0.299	-0.561	-0.610	-0.083	-0.061	0.078	0.041	-0.001	0.178	-0.143	0.474	0.306	1,000

Author's elaboration.

BOX B.1

Underidentification, overidentification and endogeneity tests – HHI, CR4

```
ivreg2 lnpcm lnfirms linc (lnhhi = lnland lnrci lnrhri year07-year18) lnimp lnimpsh lninv lnexp lncoex dum*, endog(lnhhi) robust
Warning - collinearities detected
Vars dropped:      dum112 dum113 dum116 dum200 dum210 dum230 dum240 dum260
                   dum270 dum290 dum300 dum310 dum320 dum330 lnrci lnrhri
                   year07 year17 year18
IV (2SLS) estimation
--------------------
Estimates efficient for homoskedasticity only
Statistics robust to heteroskedasticity
                                            Number of obs =     1091
                                            F( 17,  1073) =   123.16
                                            Prob > F      =   0.0000
Total (centered) SS     =  86.1694877       Centered R2   =   0.4029
Total (uncentered) SS   =  1324.478427      Uncentered R2 =   0.9612
Residual SS             =  51.45241925      Root MSE      =   .2172
------------------------------------------------------------------------------
             |               Robust
       lnpcm |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnhhi |   .1719601    .017888     9.61   0.000     .1369003    .2070199
     lnfirms |  -.0270928   .0101247    -2.68   0.007    -.0469368   -.0072489
        linc |  -.5336485   .1236125    -4.32   0.000    -.7759245   -.2913725
       lnimp |   .0210661   .0198597     1.06   0.289    -.0178581    .0599903
     lnimpsh |  -.0177291   .0185814    -0.95   0.340    -.0541479    .0186897
       lninv |  -.0087798   .0042352    -2.07   0.038    -.0170807    -.000479
       lnexp |    .013698   .0146501     0.94   0.350    -.0150156    .0424117
      lncoex |  -.0255069   .0182688    -1.40   0.163    -.0613131    .0102993
      dum110 |  -.2944604    .035333    -8.33   0.000    -.3637118    -.225209
      dum114 |  -.2103406   .0407228    -5.17   0.000    -.2901559   -.1305253
```

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dum115	-.025677	.0357318	-0.72	0.472	-.09571	.044356
dum117	.1121349	.0227068	4.94	0.000	.0676304	.1566394
dum118	.1632955	.0312196	5.23	0.000	.1021062	.2244848
dum119	-.2251433	.0684013	-3.29	0.001	-.3592073	-.0910793
dum220	-.1958787	.0279469	-7.01	0.000	-.2506536	-.1411038
dum250	-.0214007	.0253495	-0.84	0.399	-.0710848	.0282835
dum280	.0422526	.0290907	1.45	0.146	-.0147642	.0992693
_cons	-.9759657	.2027424	-4.81	0.000	-1.373333	-.578598

Underidentification test (Kleibergen-Paap rk LM statistic): 94.519

Chi-sq(10) P-val = 0.0000

Weak identification test (Kleibergen-Paap rk Wald F statistic): 2056.023

Stock-Yogo weak ID test critical values: 5% maximal IV relative bias 20.74

10% maximal IV relative bias 11.49

20% maximal IV relative bias 6.61

30% maximal IV relative bias 4.86

10% maximal IV size 38.54

15% maximal IV size 20.88

20% maximal IV size 14.78

25% maximal IV size 11.65

Source: Stock-Yogo (2005). Reproduced by permission.

NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Hansen J statistic (overidentification test of all instruments): 22.462

Chi-sq(9) P-val = 0.0075

-endog- option:

Endogeneity test of endogenous regressors: 5.913

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```
                                    Chi-sq(1) P-val =    0.0150

Regressors tested:   lnhhi

------------------------------------------------------------------------------

Instrumented:         lnhhi

Included instruments: lnfirms linc lnimp lnimpsh lninv lnexp lncoex dum110

                      dum114 dum115 dum117 dum118 dum119 dum220 dum250 dum280

Excluded instruments: lnland year08 year09 year10 year11 year12 year13 year14

                      year15 year16

Dropped collinear:    dum112 dum113 dum116 dum200 dum210 dum230 dum240 dum260

                      dum270 dum290 dum300 dum310 dum320 dum330 lnrci lnrhri

                      year07 year17 year18

ivreg2 lnpcm lnfirms linc (lnc4 = lnland lnrci lnrhri year07-year18) lnimp lnimpsh lninv lnexp lncoex dum*, endog(lnc4)
i(class) robust

Warning - collinearities detected

Vars dropped:       dum112 dum113 dum116 dum210 dum230 dum240 dum260 dum270

                    dum290 dum310 dum320 dum330 lnrhri year07 year17 year18

IV (2SLS) estimation

--------------------

Estimates efficient for homoskedasticity only

Statistics robust to heteroskedasticity

                                          Number of obs =     1425

                                          F( 19,  1405) =    97.99

                                          Prob > F      =   0.0000

Total (centered) SS     =  160.9293146            Centered R2   =   0.4156

Total (uncentered) SS   =  1748.318114            Uncentered R2 =   0.9462

Residual SS             =  94.04061766            Root MSE      =   .2569

------------------------------------------------------------------------------

             |               Robust

       lnpcm |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
```

(Continues)

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```
-------------+----------------------------------------------------------------
        lnc4 |   .3741002   .0504132     7.42   0.000      .275292    .4729083
    lnfirms  |  -.0309718   .0102854    -3.01   0.003    -.0511308   -.0108127
        linc |  -.5790852   .1559395    -3.71   0.000     -.884721   -.2734494
       lnimp |   .0207305   .0194169     1.07   0.286    -.0173259    .0587869
    lnimpsh  |  -.0182338   .0184328    -0.99   0.323    -.0543614    .0178937
       lninv |  -.0187645   .0037752    -4.97   0.000    -.0261637   -.0113653
       lnexp |   .0090441   .0143401     0.63   0.528     -.019062    .0371501
      lncoex |  -.0248625   .0183425    -1.36   0.175    -.0608132    .0110883
     dum110  |  -.4167168   .0464792    -8.97   0.000    -.5078143   -.3256192
     dum114  |  -.0904735   .0349025    -2.59   0.010    -.1588811   -.0220659
     dum115  |  -.0391946   .0359562    -1.09   0.276    -.1096675    .0312783
     dum117  |   .0971029   .0231619     4.19   0.000     .0517065    .1424993
     dum118  |   .1107029   .0341308     3.24   0.001     .0438078    .1775979
     dum119  |   -.081795   .0535025    -1.53   0.126    -.1866581     .023068
     dum200  |   .0736338   .0307614     2.39   0.017     .0133425    .1339251
     dum220  |  -.2257025   .0291241    -7.75   0.000    -.2827846   -.1686203
     dum250  |  -.0167236   .0253656    -0.66   0.510    -.0664393     .032992
     dum280  |    .100229    .034323     2.92   0.003     .0329572    .1675008
     dum300  |  -.3339423   .0621909    -5.37   0.000    -.4558342   -.2120504
       _cons |  -1.017502   .1878844    -5.42   0.000    -1.385749   -.6492555
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):           193.053
                                                  Chi-sq(11) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Kleibergen-Paap rk Wald F statistic):       642.221
Stock-Yogo weak ID test critical values:  5% maximal IV relative bias    20.90
                                                  10% maximal IV relative bias    11.51
```

(Continues)

(Continued)

20% maximal IV relative bias 6.56

30% maximal IV relative bias 4.80

10% maximal IV size 40.90

15% maximal IV size 22.06

20% maximal IV size 15.56

25% maximal IV size 12.23

Source: Stock-Yogo (2005). Reproduced by permission.

NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Hansen J statistic (overidentification test of all instruments): 41.306

Chi-sq(10) P-val = 0.0000

-endog- option:

Endogeneity test of endogenous regressors: 7.185

Chi-sq(1) P-val = 0.0074

Regressors tested: lnc4

Instrumented: lnc4

Included instruments: lnfirms linc lnimp lnimpsh lninv lnexp lncoex dum110 dum114 dum115 dum117 dum118 dum119 dum200 dum220 dum250 dum280 dum300

Excluded instruments: lnland lnrci year08 year09 year10 year11 year12 year13 year14 year15 year16

Dropped collinear: dum112 dum113 dum116 dum210 dum230 dum240 dum260 dum270 dum290 dum310 dum320 dum330 lnrhri year07 year17 year1

Author's elaboration.

TABLE B.4
First stage regression – HHI

Variables	(1) OLS (HHI)	(2) FE (HHI)	(3) RE (HHI)
RCI	-0.906***	-	-0.868***
	(0.054)		(0.17)
RHCI	-1.427***	-	-1.534***
	(0.152)		(0.483)
LAND	-1.017***	-	-1.118***
	(0.097)		(0.309)
Observations	1145	1145	1145
R-Squared	0.7209	0.3159	0.3159
Dummy year	Yes	Yes	Yes

Author's elaboration.
Obs.: 1. Robust standard errors are in parentheses.
2. *** p < 0.01, ** p < 0.05, * p < 0.1.

TABLE B.5
First stage regression – CR4

Variables	(1) OLS (CR4)	(2) FE (CR4)	(3) RE (CR4)
RCI	-0.176***	-	-0.175***
	(0.019)		(0.057)
RHCI	-0.782***	-	-0.796***
	(0.048)		(0.146)
LAND	-0.048	-	-0.051
	(0.038)		(0.118)
Observations	1569	1569	1569
R-Squared	0.4422	0.3025	0.3025
Dummy year	Yes	Yes	Yes

Author's elaboration.
Obs.: 1. Robust standard errors are in parentheses.
2. *** p < 0.01, ** p < 0.05, * p < 0.1.

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