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Structure, Conduct and Performance: a Simultaneous Equations Investigation for the Brazilian Manufacturing Industry

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Structure, Conduct and Performance: a Simultaneous Equations Investigation for the Brazilian Manufacturing Industry[*]

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Abstract

The paper investigated structure-conduct-performance (SCP) relationships in the context of the Brazilian manufacturing industry 1996. For that purpose, it considered a system with 4 equations pertaining concentration, advertising, R&D and profitability that was estimated with simultaneous equation models. In addition to the usual explanatory variables proxying barriers to entry and demand conditions, the paper considered organizational practices and incentive schemes variables. The evidence indicated an important role for variables related to barriers to entry in affecting market structure, an important and non-linear effect of concentration on advertising, a relevant impact of firm-size on the propensity to exert R&D effort and finally a significant positive impact of concentration on profitability and were similar to the previous evidence for developed countries. Additionally, no important roles were detected for organizational practices and incentive schemes on the SCP relationships.

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Introduction

The structure-conduct-performance (SCP) paradigm has constituted an enduring empirical tradition in empirical Industrial Economics and has the advantage of clarifying the basic building blocks of the competitive mechanisms. The recent literature, however, has indicated a gradual disenchantment with large inter-industry models as idiosyncratic factors at the sector and firm level should be properly accounted by means of theoretically sound game-theoretical models for specific industries [see e.g. Bresnahan (1989) and Schmalensee (1989)]. The consideration of simple aspects of market structure that are associated with robust inter-industry regularities was advanced by Sutton (1991, 1998). Additionally, the aforementioned works emphasized the endogeneity of market structure

At the empirical level the importance of accounting for endogeneities in the econometric analysis has been previously recognized in the SCP literature [see e.g. Geroski (1982) and Evans et al (1993)]. In fact, a handful of applications of simultaneous equations approaches to investigate SCP issues has emerged as exemplified by the contributions by, Strickland and Weiss (1976), Martin (1979), Connoly and Hirschey (1984) Uri (1988) and Delorme et al (2002). The scarcity of studies within that approach reflects difficulties in obtaining the relevant detailed data and yet the aforementioned shift towards industry-specific studies with a clear oligopoly model foundation.

In the present paper, one undertakes an investigation of SCP relationships by means of a simultaneous equations approach as applied to the Brazilian

manufacturing industry, on the grounds that it might highlight useful empirical regularities. The motivation for yet another study of this type is twofold. First, the previous literature has focused on developed countries and therefore the study of a large heterogeneous industry like the Brazilian one that is characterized by the co-existence of modern and traditional segments can provide potentially distinct insights. Indeed In fact, the scarcity of studies in the Brazilian case can be noted in terms of the single-equation traditional structure-performance study by Macedo and Portugal (1995) and the dynamic panel data investigation by Lima and Resende (2004) within a conjectural variation framework.

Second, despite the undesirable cross-sectional feature of the data, there is a unusual availability of data pertaining organizational practices in the present case. In fact, at a more generic level it has been recognized that the internal organization of the firm can possess a decisive role in determining profitability [see Thompson (1981)] but the effect of different modern organizational practices have not been previously addressed in the context of SCP studies.

The paper is organized as follows. The second section discusses the data sources and variable constructions and yet outlines the empirical model to be estimated. The third section presents the empirical results. The fourth section brings some final comments.

2. Data Construction

2.1-Data Source

The basic data source of the study is the extended survey carried out by Fundação SEADE for firms in the state of São Paulo [Pesquisa de Atividade Econômica Paulista-PAEP]. That state responds for the bulk of industrial production in Brazil. Even though, data is essentially available in terms of a cross-section for 1996 (with the exception of a few variables), it is worth mentioning the wealth of information in terms of organizational practices. That kind of information is rarely available and the same occurs with the advertising data used in this study. Our sample includes 7188 manufacturing firms classified at the 4-digits level, though in some cases we were only able to obtain data from complementary sources at the 3-digits level. The oil refining sector in 1996 was totally dominated by public production subject by a high degree of regulation and for that reason was excluded from the studied sample.

2.2- Empirical Model

The majority of the literature modeling ECP in terms of simultaneous equations considered a system comprising 3 equations referring to concentration, advertising and profitability, as for example the studies by Strickland and Weiss (1976), Martin (1979) and Delorme et al (2002).[1] Other studies included a fourth equation pertaining R&D as done by Connoly and Hirschey (1984) and Uri (1988). Previous studies involved different complexities

[1] Martin (1993) provides a partial overview of those kinds of studies and yet develops a useful discussion of the econometric identification issues involved.

in terms of the explanatory variables. In fact, Delorme et al (2002) attempted to introduce some dynamics by means of a one-period lag structure but consider a limited number of variables in the analysis involving profit, advertising, concentration, R&D, investment and growth. There is clearly a trade-off on undertaking a dynamic analysis and yet rely on a detailed explanatory structure. [2] In the present study, we follow the bulk of the empirical literature by mostly considering contemporaneous relationships, though with a large availability of potentially relevant explanatory equations. There are, however, qualitative variables in the R&D equation that possess a lagged character as one shall see. The specifications of the different equations nearly match the largest set of explanatory variables considered in the more detailed studies. More detailed comments will be provided to less conventional variables and will be gradually explained as they appear in the different equations.

<u>concentration equation</u>

CONC = f (PROF, EX, R&D, ADV, MES, CD)

Where

CONC : industrial concentration as measured by the Herfindahl index $H \equiv \sum_i s_i^2$

with s_i standing for market shares calculated at the 4-digits level upon data on sales (net operating revenues)

. PROF: profit margin as defined by :

((gross value of production)/(indirect consumption + wages)) – 1

[2] Santos (1995) considered a flexible dynamic specification in terms of a VAR approach but then had to rely in a simplistic 3 variables system (concentration, advertising and profitability) as applied to a specific sector.

. Usual developments of the relationship between the Lerner index and the Herfindahl index provide a motivation for the concentration-profitability relationship

. EX export intensity defined as exports divided by apparent consumption as provided at the 3-digits level by Moreira (1999), calculated upon data from the SRF-Ministry of Finance, Brazil. This variable indicates, in part, if the firm belongs to a dynamic exporting sector. This variable attempts to capture the dynamic character of the industry as approximated by the export intensity of the sector in some other studies a variable relating to industry growth was available;

R&D: research and development intensity defined as the number of employees allocated to R&D activities divided by the total number of employees

. ADV: advertising intensity defined as advertising expenses divided by sales. The perception that in many cases where there is a preference for the established brand advertising can have a role as an entry barrier;

. MES: minimum efficient scale proxied by the average firm size in terms of the number of employees

. CD: cost disadvantage as measured by percentage of the employment of firms in a given sector that are in firms below the minimum efficient. The larger the proportion of firms operating in a suboptimal scale, the lower would be the cost disadvantage of those smaller scale firms. This variable can be thought of an inverse proxy foe barriers to entry associated with scale effects [3]

[3] Similar measures were considered by Mata and Machado (1996) and Görg and Strobl (2002) in the context of the determinants of firms' start-up size.

advertising intensity

ADV = f (PROF,CONC, $CONC^2$, EX, DUR)

The Dorfman-Steiner condition establishes an equilibrium condition for a profit maximizing monopolist that motivates a positive association between advertising intensity and profitability (with no causality specified). Even though it holds for a monopoly or as a limiting case to a collusive oligopoly it has been routinely used to motivate that pair of variables that appear in the advertising and profitability equations

The inclusion of concentration and squared concentration are motivated by a possible inverted U relationship with higher advertising intensity prevailing in oligopolistic industries [see e.g. Cable (1972)]

. DUR : dummy variable that assumes value 1 if the firm is in a sector characterized by durable goods and 0 otherwise. One would expect in principle a less important role for advertising in the case of durable goods as price competition would become more important; [see e.g. Comanor and Wilson (1974)];

R&D equation

In addition to usual variables considered in the empirical literature, one considers variables that are likely to positively influence an innovative environment within the firm. Some variables have a lagged feature and some reflect modern organizational practices or yet indicate the access to information technology.

R&D = f (CONC, PROF, SIZE, KAIZEN, INCREMI, IPROC, MICRO. INTER, INTRA)

. SIZE: firm size in terms of the total number of employees

. KAIZEN: dummy variable that assumes value 1 if the firm has improvement groups and 0 otherwise;

. SIGI: dummy variable that assumes value 1 if a significant product innovation took place in the 1994-96 period and 0 otherwise;

INCREMI: dummy variable that assumes value 1 if an incremental product innovation took place in the 1994-96 period and 0 otherwise;

. IPROC: dummy variable that assumes value 1 if a process innovation took place in the 1994-96 period and 0 otherwise

. MICRO: number of microcomputers per employee;

INTER: dummy variable that assumes value 1 if the firm had access to Internet and 0 otherwise;

. INTRA: dummy variable that assumes value 1 if the firm had intranet in terms of local data exchange (for example LAN networks) and 0 otherwise;

.profitability equation

This equation attempts to control for differences in demand and entry conditions across industries. Once more we follow a specification consistent with nearly the largest set of explanatory considered in the literature

PROF = f(CONC, CD, ADV. R&D, EX, IM, TQM, IJIT, SCP, PPROF, PREW)

. IM: import intensity defined as imports divided by apparent consumption as provided at the 3-digits level by Moreira (1999), calculated upon data from the SRF-Ministry of Finance, Brazil. This variable reflects competitive pressures from foreign products;

. TQM: dummy variable that assumes value 1 if the firm had a total quality management program and 0 otherwise;

. IJIT: dummy variable that assumes value 1 if the firm had an internal just-in-time program and 0 otherwise;

. SCP: dummy variable that assumes value 1 if the firm had statistical control of processes program and 0 otherwise;

. PPROF: dummy variable that assumes value 1 if the firm had a profit participation scheme for employees and 0 otherwise;

. PREW: dummy variable that assumes value 1 if the firm had had a productivity reward scheme for employees statistical control of processes program and 0 otherwise;

3. Empirical Results

The system of simultaneous equations was estimated by means of three stage least squares and CONC, $CONC^2$, ADV, R&D and PROF were treated as endogenous and therefore the remaining variables were listed as instruments in the estimation. In order to control for sectoral heterogeneity, sectoral dummy variables were constructed at the 3-digits level and included in each equation with potentially different coefficients. There were 89 of such variables and in

practice there were included 88 so as to avoid the dummy trap. These sectoral dummies were significant at the 5 % level in 38.92 % of the cases with specially strong presence in the case of the concentration and profitability equations and therefore indicate that some unobserved sectoral heterogeneity can have an important role in SCP studies.[4] The results are presented in table 1.

INSERT TABLE 1 AROUND HERE

The results are not very strong in terms of significant coefficients but some salient results emerge:

a) In the concentration equation the minimum efficient scale (MES) exert the expected positive effect on concentration, and the cost disadvantage variable (CD) that can be interpreted as an inverse proxy for barriers to entry, display the expected negative sign. Variables related to entry barriers appear therefore to have some impact on market structure.

b) In the advertising equation the so-called inverted U relationship appears to be supported in terms of positive significant coefficient for CONC and negative significant coefficient for $CONC^2$. A counterintuitive result appears in terms of the negative coefficient with respect to profitability. One needs, however, to bear in mind that the positive sign evoked from the Dorfman-Steiner condition can be questioned as it refers to a monopoly setup whereas oligopoly is likely to be prevalent.

[4] The results for the sectoral dummies are not reported for conciseness but can be provided upon request.

c) In the R&D equation, one observes that larger firms are more likely to exert higher R&D efforts and surprisingly one observes that previous innovation successes (expressed in terms of SIGI, INCREMI, IPROC) , access to information technology (in terms of INTER and INTRA) and modern organization practices (in terms of KAIZEN) have a negative impact on the current R&D effort. In the case of innovation accommodation given past successes could be occurring but in the cases of the other variables, the negative coefficients have a less evident explanation;

d) In the profitability equation, one only obtains a strong positive effect accruing from concentration but variables pertaining modern organizational practices and explicit incentive schemes had no effect on profitability.

4. Final Comments

The paper implemented a simultaneous equations approach for investigating structure-conduct-performance relationships in the Brazilian manufacturing industry. The evidence for this developing country was in fact similar to previous studies for developed counties. In particular, one could identify an important role for variables related to barriers to entry in affecting market structure, an important and non-linear effect of concentration on advertising, a relevant impact of firm-size on the propensity to exert R&D effort and finally a significant positive impact of concentration on profitability.

.The relatively important impact of sectoral dummies indicate that sectoral specificities, other than those incorporated in the explanatory variables might be relevant for the SCP relationships.

Despite the wealth of qualitative information on modern organizational practices, as a rule, there is no evidence of important effects in the SCP relationships associated with those practices. Nevertheless, a careful investigation of the role of modern organizational practices and incentives schemes is still warranted. In particular, patterns of strategic complementarities on the adoption of different practices deserve attention in future studies.

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Table 1
Structure-conduct-performance model estimates (no. of observations

Variables	**Equation**			
	CONC	**ADV**	**R&D**	**PROF**
Constant	0.118 (0.000)	-0.227E-02 (0.747)	0.738E-02 (0.000)	-0.012 (0.262)
PROF	2.925 (0.062)	-0.442 (0.027)	-0.088 (0.530)	-
MES	0.123E-03 (0.000)	-		-
CDR	-0.396E-02 (0.000)	-		0.359 (0.000)
R&D	-0.542 (0.642)	-	-	0.324 (0.372)
EX	-0.27E03 (0.790)	-0.304E-03 (0.114)	-0.219E-04 (0.611)	0.540E-04 (0.806)
IM	-	-	-	0.710E-04 (0..578)
ADV	1.7184 (0.132)	-		-0.212 (0.333)
CONC	-	0.138 (0.024)	-0.222E-02 (0.275)	0.052 (0.000)
$CONC^2$	-	-0.208 (0.034)	-	-
DUR	-	0.255E-03 (0.429)	-	-
TAM	-	-	0.669E-06 (0.043)	-
KAIZEN	-	-	-0.170E-02 (0.000)	-
SIGI	-	-	-0.983E03 (0.001)	-
INCREMI	-	-	-0.121E-02 (0.000)	-
PROCI	-	-	-0.930E-03 (0.007)	-
MICRO	-	-	-0.0189E-02 (0.095)	-
INTER	-	-	-0.110E-02 (0.007)	-
INTRA	-	-	-0.699E-03 (0.000)	-
PPROF	-	-	-	0.011 (0.082)

PREW				0.658E-02 (0.517)
TQM	-	-	-	-0.304E-02 (0.384)
IJIT	-	-	-	0.532E-03 (0.479)
SCP	-	-	-	0.792E-03 (0.553)
R^2	0.595	0.008	0.105	0.006

Note: the underlying standard errors are heteroskedasticity-robust