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Price synchronization in retailing: some empirical evidence

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The paper investigates the synchronization of price changes in the context of retail tire dealers in São Paulo-Brazil and selected items in supermarkets for cleaning supplies and food in Rio de Janeiro-Brazil. Results indicate similar and non-negligible synchronization for different brands, although magnitudes are distant from a perfect synchronization pattern. We find interesting patterns in inter-firm competition, with similar magnitudes across different tire types. Intra-chain synchronization is substantial, indicating that a common price adjustment policy tends to be sustained for each chain across different products.

Keywords: price synchronization; staggering; retail.
JEL Classification: L11; L81.

INTRODUCTION

Temporal price dispersion is now recognized as a relevant phenomenon. In fact, the informational foundation of price promotions (as in Varian, 1980) indicates the prevalence of mixed strategies in pricing strategies. In broad terms, empirical consistency with randomized prices is found in terms of substantial switches across distribution quantiles over time [see e.g. Lach (2002) for Israel, and Hollanda (2006) and Rega (2007) for Brazil], or consistency with the theoretical equilibrium price density as investigated by Villas-Boas (1995). Also, Hosken and Reiffen (2004)

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investigates asymmetric price adjustments by assessing the likelihood of price increases *vis-à-vis* price reductions.

Moreover, other microeconomic aspects of retail pricing dynamics are evolving as new detailed data sources become available. Indeed, studies that assess the distribution of price adjustments and survival of prices are becoming more common, as exemplified by Dias et al. (2007) and Barros and Matos (2009).

Finally, another relevant aspect that pertains to price synchronization is the indication of coordinating behaviors by different firms (even if tacitly). For instance, Lach and Tsiddon (1996) detect that prices changes across different Israeli grocery stores appear to be staggered. In that sense, it is relevant to conceive measures that summarize the prevailing degree of price synchronization. The related microeconomic studies can investigate actual frictions in price setting that could reflect underlying informational and adjustment cost aspects.

Fisher and Konieczny (2000) delineate some essential elements for the construction of a price synchronization index that are further detailed by Dias et al. (2005). The present paper focuses on the application of the referred index for the Brazilian retail market, specifically tire dealers and selected items in supermarkets. We explore the existing gap in the related literature for developing countries that includes a more specific application in Resende and Zeidan (2008). Evidence suggests similar and non-negligible synchronization for different brands/tire types, although the magnitudes are distant from perfect synchronization. Analogous results prevail for the selected items in supermarkets.

The paper is organized as follows. The second section presents the measure of price synchronization and test procedure for assessing a particular synchronization behavior. The third section describes the data and presents the empirical results. The fourth section brings some final comments.

MEASURING PRICE SYNCHRONIZATION

Staggering is usually considered a strategy derived from incomplete and imperfect information and refers to sequential price adjustments that contrast with simultaneous synchronized patterns for price adjustments. Most models that deal with staggering follow a macroeconomic setting in which inflation leads to different pricing strategies. For instance, Ball and Cecchetti (1988) emphasize informational constraints on the current state of the economy and information gathering by observing prices set by others agents. Bhaskar (2002), on the other hand, relies on imperfect competition, not information, as the means to derive stable Nash equilibria both for price staggering and synchronization.

In contrast, Sheshinski and Weiss (1992) present a formal microeconomic model of staggering. Their model is not inter-firm, but deals with a multiproduct monopoly in the presence of inflation and fixed costs of nominal price changes. Other models in the same vein pinpoint rigidities associated to price adjustment costs (*menu costs*). Lach and Tsiddon (1992) undertake an empirical application

to investigate the effect of inflation on price dispersion and the evidence seems coherent with menu cost arguments. The study considers disaggregated data on prices of foodstuffs in Israel during 1978-84, and obtains evidence that price changes are not synchronized even under episodes of high inflation, indicating that staggering is a relevant phenomenon. Moreover, Fisher and Konieczny (2000) found that lower and more stable inflation rates are associated with more synchronized price changes in the case of Canadian daily newspapers. It is worth mentioning that chronic high rates of inflation in Brazil cease to exist after the stabilization program in 1994 (*Plano Real*), but are still higher than in developed markets. In summary, the notion that nominal prices adjustments can be costly leads to discontinuous price behavior that can be affected by an inflationary process. Here we follow the last class of models and investigate the behavior of price synchronization in two different markets for the Brazilian economy.

Empirically, staggering and synchronization are investigated as a microeconomic feature through the Fisher and Konieczny (2000) index. Dias et al. (2005) provide a clear interpretation for the index of price changes in the context of inter-firm price changes. It builds on Fisher and Konieczny (2000), and suggests the following summary measure for capturing the synchronization of price changes across different firms. The Fisher and Konieczny (FK) index is:

$$FK = \sqrt{\frac{1}{T}\frac{\sum_{t=1}^{T}(p_t - \bar{p})^2}{\bar{p}(1-\bar{p})}} = \frac{\sqrt{s^2_{p_t}}}{\sqrt{\bar{p}(1-\bar{p})}} \qquad (1)$$

In (1), p_r denotes the proportion of firms that changed the price of the product between periods t –1 and t, $\bar{p} = \sum_t p_t / T$ is the corresponding sample mean, and s^2_p stands for the associated sample variance. Some polar cases are captured by the index. In the case of perfect synchronization either all prices change at the same time or no price changes at all. Under this binary pattern, $s^2_p = \bar{p}(1-\bar{p})$, and thus FK = 1. Another salient case occurs when $p_r = \bar{p}\ \forall$ t, which leads to FK = 0. This case corresponds to uniform price staggering, in which a proportion $\bar{p}$ of all firms change their prices every period. Intermédiate cases are usually not found in the literature, due to its difficult econo mic interpretation.

EMPIRICAL ANALYSIS

Data sources

The paper relies on two data sets for retail markets in Brazil. First, we consider bi-monthly data for chains of retail tire dealers in São Paulo-Brazil as provided by the Associação Brasileira dos Revendedores de Pneus (ABRAPNEUS). The

sample period is from 08/16/2003 to 01/16/2006) in general, except for two models of a given brand for which the available data refers to a shorter period.

Data are also divided in spot or post-dated sales. Post-dated sales refer to sales made with post-dated checks, usually a month. The practice of post-dated checks is common in Brazil, being a leftover of the inflationary period, and it is still in use due to many factors, including tradition and high short term-interest rates.

Data are also available for four brands (Michelin, Goodyear, Pirelli and Firestone) and seven different kinds of tires. Combined with the two methods of sale, spot and post-dated, that gives us 28 different combinations of brands, tires and methods of sale. This kind of comprehensive data is particularly useful to capture different strategies implicit in price synchronization.

A second data source relies on prices at supermarkets as collected in surveys for constructing consumer price indexes in Rio de Janeiro [Índice de Preços ao Consumidor-IPC, Instituto Brasileiro de Economia-Fundação Getulio Vargas-IBRE-FGV]. We have special access to the unpublished data for 8 items [saltine crackers, grated parmesan cheese, ketchup, mustard, pasta (spaghetti), bleach, fabric softener and soap powder] for different brands in different stores. There are rotations in the data collection and therefore survey personnel do not always assess a given store in the 3 monthly visits. Hence, in order to use equidistant observations it is necessary to consider only the first observation in each month. Monthly data partially mask more variable patterns of price adjustment within each month, and therefore overestimate synchronization.

Empirical results

We consider price synchronization in terms of different levels of analysis.

Product level synchronization

This is the most disaggregated definition and assesses synchronization across identical products irrespective of the store (chain). It would indicate the prevalence of the *law of one price*. High degree of price co-movements would be consistent with a competitive setting if synchronization prevails at lower levels or yet some tacit collusive agreement if co-movements are the norm at higher prices levels. It is important to stress that the index in this paper does not capture relative magnitudes of adjustment but only their occurrence pattern.

a) Intra-brand synchronization

In this case one captures whether there is a general synchronization pattern across different products within a given brand and independent of the seller. This form of synchronization would tend to reflect general pricing patterns practiced by the producers in the absence of specific arrangements with the retailer.

b) Intra-chain synchronization

Within a given chain, one would be interested in assessing different pricing patterns that could reflect on price discrimination practices based on information at the store and chain level. In a different context, it is common that a given clothing store charges different values for identical products in wealthier and less wealthy neighborhoods despite negligible discrepancies in operational costs. In the present application we have information at the chain (firm) level (and not the identification of particular stores within a chain) for the tire segment and therefore the FK index would reveal only the degree of intra-chain synchronization across products.

Overall synchronization

This more common aggregated indicator is the less informative as it can consider a set of heterogeneous products.

First, we present the empirical evidence for tire dealers. The FK price synchronization index results are in Table 1 for spot and post-dated sales. Each index is calculated for a given brand of a particular tire type across the different dealers and also at the intra-chain level.

Table 1: Fisher-Konieczny (FK) index of price changes synchronization for retail tire dealers — spot sales

Type of tire	Brands			
	Firestone	Goodyear	Michelin	Pirelli
18565-14	0.617	0.656	0.664	0.558
750-16	0.676	0.703	0.789*	0.590
90020-14	0.668	0.732	0.792*	0.549
100020-16	0.698	0.741	0.817	0.562
100020R16	0.670	0.730	NA	0.580
16570-13	0.613	0.626	0.699	0.550
17570-13	0.656	0.632	0.693	0.549
intra-brand price synchronization				
	0.599	0.614	0.580	0.511
overall price synchronization: 0.454				
intra-chain price synchronization				
5 Estrelas: 0.850	Com. Douglas: 0.892		Com. Pneutop: 0.851	
Pneus Linhares: 0.884	Rankar: 0.777		Codema: 0.926	
DPaschoal: 0.882	Nova Era: 0.908		Platinum Pneus: 0.823	
Roma Pneus: 0.831	Zacharias Pneus: 0.669		Caporrino: 0.988	
Dukadan: 0.930	Abouchar Dal: 0.920		Auto Lins: 0.803	
Caçula: 0.916	Casa Fernandes: 0.887		Da Costa Pneus: 0.773	
Pneuac: 0.942	Pneuasta: 0.972		Paneuastor: 0.947	
Pneuastúria: 0.835		Valetão: 0.896		

Note: (*) indicates a smaller sample (16/08/2003-01/07/2005) in contrast with the usual sample (16/08/2003-16/01/2006); NA: indicates non-availability of data.

At the disaggregated level, the index does not approach the aforementioned polar cases [perfect synchronization (FK = 1), or uniform staggering (FK =0)]. Salient results are:

i. Except for the Pirelli brand, for which FK typically situated around 0.5, we observe non-negligible synchronization of price changes for the different brands of different types with the magnitudes of FK approaching values close to 0.7 in many cases.

ii. The magnitude of the FK indexes for a brand of a given type is very similar if we compare spot and post-dated sales. This feature indicates that essentially the same price adjustment rules by tire dealers are employed independently of the sales method. In fact, if one considers the stacked vector referring to spot and post-dated sales one obtains a correlation coefficient of 0.729 (p-value = 0.000).

iii. Overall the FK indexes are similar for the different brands/tire types.

iv. When we consider the index at the intra-chain level, large magnitudes prevail (typically above 0.8), which indicates a substantial synchronization within stores that would tend to indicate a common price adjustment policy for each chain across its different products.[1]

Table 2 presents the evidence for synchronization in selected retail items in supermarkets, and the following salient results can be highlighted:

i. Non-negligible, but moderate degrees of synchronization appear to prevail. This result somewhat mimics the aforementioned evidence for tire dealers, though the magnitudes are relatively smaller. Nevertheless, once more we observe occasional higher values approaching 0.7.

ii. The magnitude of the FK indexes for a brand of a given type is in general similar for saltine crackers, grated parmesan cheese, ketchup, mustard and fabric softener. More discernible differences occur within the items pasta (spaghetti), soap powder and bleach, despite the more homogeneous character of this last category.

iii. The synchronization patterns do not appear to display a significant contrast across different items of a particular category and therefore the aggregate index for each category appears to be representative.

[1] Despite the overly high magnitudes for intra-chain price synchronization, one can observe non-negligible discrepancies in the FK index on some cases as exemplified for Zacharias Pneus (0.688) and Caporrino (0.988).

Table 2: Fisher-Konieczny (FK) index of price changes synchronization for retail tire dealers — post-dated sales

Type of tire	Brands			
	Firestone	Goodyear	Michelin	Pirelli
18565-14	0.604	0.621	0.614	0.441
750-16	0.633	0.726	0.773*	0.503
90020-14	0.653	0.716	0.828*	0.828
100020-16	0.682	0.735	0.735	0.462
100020R16	0.610	0.740	NA	0.534
16570-13	0.605	0.644	0.667	0.452
17570-13	0.638	0.707	0.640	0.411
intra-brand price synchronization				
	0.562	0.627	0.592	0.483
overall price synchronization: 0.398				
intra-chain price synchronization				
5 Estrelas: 0.835	Com. Douglas: 0.829		Com. Pneutop: 0.842	
Pneus Linhares: 0.824	Rankar: 0.802		Codema: 0.880	
DPaschoal: 0.900	Nova Era: 0.906		Platinum Pneus: 0.788	
Roma Pneus: 0.815	Zacharias Pneus: 0.687		Caporrino: 0.975	
Dukadan: 0.974	Abouchar Dal: 0.920		Auto Lins: 0.859	
Caçula: 0.880	Casa Fernandes: 0.901		Da Costa Pneus: 0.760	
Pneuac: 0.905	Pneuasta: 0.918		Paneuastor: 0.925	
Pneuastúria: 0.795		Valetão: 0.828		

Note: (*) indicates a smaller sample (16/08/2003-01/07/2005) in contrast with the usual sample (16/08/2003-16/01/2006); NA: indicates non-availability of data.

Altogether the evidence appears to indicate significant synchronization of price changes that might be consistent with significant interdependence across tire dealers and supermarket stores. Nevertheless, results are distant from perfect synchronization (FK = 1), and therefore do not provide an appealing preliminary evidence towards tacit coordinating behaviors.

The predominant results in the literature are for the polar cases of perfect synchronization and staggering pattern. The present interesting results indicate consistent strategies since results do not vary much for either brand, tire model and payment method. In the context of supermarkets, similar results appear to prevail in the case of cleaning supplies and food items. This is somewhat surprising because the literature does not present, until now, results that indicate a stable strategy that does not follow the polar cases of perfect staggering and synchronization.

Finally, one could wonder whether formal tests of synchronization would be relevant. Dias et al. (2005) discuss a test for uniform staggering based on Calvo (1983). The corresponding test statistic is given by $Q = (NT)\,FK^2$, where N stands for the number of firms in each period and T for the number of time periods. Under

Table 3: Fisher-Konieczny (FK) index of price changes synchronization for supermarket retail — selected items

Item/brand	FK	# of firms
Saltine crackers	0.39	17
Aymoré	0.33	10
Piraquê	0.34	17
Tostines	0.41	5
Greted parmesan	0.52	6
Boa Nata	0.44	6
Marília	0.49	6
Quata	0.54	4
Regina	0.66	3
Vigor	0.66	3
Ketchup	0.60	13
Arisco	0.23	13
Etti*	0.88	2
Helmman's fco 400 g	0.41	3
Helmman's fco 397 g	0.59	7
Mustard**	0.59	5
Arisco	0.54	3
Helmman's	0.49	5
Pasta (spaghetti)	0.49	16
Adria	0.31	16
Petybom	0.47	3
Piraquê (500 g)	0.32	13
Piraquê (1 kg)	0.47	4
Renata	0.47	3
Bleach	0.56	17
Brilux	0.58	4
Carrefour	0.69	2
Superglobo 1 l	0.37	17
Superglobo 2 l	0.41	5
Fabric softener	0.54	13
Comfort 500 ml	0.51	13
Comfort 2 l	0.54	4
Monbijou	0.50	3
Soap powder	0.46	18
Ariel	0.36	12
Gessy	0.33	18
Minerva	0.52	6
overall price synchronization: 0.54		

Note: There were 35 observations starting with August 2004, except for mustard for which there were 30 observations starting with January 2005.

the null hypothesis of uniform staggering, Q would be distributed as a χ^2(T-1). In our present application it is evident that the test would clearly lead to the rejection of uniform staggering in all cases. In fact, the values of FK are well above zero, which makes the test redundant.

The economic rationale is that there is a lack in our understanding of pricing strategies. Our results indicate that mixed synchronization strategies can be the outcome of an empirical investigation. There is no underlying economic model that explains this behavior. Nevertheless, the systematically high values for intra-chain suggest homogeneous patterns that can be consistent with representative firm frameworks as considered in macroeconomic approaches pertaining price adjustment. However, it would be desirable to improve data availability so as allow a large scale evaluation of price synchronization in general and intra-chain synchronization, in particular, that was only feasible for tires on the basis of a different data source.

FINAL COMMENTS

The paper aims at investigating the synchronization of price changes in retail tire dealers and supermarkets in Brazil. Data are particularly suited for that purpose, with four brands, seven tire types, and two payment methods on a period of four years for the retail tire market, and data for 8 items in different brands and stores in different supermarkets.

Evidence suggests similar and non-negligible synchronization for different brands/tire types, although the magnitudes are distant from perfect synchronization. Analogous results prevail for the selected items in supermarkets. Non-negligible synchronization is an interesting result in itself since the literature tends to emphasize the cases of perfect synchronization or staggering. Moreover, the results are consistent throughout brands, tire types and payment methods for tire retailers, and also for supermarket data.

Beyond applications in other contexts, an important avenue for new research would be an econometric investigation of the determinants of price synchronization, as well as a theoretical model that would explain this behavior. In that sense, scanner data for different products would be relevant should such data be available.

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APPENDIX

Selected Retail Items in Supermarkets

Saltine crackers (package with 500 g): Aymoré; Piraquê; Tostines
Uncooked spaghetti pasta: Adria with eggs (500 g); Petybom with eggs (500 g); Piraquê with eggs (500 g); Piraquê with semolina (1 kg)
Bleach: Brilux (500 ml); Carrefour (500 ml); Super Globo (1 l and 2 l)
Fabric softeners: Comfort (500 ml and 2 l); Mon Bijou (500 ml)
Ketchup: Arisco (500 g); Etti (500 g); Hellman's (397 g or 400 g);
Mustard (500 g): Arisco; Hellman's
Grated parmesan cheese (50 g): Regina; Marília; Boa Nata; Vigor; Quata
Soap powder (500 g): Ariel; Gessy; Minerva