Asymmetric Price Transmission in Local Fuel Markets in Brazil: an Empirical Study

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Abstract

The paper undertakes a cross-sectoral analysis of a salient empirical implication of the model of tacit collusion advanced by Abreu et al (1986). Specifically, the prevalence of a first order Markovian process for alternating between price wars and collusive periods is assessed by means of non-parametric tests. The analysis focuses on 30 different industries in Canada. The evidence provides weak support for optimal collusion in one industry, which is consistent with the idea that such collusive arrangements are unusual.

1 Introduction

The transmission of prices between the wholesale and the retail segments of fuel markets has gained attention in the related literature as indicated, for example, by Bacon (1991), Duffy-Deno (1996), Godby et al. (2000) and Eckert (2002). The evidence, typically based on time series methods, favors the existence of asymmetric price adjustments. Therefore, retail prices would tend to more promptly adjust upwards after wholesale price increases, but to slightly adjust following price reductions in the wholesale segment. Possible explaining factors include the possibility of holding inventory, transportation costs or the exercise of market power by intermediaries [see e.g. Ray et al. (2006)].

The present paper aims at investigating possible asymmetric transmission patterns between the wholesale and retail segments, in the context of local markets for fuels in Brazil, and it contributes to the literature in two aspects:

a) By investigating the asymmetric adjustment hypothesis in the context of an emerging economy as the previously literature essentially focused on developed countries;

b) By considering a panel data econometric approach that was previously unexplored in that context. In fact, the literature relied on time series methods with data for representative gas stations. Moreover, the unique opportunity of incorporating interdependencies between the gasoline and ethanol segments makes the Brazilian case additionally interesting. In fact, the diffusion of flex-fuel cars in Brazil has become increasingly important [see e.g. Freitas and Kaneko (2011) and Salvo and Huse (2011)].

The paper is organized as follows. The second section discusses the theoretical arguments that can lead to asymmetric patterns in price transmission between wholesale and retail and discusses the previous empirical evidence. The third section discusses the construction of data and presents the empirical model to be estimated. The fourth section presents the empirical results. The fifth section brings some final comments.

2   Price transmission: conceptual aspects

2.1   Overview

Most of the literature on price transmission between the wholesale and retail segments is empirical. The central underlying explanation for asymmetric price transmission relies on market power reasoning as suggested by Borenstein and Shepard (1996). Ray et al. (2006) address the gap in the literature by combining aspects of literature about the behavior of distribution channels with adjustment costs in prices. In particular, they suggest that the adjustment costs faced by the retail firm can lead to asymmetric behavior of wholesale prices.

The magnitude of adjustment prices in the retail segment will affect the transmission pattern. In the case of small fluctuations in wholesale prices, adjustments in retail prices would be avoided if they are costly. Thus, the demand curve is perceived by the wholesalers as possessing a perfectly inelastic region, where their prices can vary without any reduction in quantity demanded. Therefore, small price increases are profitable for the wholesalers whereas small reductions are not.[1] In the case of large changes in wholesale prices, the aforementioned authors consider that retail prices respond promptly. On the other hand, there would be different behaviors with respect to asymmetry depending on the magnitude of changes in wholesale prices. In any case, it is important to stress the simplified sequential reasoning a la Stackelberg considered by those authors.

Moreover, Kinnucan and Forker (1987) contend that asymmetric price transmission could also relate to government intervention, and the elasticity of price transmission between the wholesale and retail segments would depend on the nature of the triggering price change and on whether it is associated to demand increase in retail or cost increases in the wholesale.

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[1] Analogous discussion is presented in Lima and Resende (2011)

2.2 Empirical framework

In the present paper we will follow a methodology similar to the one implemented by Minten and Kyle (2000) and Resende and Lima (2011) in the context of local good markets in Zaire and Brazil respectively.

A basic inspiration of those papers comes from the approach advanced by Houck (1977). Let a variable Y depend on an exogenous variable characterized by situations of abrupt increase or decrease. Expression (1) could easily be extended to include other exogenous variables that can be segmented or not:

$$\Delta Y_i = \alpha_0 + \alpha_1 \Delta X_i^* + \alpha_2 \Delta X_i^{**} \qquad (1)$$

where for i = 1, 2, ..., t, one has Δ Yi = Yi – Yi-1 ; Δ Xi* = Xi – Xi-1 if Xi > Xi-1 and 0 otherwise; Δ Xi** = Xi – Xi if Xi $\leq$ Xi-1 and 0 otherwise.

Note that the segmented variables would be equivalent in our context, to consider the variation in wholesale prices in successive periods by multiplication with a dummy variable set to a strict price increase or non-increase.

One can relate expression (1) with the initial position of the dependent variable Y_0 (Y would refer to the retail price in the present application and segmented variables X are related to wholesale prices and other control variables). Using the next identity:

$$Y_t = Y_0 + \sum_{i=1}^{t} Y_i \qquad (2)$$

and combining (1) and (2) one obtains:[2]

$$Y_t - Y_0 = \alpha_0 t + \alpha_1 (\sum_{i-1}^{t} \Delta X_i^*) + \alpha_2 (\sum_{i=1}^{t} \Delta X_i^{**}) \qquad (3)$$

Therefore, the variation of the retail price relative to the initial position may be related to a time trend variable and segmented variables capturing accumulated changes in prices. The inclusion of additional exogenous variables in equation (1) would have led to a broader empirical specification as other exogenous variables (segmented or not) could be considered in terms of accumulated changes. The main hypothesis of interest

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[2] Expression (3) could be extended in terms of a specification with lags [see Ward (1982)].

would require symmetric adjustment ($\alpha_1 = \alpha_2$) to be tested against the alternative hypothesis of asymmetric adjustment ($\alpha_1 \neq \alpha_2$).

Finally, one should mention a second generation of empirical work considers the potential problem of spurious regressions in the case of non-stationary variables. In fact, the comprehensive review of Meyer and Von Cramon-Taubadel (2004) points out the use of error correction models in the investigation of asymmetric price adjustments. A potential limitation of the time series literature is the focus on some representative fuel station data and thus the consideration of panel data methods can provide available addition to the literature on asymmetric price transmission.

In the case of the Brazilian fuel markets, the significant regulation in term of the state-owned firm Petrobras tend to make wholesale price adjustments of gasoline less frequent than changes in crude oil and therefore provide fewer events where wholesale change could potentially transmit asymmetrically to the retail segment. In that sense, we are implementing a conservative test of asymmetric price transmission. Moreover, it is important to acknowledge possible interdependencies between the gasoline and ethanol segments, The latter is seasonally affected by the state of the sugar cane crop and is 30% less efficient than gasoline and thus the markets are related especially as flex-fuel vehicles become more widespread.

3   Empirical Application

3.1   Econometric Issues

One can observe in the empirical literature a clear prevalence of models for time series data for the study of asymmetric price transmission and often, the availability of long series allows a focus on long-term patterns. Examples include analysis of cointegration in the context of threshold autoregressive models and cyclical properties investigated in the frequency domain. In this paper, the sample period is relatively short and so we seek to undertake an analysis similar to that developed in the work of food Minten and Kyle (2000) and Resende and Lima (2011), which were based on approach suggested by Houck (1977) to test for asymmetries. The empirical specification indicated by

expression (3) in the present application is described in terms of a system with 2 equations as given by expressions (4) and (5):

$$RPG_t - RPG_0 = \alpha_0 + \alpha_1 t + \alpha_2 (\sum_{i=1}^{t} \Delta WPG_i^*) + \alpha_3 (\sum_{i=1}^{t} \Delta WPG_i^{**}) + \alpha_4 CAPG_t) + \varepsilon_t \qquad (4)$$

$$RPE_t - RPE_0 = \beta_0 + \beta_1 t + \beta_2 (\sum_{i=1}^{t} \Delta WPE_i^*) + \beta_3 (\sum_{i=1}^{t} \Delta WPE_i^{**}) + \beta_4 CAPE_t + v_t \qquad (5)$$

where ε_t and v_t denote stochastic errors that could be potentially correlated as the shocks could be correlated and the other variables are defined as follows:

- $RPG_t - RPG_0$: difference of retail price for gasoline relative to the value in the initial period;
- t: time trend;
- $\sum_{i=1}^{t} \Delta WPG_i^*$: cumulative wholesale price variations in gasoline in the case of price increases in two consecutive periods;
- $\sum_{i=1}^{t} \Delta WPG_i^{**}$: cumulative wholesale price variations in gasoline in the case of price reductions or constancy in two consecutive periods;
- CAPG: storage capacity for gasoline (in m^3);
- $RPE_t - RPE_0$: difference of retail price for ethanol relative to the value in the initial period;
- $\sum_{i=1}^{t} \Delta WPE_i^*$: cumulative wholesale price variations in ethanol in the case of price increases in two consecutive periods;
- $\sum_{i=1}^{t} \Delta WPE_i^{**}$: cumulative wholesale price variations in ethanol in the case of price reductions or constancy in two consecutive periods;
- CAPE: storage capacity for ethanol (in m^3).

The main tests of interest would consider $\alpha_2 = \alpha_3$ under the null hypothesis against the alternative of asymmetric price transmission ($\alpha_2 \neq \alpha_3$) for the gasoline market. Similarly, for the ethanol market, one would seek to test $\beta_2 = \beta_3$ against $\beta_2 \neq \beta_3$.

Minten and Kyle (2000) suggest the possibility of estimating a system using seemingly unrelated regressions [SUR-seemingly unrelated regressions]. In fact, the possibility of contemporaneous correlations among the errors associated with different vegetables markets is appealing. However, previous applications of that approach focused on time

series data. In contrast, the present application considers an unbalanced panel of fuel stations in term of 2 potentially interdependent fuels (gasoline and ethanol).

An econometric estimation procedure for estimating a random effect model for SUR in the context of unbalanced panel was advanced by Biørn (2004) based on a multistep algorithm that uses generalized least square (GLS) and maximum likelihood procedures. The referred work generalizes Magnus (1982) by addressing unbalanced panels in the context of SUR, upon the overall within-individual and between-individual covariation matrices. Biorn (2004) derived the unbiased estimators in the context of each balanced panel. The estimated covariance matrices are considered in terms of a generalized least squares (GLS) estimator and yet obtain a GLS estimator for individuals observed a particular number of times (say p =1,….P). [3]

Next, in order to achieve an efficient estimation, a multistep maximum likelihood estimation is implemented and the maximization problem comprises two parts: (a) maximize the log likelihood to the parameter vector β and covariance matrices Σ_ε and Σ_V; (b) maximize the log likelihood with respect to Σ_ε and Σ_V taking as given β. The related algorithm will be conducted until convergence of overall estimates.

In the present application, Stata 12.0 was used in terms of the command xtsur advanced by Nguyen e Nguyen (2010).

3.2   Data

The basic data source is provided by a weekly survey on fuel stations prices carried out by the Brazilian regulatory agency [Agência Nacional do Petróleo, Gás Natural e Biocombustíveis–ANP]. This source provides data on retail and wholesale prices for gasoline and ethanol for sampled fuel stations in selected cities of Brazil. Moreover, even though it was not part of the survey, it was possible to obtain data on storage capacity by type of fuel (in m^3). In the present application, we focus on the fuel market of Belo Horizonte-Minas Gerais. That city is particularly interesting as repeated cartel charges were made in the past. After dealing with data omissions the most comprehensive unbalanced panel was constructed upon weekly data for the weeks of the

3 The summary closely builds on Nguyen e Nguyen (2010) and full technical details can be found in Biorn (2004).

interval from April 14, 2004 to June 6, 2005. The quality of the survey for more recent data in general and for the city of Rio de Janeiro was below the desirable sample size, with a large number of unreported data. It was considered in the sample fuel stations with continuously reported data of at least 5 consecutive weeks. Thus, the database included 32 fuel stations, with a total of 1258 observations. Table 1 presents the corresponding summary statistics where a non-negligible heterogeneity is indicated.

Table 1

Summary statistics (No. of observations: 1258)

Variables	Minimum	Maximum	Mean	Std. Deviation
$RPG_t - RPG_0$	0.151	0.702	0.381	0.082
ΔWPG^*	0.478	1.626	0.990	0.179
ΔWPG^{**}	-1.270	-0.160	-0.678	0.185
CAPG	15	75	33.287	13.622
$RPE_t - RPG_0$	-0.052	0.822	0.350	0.180
ΔWPE^*	1.080	3.305	2.413	0.381
ΔWPE^{**}	-3.178	-0.913	-2.093	0.452
CAPE	8	45	17.769	7.154

4   Empirical Results

The estimation results are presented in table 2, and the evidence indicates a satisfactory statistical fit with highly significant individual coefficients in both gasoline and ethanol equations. It is worth mentioning the significance of the coefficients related to the storage capacity and, therefore, to the potential strategic use of inventories. Nevertheless, one should note that, as expected, the storage capacities are much larger for gasoline that is the dominant fuel in the market and one observes distinct reaction patterns in the two markets.

Table 2

Seemingly Unrelated Regression Estimates for Unbalanced Panel Data

Gasoline equation dep. variable: $RPG_t - RPG_0$		Ethanol equation dep. variable: $RPE_t - RPE_0$	
explanatory variables	coefficients	explanatory variables	coefficients
ΔWPG*	0.922 (0.000)	ΔWPE*	0.879 (0.000)
ΔWPG**	0.983 (0.000)	ΔWPE**	0.800 (0.000)
CAPG	0.001 (0.008)	CAPE	-0.001 (0.000)
TIME	-0.001 (0.000)	TIME	-0.002 (0.000)
Test for equality of coefficients of GU and GD		Test for equality of coefficients of EU and ED	
$\chi^2 (1) = 4.380 \ (0.036)$		$\chi^2 (1) = 28.550 \ (0.000)$	

The tests with the null hypothesis of symmetric price transmission are strongly rejected both in the gasoline and ethanol markets and thus even this more comprehensive evidence based on panel data it conforms with previous studies for developed countries that relied on time series methods.

5   Final Comments

The paper aimed at investigating the prevalence of asymmetric price transmission between the wholesale and retail segments taking as reference a local fuel market in Brazil. Beyond considering the case of an emerging economy, the paper benefited from the availability of panel data and the co-existence of two distinct fuels that rendered the investigation particularly appealing.

The econometric evidence indicated that asymmetric price adjustments appear to prevail in both the gasoline and ethanol markets and revealed the importance of controlling for storage capacity that sustain the ability to keep inventories. The evidence, therefore, favors asymmetric price transmission patterns as previously found in the literature for developed countries.

Avenues for future research include more comprehensive panel data investigations comprising different cities and a larger time span. However, initiatives of that sort currently are constrained by the data availability and its quality.

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