

## Price Setting Policy Determinants: Micro Evidence from Brazil

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### Abstract

The paper studies frequency of price changes from a survey data on Brazilian companies. The data set has the advantage of including all the economic sectors: agricultural and food products, trading, industry and services. Strong evidence of price nominal rigidities is found on the data with average and median price durations around 10.1 and 8.1 months, which is very close to results reported for the euro area and the United States. Using econometric modeling through an ordered probit we find that price change duration is mostly explained by the degree of competition, product specialization, firm size and economic sector dummies. The empirical results refute somewhat common used macroeconomic modeling for monetary policy evaluation, particularly those models that rely heavily on time-independent and homogenous pricing rules. Those results shed light on some necessary stylized facts that a macroeconomic pricing setting model would need to reproduce.

**Keywords:** price setting; frequency of price changes; nominal rigidities; sticky prices; survey data.

**JEL classification:** E31, D40.

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### 1. Introduction

Price stickiness and nominal rigidities play a central role in modern macroeconomic models. For instance, as emphasized by Galí and Gertler (2007) the baseline model for monetary policy evaluation relies on an assumption that firms set prices individually on a staggered basis. Usually, a Calvo (1983) formulation is used where at each period there is a fixed probability that a given firm will change its price independently of its history. Although this formulation simplifies aggregation across firms and produces parsimonious aggregate supply curves, there is increasingly empirical micro evidence that price changes does not operate this way.

Angeloni et. al. (2005) compares recent micro evidence with the main macro models used in monetary policy analysis. Their results indicate that those models are seriously challenged by stylized facts on price setting practices and inflation persistence. Álvarez et. al. (2005) summarizes micro evidence of price setting policies from the analysis of consumer and producer prices panel quotes and firms' surveys. Their general results points to some stylized facts: i) firms change price infrequently, on average once a year; ii) price setting behavior is heterogeneous across firms; iii) implicit or explicit contracts and coordination failure theories are important and iv) downward price rigidity is one slightly higher than upward rigidity.

The main goal of this paper is to explore the first two stylized facts of Álvarez et. al. (2005). Our central questions are: Is there evidence of sticky in Brazilian companies pricing policies? If the answer is yes, how frequency of price changes is influenced by firms' heterogeneity? The paper is structured as follows. Section 2 presents the data used in the analysis and investigates the first question. Section 3 studies the empirical determinants of price change durations and aims to answer the second question. Section 4 concludes.

## 2. Data

We look at a survey of Brazilian firms organized by the research department of Ibmec São Paulo and conducted by Sensus, a market and opinion research institute with a sample of 281 Brazilian companies. The sample selected by using the same companies surveyed by Gazeta Mercantil, one of the major business newspapers in Brazil, in order to keep track of financial data of those companies and also to have a representative sample of the major business sectors of the Brazilian Economy.

Table 1 presents the variables definitions we employed in our analysis. Based on the stylized fact that price setting behavior is heterogeneous across firms, we select as explanatory variables firms characteristics in terms of cost structure, degree of competition, firm size, production diversification level, demand elasticity and economic sector. Those variables were drawn from a larger questionnaire involving a total of 90 questions. Questions were answered at the company site by the company's owner, director or the financial manager in the majority of the cases.

Table 2 presents summary statistics for our variables of interest while Table 3 displays the correlation matrix. A striking fact is that price average and median durations in Brazil are surprisingly high, the mean is 10.06 months and the median is 12 months. Although Brazil has a very high inflation tradition, with yearly rates above 100% from 1980 to 1994, we detect no such thing as an *inflationary culture* that could induce more frequent price changes. In fact, Brazilian numbers are quite similar to euro area and even higher than the United States. Álvarez et. al (2005) report that for the euro area and the United States, the respective mean price durations are 10.8 and 8.3 months. This is in accordance with the fact that the CPI in the Brazilian economy was only 3.1% in 2006 and 4.5% in 2007, inflation rates just slightly above euro area and the U.S. standards. A similar result appears in Gagnon (2007). She studies the Mexican economy price setting in high and low inflation regimes and concludes that in fact, for annual inflation rates below 10%, price average durations in Mexico are very close to U.S. values.

Looking at the other variables, we can see that wage change duration is closely matched by the mean and median values for price changes; however, it has a much lower variability. Market share and number of competitors indicates the presence of strong power in Brazilian companies, which is characteristic in an Emerging economy as Brazil and can be one particular explanation for high price change durations. The main product percentage mean and median is also high, indicating that Brazilian companies are in general, not very diversified across products. The average demand elasticity indicates that the majority of Brazilian companies are on the elastic region of their demand curves. The number of observations across variables varies due to not available responses in some questionnaires.

The stylized fact of price adjustments being heterogeneous across sectors is replicated in our survey. Table 4 displays data on price frequencies across sectors and compares it to

euro area and U.S. data. From there, we can see the existence of a strong heterogeneity across sectors, which are closely matched by euro area and U.S. data. In general, the trading sector has longer price durations followed by the agricultural and food products. Industry and services have the longest durations and lower frequencies.

In summary, we can associate some stylized facts to our data. First, prices are indeed sticky and have high average durations. Second, price changing decision rules are very heterogeneous across firms. Now we turn to the question of price change determinants.

### 3. Price change determinants

In this section we aim to model the firm's decision about price changes as a function of market characteristics. Motivated by our discussion in section 2, we selected as potential explanatory variables: the wage change duration, as a proxy for cost structure; market share or number of competitors, for competition level; log of net revenues, for size effects; participation of the main product on total sales, for diversification level and demand elasticity for market conditions. We also used a dummy for economic sectors in order to capture all other market specificities not captured by the previous variables.

Since our dependent variable is a discrete ordered variable, we employ an ordered qualitative response model for the price change frequency. In particular, we apply an ordered probit model, where, if  $y_i$  is the price duration choice of firm  $i$  and  $X_i$  denotes the vector of firm's  $i$  characteristics, then the probability of  $y_i$  assuming a given discrete value  $J= 0, 1, 2, \dots, 12, \dots, 60$  is:

$$\Pr(y_i = J) = \Pr(y_i^* < \gamma_J) = \Pr(X_i\beta + u_i < \gamma_J) \quad (1.1).$$

Where  $\beta$  and  $\gamma_J$ ,  $J= 0, 1, 2, \dots, 12, \dots, 60$  are the estimated parameters. Table 5 reports the ordered probit results for different specifications of explanatory variables.

The empirical results show that the degree of competition represented either by the market share or the number of competitors is significant in all the specifications. Estimated coefficients indicate price changes duration negatively correlated to competition level, a firm with higher market share or with a lower number of competitors will change prices less frequently. Larger firms will also change price less regularly, a fact possibly related to market power. As expected from the analysis of section 2, the trade and industry service have significantly higher price duration than the trade and agricultural and food processing industries.

The level of specialization in production seems to play an important role also, firms more concentrated in one product will change price less frequently. The coefficient for wage duration changes has the expected sign, although it is not statistically significant when we control of all the effects. Demand elasticity has an interesting effect, price change duration decreases with demand elasticity. The result makes economic sense since higher demand elasticity (in absolute value) will induce more volatile change in sales when price changes, a fact that risks averse firms managers' would avoid.

#### 4. Conclusion

The paper studied price setting policies using as micro evidence a survey data for 281 Brazilian companies. The analyses demonstrate interesting stylized facts, some already noticed in other micro evidence studies for the euro area and the U.S. The empirical results refute somewhat common used macroeconomic modeling for monetary policy evaluation, particularly those model that rely heavily on time-independent and homogenous pricing rules like the ones in the Calvo (1983) staggered pricing tradition. New research on the topic has two equally productive veins: investing on theoretical pricing rule models that replicate empirical stylized facts and further exploring empirical determinants of different price setting policies across firms.

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Tables

**Table 1: Variable definitions.**

Variable	Survey question	Answer
Price change duration	“In which frequency does your company change prices?”	Open answer, number of months.
Wage change duration	“In which frequency does your company change wages?”	Open answer, number of months.
Market share	“What was the market share of your main product in the year of 2006?”	Open answer, %0-100.
Log Net revenue (R\$)	“What were the total net revenue sales of your company in 2006?”	Open answer, thousands of Brazilian reais (R\$).
Participation of the main product	“What is the percentage of your main product in total revenues?”	Open answer, %0-100.
Number of Competitors	“How many competitors are in the market of your main product?”	Open answer, discrete number.
Demand Elasticity	“Everything else equal, in the year of 2006, if you increase your price by 10%, what happens with your sales?”	Multiple choice <sup>a</sup> : a) Nothing; b) Decrease by 10% to 30%; c) Decrease by 30% to 60%; d) Decrease by 60% to 100%; e) Decrease by more than 100%.

Source: Ibmecc São Paulo / Sensus Brazilian Companies Survey.

Note: a – Values were converted to numbers: option a) is 0, option b) is 2; option c) is 4; options d) and e) are 8.

**Table 2: Summary statistics.**

Variable	Median	Mean	Std. Dev.	Obs.
Price change duration	12.0	10.06	8.14	202
Wage change duration	12.0	11.58	2.41	258
Market share	30.0	35.70	32.29	154
Log Net revenue (R\$1,000*)	10.1	10.02	2.29	281
% main product	70.0	67.00	31.60	214
Numb. of Competitors	70.0	16.44	27.64	211
Demand Elasticity	2.0	2.17	1.69	237

Source: Ibmecc São Paulo / Sensus Brazilian Companies Survey.

Note: \* R\$1,000 is approximately US\$600 by average April 2007 quotes.

**Table 3: Correlation Matrix**

Variable	Price change duration	Wage change duration	Market share	Log Net revenue (R\$1,000*)	Number of Competitors	Demand Elasticity
Price change duration	1,000					
Wage change duration	0,203	1,000				
Market share	0,246	-0,043	1,000			
Log Net revenue (R\$1,000*)	-0,039	0,062	0,172	1,000		
% main product	0,276	0,248	0,122	0,022	1,000	
Number of Competitors	-0,155	0,108	-0,338	-0,133	0,024	1,000
Demand Elasticity	-0,128	-0,051	-0,037	-0,297	-0,027	0,227

Source: Ibmec São Paulo / Sensus Brazilian Companies Survey.

**Table 4: Price frequency changes by sector.**

Sector	Median duration	Mean duration	Duration Std. Dev.	Obs.	Freq. <sup>a</sup> Brazil	Freq. <sup>a</sup> U.S.	Freq. <sup>a</sup> Euro A.
All sectors	3	10.1	8.1	202	21.9	20.8	15.9
Agricultural and Food Products	6	8.3	9.9	23	29.4	27-48 <sup>b</sup>	14-28 <sup>b</sup>
Trade	4	6.2	6.2	49	43.8	n.a.	18
Industry	12	11.5	8.4	64	14.3	22 <sup>c</sup>	9 <sup>c</sup>
Services	12	12.2	7.5	66	10.3	n.a.	11

Source: Ibmec São Paulo / Sensus Brazilian Companies Survey., Álvarez et.al. (2005) for U.S. and Euro area values.

Note: a - Mean frequency prices in percentage points per month, (2005).

b – Unprocessed and processed food CPI data.

c – Non-energy industrial goods CPI data.

Table 5: Ordered Probit – Dependent variable: Price change frequency

Independent variable	Regressions					
Wage duration	.1509*** (.0477)	.1509*** (.0477)	.0952 (.0602)	.0555 (.0443)	.0520 (.0450)	.1033* (.0618)
Market share	.0084** (.0034)	.0084** (.0035)	.0084** (.0038)			.0077* (.0040)
# of competitors				-.0102*** (.0039)	-.0108*** (.0040)	
Log revenue		-.0003 (.0471)	-.0919 .0603	-.0826* (.0484)	-.1277** (.0510)	-.1626** (.0669)
% main product			.0086** (.0041)	.0120*** (.0033)	.0097*** (.0035)	.0037 (.0044)
Dem. Elasticity			-.1681** (.0725)	-.0158 (.0621)	-.0438 (.0641)	-.1933** (.0770)
Trade					-.4317 (.3561)	-.4833 (.4446)
Industry					.6919** (.3386)	.7303* (.4149)
Services					.9809*** (.3555)	1,2753*** (.4696)
Pseudo R <sup>2</sup>	.0443	.0443	.0676	.0565	.118	.1438
Number of obs.	119	119	97	126	126	97

Note: The asterisks \*\*\*, \*\* and \* denote statistical significance respectively at 1%, 5% and 10%.