DOCUMENTO DE TRABAJO. E2006 / 09

A Non-linear "Inflationn Relative Prices Variability" Relationship: Evidence from Latin America

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1. Introduction[1]

In a flexible price model, where money is neutral, there is independence between nominal and real variables. Relative prices depend on real factors and the general price level is determined in the monetary sector; therefore, changes in the general price level do not affect real prices. Nevertheless, this is no supported by the empirical evidence; in fact, there is a vast literature showing a strong relationship between inflation and relative prices variability (RPV)[2]. But there is no consensus about the mechanisms underlying the positive correlation between inflation and RPV[3]. Moreover, theoretical approaches like "imperfect information" or "adjustment costs" have similar implications on such relationship.

The predictions of the main theoretical models can be summarized as follows. Firstly, signal-extraction model, based on the Lucas-type confusion between aggregate and relative shocks, emphasizes the positive effect of unexpected inflation on RPV: as inflation is not always correctly anticipated, it creates "misperceptions" of absolute and relative prices. Hence, increases in unexpected inflation will raise RPV. Likewise, Lucas' imperfect information model emphasizes the role of unexpected inflation in generating intermarket RPV and points out the positive impact of inflation volatility on RPV as well (Lucas (1973)). In both models the relevant concept is the dispersion of the individual products inflation rates around the aggregate rate of inflation, i.e. the intermarket RPV. However, the empirical evidence is mixed. On one hand, several studies for very different countries confirm that intermarket RPV increases mainly with unexpected inflation, but expected inflation has no effect on RPV –see, among others, Parks (1978) for USA, Blejer (1981) for Argentina in a period in which the annual rate of inflation was over 140%, Miszler and Nautz (2004) and Nautz and Scharff (2005) for Germany-. On the other hand, there is evidence

[1] We acknowledge the financial support from Centro de Estudios Andaluces (Project ECO 17).
[2] See Vining and Elwertowski (1976) for US, Parks (1978) for the Netherlands and US, Fischer (1981) for US, Fischer (1982) for Germany, Blejer and Leiderman (1982) and Palerm (1991) for Mexico, Quddus et al. (1988) for the Chinese hyperinflation, Tommasi (1993) and Dabús (2000) for Argentina, Fielding and Mizen (2000) for ten countries of European Union and Caraballo and Usabiaga (2004) for the 17 regions of Spain, among others.
[3] It is useful to distinguish between intermarket RPV - the standard deviation of the individual rate of price change around the average inflation rate- and intramarket RPV -the standard deviation of relative price changes of a given product across stores around its average inflation rate-. In this paper we use the intermarket RPV.

showing that both expected and unexpected inflation affect RPV. For example, Fischer (1981, 1982) and Aarstol (1999) conclude for different periods in US that RPV increases with both expected inflation and positive unexpected inflation, but not with negative unexpected inflation. Tang and Wang (1993) show for the Chinese hyperinflation period (1946-1949) that RPV increases with both expected inflation and the absolute value of unexpected inflation. Moreover, Silver and Ioannidis (2001) find for nine European countries that coefficients for unexpected inflation are generally statistically significant and negative. Finally, as far as inflation volatility is concerned, empirical evidence shows that it is positively correlated to inflation, both for low and high inflation countries, as it has been found by Chang and Cheng (2000) for US and Caraballo et al. (2005) for Spain and Argentina.

A second approach assumes that nominal price changes are subject to menu costs. In this case, the optimal policy is to set prices discontinuously according to an (*S*,*s*) price rule: the firm changes its nominal price when the real price hits a lower threshold, *s*, and the nominal price is changed so that the new real price equals a higher return point *S*. The distance between *S* and *s* increases with the expected value of inflation and, therefore, expected inflation affects RPV. Moreover, if menu costs are different among firms or firms experience specific shocks, staggered price setting will arise exacerbating the effect of higher inflation on RPV. Strictly speaking, these models are usually concerned with the price setting behavior of sellers of a single product, i.e. they compare the behavior of the price of a single product with the average inflation of that product. Therefore, they have direct implications for intramarket RPV. But generally such distinction is not found in the literature, and the common practice is to interpret the positive relation between expected inflation and intermarket RPV as an implication of the menu costs model. An exception is the contribution of Lach and Tsiddon (1992) for Israel. These authors obtain the intramarket RPV for 26 food products. They conclude that the effect of expected inflation on intramarket RPV is stronger than the effect of unexpected inflation.

Finally, models based on costly consumer search lead to a positive relation between inflation and intramarket RPV. This type of models tries to explain why the same good has different prices in the market, therefore the relevant variable is the intramarket RPV. In this model, the information's obsolescence due to inflation reduces the optimal stock of price information that consumers wish to hold, and as the consumers are differentially informed, inflation leads to a higher RPV. In this sense, Domberger (1987) for the United Kingdom, Amano and Macklem (1997) for Canada, and Parsley (1996) for some cities of the US have found a positive relationship between inflation and intramarket RPV. However, the evidence suggests that when economies are experiencing very high inflation rates, intramarket RPV can even decrease when inflation increases, which implies a concave relation between RPV and inflation –see Dazinger (1987) and Van Hoomisen (1988) for Israel, and Tommasi (1993) for Argentina-.

In short, different theories posit alternative channels by which inflation affects RPV, while the empirical evidence does not support unambiguously a particular approach. This can be due to the fact that the inflation-RPV relationship is very sensitive to changes in disaggregation, periodicity of the data, price indexes and, specially, to inflation regimes. Concerning to the latter issue, Caglayan and Filiztekin (2003) for Turkey and Caraballo et. al (2005) for Spain and Argentina show that failures to control for structural changes in the inflation series will lead to biased results and misleading conclusions. Our paper is focused on this issue and, more precisely, on the changes in the relation between inflation and RPV across different inflation regimes and the mechanisms underlying such changes. In particular, we study if such relation is non-linear, as well as which factors could explain a non-concave relation at higher inflation. As it was above mentioned, Dazinger(1987), Van Hoomisen (1988) and Tommasi (1993) suggest that in economies experiencing very high inflation rates, intramarket RPV can even decrease when inflation increases, which is implying some evidence of concavity due to the presence of some unifying forces in pricing at very high inflation. On the contrary, our hypothesis is that the effects of inflation on relative prices are even stronger when inflation is increasing and therefore inflation is far from being neutral. In other words, the relation between both variables should be non concave. In order to test our hypothesis, we have chosen three countries with a very rich inflationary history: Argentina, Brazil and Peru. Our results show a clear non-concave inflation-RPV relationship at high inflation, -in fact, RPV explodes in hyperinflation- while this relation is concave at lower inflation. In turn, unexpected inflation appears to be the main explanatory factor of the non-linearity in such relation.

In those three economies inflation has fluctuated from moderate levels to hyperinflation periods; monthly inflation rates surpassed 200% in Argentina and 400% in Peru. This sample allows us to carry out an exhaustive study to determine if there are similarities among the inflation processes in these economies, and then if it is possible to reach a greater consensus about the channels underlying the relationship between inflation and RPV. Moreover, this comparative analysis can shed some light on the price behaviour at different inflation regimes. In these cases an economy exhibits a higher level of "noise", induced by a more erratic and less predictable evolution of the inflation rate, and then a loss of information that induces adaptive changes in expectations. Thus, a higher level of inflation may imply modifications in the behaviour of prices, and then larger effects on the price system.

The paper is organised as follows. Section 2 describes the data and variables. Section 3 reports the empirical findings on the relation between inflation and RPV, two alternative methodologies to obtain the inflation regimes and the changes in the inflation-RPV relationship when inflation regimes are introduced . Section 4 explains the results obtained in section 3 by means of decomposing inflation in its unexpected, expected and volatility components. Finally, section 5 concludes.

2. Price data and variables

The data set includes monthly time series of disaggregated prices. For Argentina price series have been extracted from the statistical bulletins of the Instituto Nacional de Estadísticas y Censos, from January 1960 to November 1993. Individual price data correspond to the items of the national Wholesale Price Index (WPI), at the level of WPI groups (i.e. three digits of the International Standard Industrial Classification). Since the structure of WPI in Argentina changed in July 1984, we use 87 price indexes for the January 1960-June 1984 and 64 for the July 1984-November 1993 periods.

In the case of Peru we use 168 individual prices from the Consumer Price Index (CPI) for the January 1980-April 1994 period, extracted from the Instituto Nacional de

Estadísticas. Price data include changes of price weights in 1985, 1988 and 1989. Finally, for Brazil we use 52 individual prices of the WPI for the January 1974-August 1996 period, which were obtained from the Fundação Getulio Vargas.

2.1. Price Data

In general price data are collected in two ways. Some prices are sampled daily or several times a week, and from this information a monthly average is obtained. Other prices are sampled the same day each month. In Argentina, for example, the WPI price data are collected in those two ways. The prices of agricultural products are sampled as a monthly average from daily information, and the prices of industrial and imported products are sampled the same day (the 15^{th}) of each month. In Brazil, agricultural prices are collected in the same way as in Argentina, and industrial prices are sampled once a month.

Finally, in Peru there are different ways and frequencies of price collection. The prices of goods sold in fruits and vegetables markets are sampled weekly (on Thursdays and Saturdays), and from this information a monthly average is obtained. Prices of products in commercial stores are sampled the same day each month, and rental and public utilities prices are collected once a month.

In sum, most of the prices are collected the same day each month, or result from a monthly average from daily (or nearly daily) information. Hence, these methodologies of price collection should not provoke spurious correlation between inflation and RPV[4]. A clear example is the notorious increase of RPV in both Argentine hyperinflations, during 1989 and 1990. This should be a real increment, because most of the prices used to calculate this variability are prices of the industrial and imported goods sectors, which are collected the same day of each month (data include 77 industrial and imported good prices from a total of 87 for the 1960-1984 period, and 55 of a total of 64 for the 1984-1993 period).

[4] Otherwise this correlation could be "contaminated" by the methodology of price collection and by the inflation process itself. For example, if two prices are always equal and every month a price is sampled on the first day and the other one the last day, the actual variability of relative prices is zero. At lower (higher) inflation lower (higher) relative price variability should be detected, which would be only consequence of the periodicity of price collection.

2.2. Variables

The variables used in this study are the monthly inflation rate (IN), a measure of inflation volatility, expected and unexpected inflation, and RPV[5]. The expected inflation (INE) is the inflation rate forecasted by economic agents for the current period and it is obtained from an ARMA model. Its specification was selected by applying the Schwartz and Akaike criteria. From the results of these criteria we use an ARMA (1,1) model for Argentina and Brazil, and an ARMA (1,2) for Peru. Unexpected inflation (INO) is the error of expected inflation, which results from the difference between the actual and the expected inflation (INO=IN-INE).

On the other hand, inflation volatility is measured by the variance of inflation rate (VAR) obtained from a GARCH (1,1) model. In this model we use the same specification of the expected inflation as the one used in the ARMA model to compute INE. In this way, VAR is obtained using the forecasted values from this GARCH model. Finally, as it is common in this kind of literature, RPV is measured as the standard deviation of the individual rate of price change around the average inflation rate. We introduce a slight variation because at high inflation the usual RPV can be spuriously correlated with the mean of the distribution -the average inflation rate-. In order to avoid this problem, we define RPV as:

$$RPV_t = \frac{\sum_i w_{it}(IN_{it} - IN_t)^2}{(1 + IN_t)^2}$$

where RPV denotes the relative price variability, w_{it} is the weight of price i in the price index, IN_{it} is the inflation rate of price i at month t and IN_t is the inflation rate at period t[6].

[5] In order to analyze the stationarity of the series, we have applied the ADF test to the monthly inflation rate and to RPV, which leads us to reject the unit root hypothesis even at the 1% level.
[6] Except for Brazil, where we only estimate a non-weighted RPV due to the unavailability of the corresponding weights of individual prices.

3. Empirical Evidence

This section presents the empirical results. Given that the series show an important autocorrelation component, the conclusions about the significance of the regressors are based on the Newey-West consistent covariance estimator. In addition, to test the robustness of the results, we apply a nonlinear least squares estimation method, by assuming a first order autocorrelation component.

The results of the estimations appear in Table 1, where RPV is explained by a polynomial of the inflation rate. To test autocorrelation, we use the the Ljung-Box test. In turn, figures 1, 2 and 3, obtained from these estimations, illustrate such results. Moreover, when the estimation presents a serious case of autocorrelation, the results of the nonlinear least squares estimation are also presented.

Table 1 shows a clear non-linear inflation-RPV relationship, which is particularly evident in the figures. This relationship is concave in lower inflation periods, but convex at high inflation, and particularly at hyperinflation. In lower inflation the quadratic term prevails over the cubic term, while in high inflation the cubic term begins to be more significant than the quadratic term. Therefore, in low inflation the negative sign associated to the quadratic term suggests a concave relationship, while the positive sign associated to the cubic term points out a convex relationship between those variables at high inflation.

TABLE 1

Dependent Variable: RPV	Argentina			Brazil		Peru		
	(I)*‡	(II)*‡	(III)**†	(I)*‡	(II)*†	(I)*‡	(II)*‡	(III)**†
IN	0.07038	0.06866	0.07644	1.14831	1.05836	1.13353	0.96401	1.14849
	(2.884)	(2.887)	(3.631)	(4.210)	(4.509)	(4.695)	(3.532)	(3.552)
IN^2	-0.00076	-0.00081	-0.00092	-0.03292	-0.03060	-0.00583	-0.00408	-0.00597
	(-2.129)	(-2.319)	(-3.036)	(-3.223)	(-3.469)	(-2.236)	(-1.516)	(-1.974)
IN^3	0.000005	0.000005	0.000005	0.00032	0.00029	0.00001	0.00001	0.00001
	(3.911)	(4.239)	(5.041)	(3.450)	(3.523)	(2.648)	(1.980)	(2.423)
VAR		0.00874			0.51631		0.06070	
		(1.765)			(1.833)		(5.669)	
Constant	0.18697	0.13817	0.16885	-0.77078	-2.49556	-1.20722	-0.86314	-1.31060
	(2.832)	(1.913)	(1.810)	(-1.013)	(-1.982)	(-0.967)	(-0.622)	(-0.764)
AR(1)			0.56439					0.15689
			(4.175)					(1.233)
Adjusted R^2	0.742	0.748	0.823	0.236	0.318	0.903	0.915	0.905
p-value Ljung-Box(L=1)	0.000	0.000		0.054	0.469	0.043	0.084	
p-value Ljung-Box(L=2)	0.000	0.000	0.387	0.025	0.492	0.008	0.047	0.013
Observations	407	407	406	270	270	171	171	171

The values in brackets are the t-statistics.
* Estimated by Ordinary Least Squares
** Estimated applying a Marquardt Non Linear Least Squares Algorithm
† White Heteroskedasticity-Consistent Standard Errors & Covariance
‡ Newey-West HAC Standard Errors & Covariance

FIGURE 1: ARGENTINA

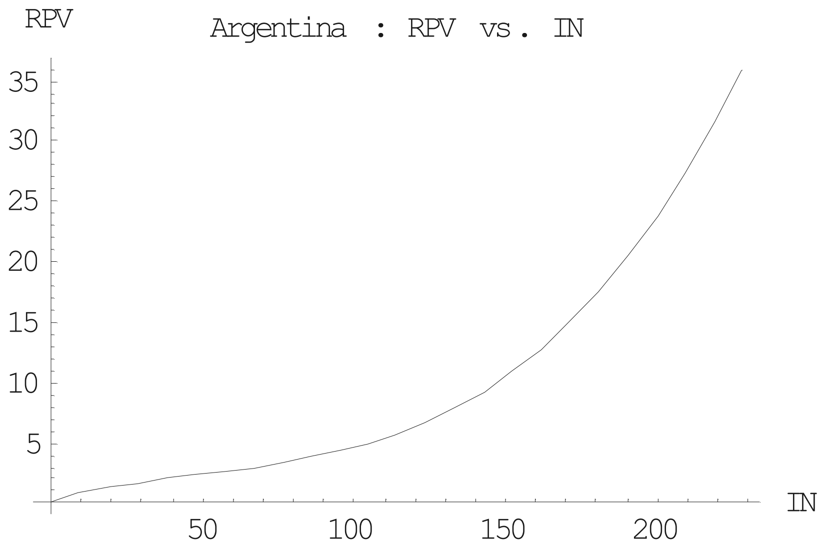


FIGURE 2: BRAZIL

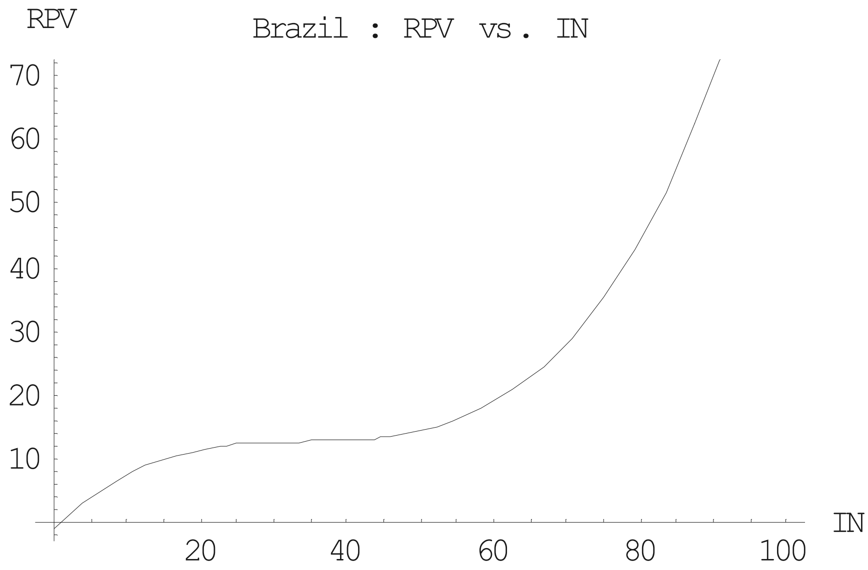
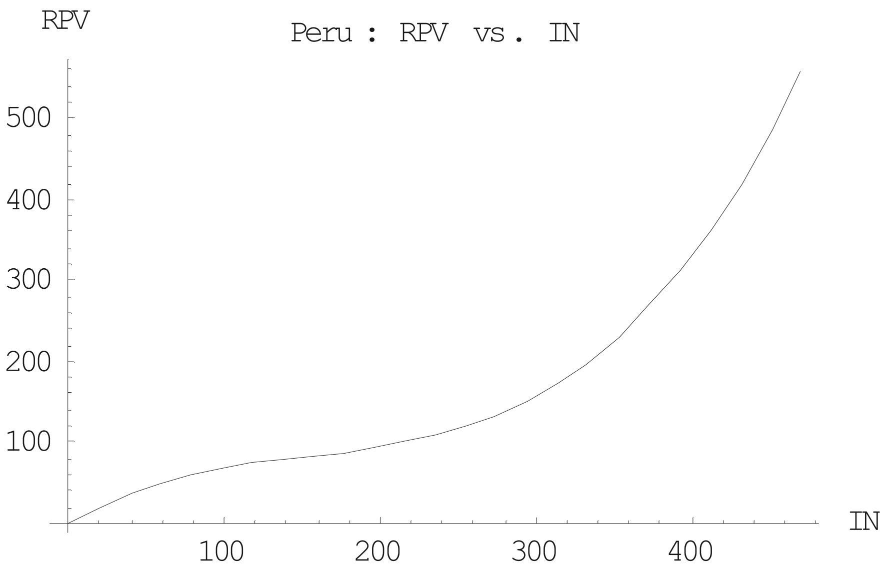


FIGURE 3: PERU



In short, our results suggest that the inflation-RPV relationship changes at different inflation levels. This evidence deserves a more careful study in order to see if these conclusions hold when inflationary regimes are introduced as controls. Thus, in order to verify if the results are robust to alternative methods of classifying the total period in inflationary regimes, we apply two methodologies. On one hand, it can be considered that the thresholds of inflation that divide the regimes are determined exogenously, and on the other hand it can be assumed that regimes are generated endogenously. The first methodology follows a version of the criterion previously applied in Dabús (1993,2000) for Argentina. This method sets three thresholds of monthly inflation to distinguish such regimes, 1%, 10%, and 50%[7]. Therefore, we obtain four regimes: moderate (under 1%), high (1-10%), very high (10-50%) and hyperinflation (over 50%). After that, the different inflation periods of each country are classified in these regimes, which are presented in table 1 in the Appendix. The second methodology is based on a Markov switching regression model – see Hamilton (1989,1994)-. With this method, regimes are defined using a model that endogenously determines the probability of being in a regime. We assume that a particular period can be included in a specific regime when the probability of being in such regime is above 0.5[8]. Finally, the inflation regimes obtained with both methodologies are represented by dummy variables, D1, D2, D3 and D4, which mean moderate, high, very high and hyperinflation, respectively.

Table 2 shows the results of estimations with Dabús' methodology and table 3 presents the results corresponding to the Markov switching model method. The cubic term of inflation was not included because the dummy variables combined with the inflation rate capture the linear relation between inflation and RPV, and a convex or concave relation when they are combined with the inflation quadratic term. For example, results obtained in table 1 show a convex relation under hyperinflation. This fact is also captured by the regime dummies, the inflation rate and the inflation quadratic term, therefore it can be concluded that the cubic term is relevant only when the regimes are removed from the regression.

[7] This methodology was developed by Dabús (1993). See Caraballo et al. (2004) for further details.
[8] We specified the Markov switching regression model as an autorregresive model of order 1 with three states. To estimate this model we used a reformulated version of the algorithm provided by James D. Hamilton in his web page. Since the algorithm does not converge to any result for each of the complete series, the hyperinflation months were removed from the estimation. Hence, we obtained four regimes, one of hyperinflation, which includes the hyperinflation periods that were excluded from the sample, while the other three regimes (moderate, high and very high inflation) were determined by the model.

For both methodologies, the dummies were statistically significant and with the expected sign, which suggests the relevance of the different regimes to explain RPV. On the other hand, when the inflation rate is included, results are slightly different depending on the methods applied in order to obtain the inflation regimes. As far as for Dabús' method is concerned, Table 2 shows mixed evidence for the hypothesis of a non-linear relationship (a concave relationship in low levels of inflation and a convex relationship in high levels of inflation) in Argentina, but it doesn't hold for Brazil and Peru. Thus, in Argentina the concave relationship is significant for the high inflation regime and the convex relationship is significant for the hyperinflation one but the non-linear relationship is not significant in the moderate inflation regime. On the contrary, Brazil shows a convex relationship in the moderate inflation regime and a linear relationship in high and very high inflation contexts, while in Peru only the linear relationships are statistically different from zero.

However, the results obtained with the Markov switching regression model – see table 3- support to a greater extent the non-linear relationship hypothesis: Although for the three countries we find a linear relationship in moderate inflation, results show a convex relationship for higher levels of inflation. Thereby, a convex relation is found in hyperinflation period for Argentina, in very high inflation regime in Brazil and in high inflation and hyperinflation regimes in Peru.

TABLE 2

Dependent Variable: RPV Estimated by Ordinary Least Squares						
	Argentina		Brazil		Peru	
	(I)‡	(II)‡	(I)‡	(II)‡	(I)†	(II)‡
D1	0.3019*		1.4034*			
D2	0.4909*		2.0668*		4.564735*	
D3	1.2448*		11.4095*		40.75923*	
D4	6.409*					
D1*IN		0.0969**		0.2201		
D1*IN²		0.0070		1.0353**		
D2*IN		0.1227*		0.4867*		0.8595*
D2*IN²		-0.0049*		0.0028		-0.0021
D3*IN		0.0313		0.5553*		0.7879*
D3*IN²		0.0014		-0.0024		0.0005
D4*IN		-0.0124				
D4*IN²		0.0006*				
Adjusted R^2	0.290	0.730	0.172	0.186	0.156	0.896
p-val Ljung-Box(L=1)	0.000	0.000	0.015	0.004	0.309	0.059
Observations	407	407	270	270	171	171

* (**) Coefficient different from cero at 1% (5%) significance level
† White Heteroskedasticity-Consistent Standard Errors & Covariance
‡ Newey-West HAC Standard Errors & Covariance
Estimations include dummies variables that were obtained by Dabús' methodology

TABLE 3

Dependent Variable: RPV Estimated by Ordinary Least Squares						
	Argentina		Brazil		Peru	
	(I)‡	(II)‡	(I)‡	(II)†	(I)†	(II)‡
D1	0.4536*		5.5193*		6.2964*	
D2	0.9621*		8.6547*		45.61*	
D3	3.3885**		9.5048*		28.599*	
D4	6.7694*		37.5441*		180.40	
D1*IN		0.1129*		0.7512*		0.9621*
D1 *IN²		-0.0023		0.0034		-0.0083
D2 *IN		-0.0312		-0.0148		-0.6177
D2 *IN²		0.0034		0.0147		0.0802*
D3 *IN		0.0671		-0.0114		2.0845**
D3 *IN²		0.0003		0.0079**		-0.0328
D4 *IN		-0.0045		0.2060		0.3996*
D4 *IN²		0.0005*		0.0038		0.0013*
Adjusted R^2	0.329	0.726	0.091	0.288	0.434	0.957
p-val Ljung-Box(L=1)	0.000	0.000	0.000	0.220	0.284	0.002
Observations	407	407	270	270	171	171

* (**) Coefficient different from cero at 1% (5%) significance level
† White Heteroskedasticity-Consistent Standard Errors & Covariance
‡ Newey-West HAC Standard Errors & Covariance
Estimations include dummies variables obtained by Markov switching regression model

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4. Inflation Expectations and Non-Linearities

In the previous section empirical results show a convex relationship between inflation and RPV in very high and hyperinflation regimes for the three countries under study. In this section we focus on the reasons for such non-linear relationship. In other words, we try to explain why the impact of inflation on RPV is increasing with the inflation level. In order to do that, we regress RPV on the components of the inflation rate: its volatility (VAR), and expected (INE) and unexpected inflation (INO). As it was explained in section 2.2, INE and INO were obtained from an ARMA model, and VAR from a GARCH model. In addition to this, and given that the results may depend on the specification of INE, an alternative way of constructing the expected inflation is introduced to test the robustness of the results. Thus, we define INE' as the expected inflation obtained assuming stationary expectations; i.e., the inflation in *t* is equal to the inflation in *t-1*. In turn, the alternative measure of unexpected inflation can be defined as: INO'= IN-INE'. Finally, in order to test a non-linear relationship between RPV and inflation expectations, once again we include the polynomial terms of INE, INO, INE' and INO'.

TABLE 4

Dependent Variable: RPV
Estimated by Ordinary Least Squares

	Argentina				Brazil				Peru			
	(I)*‡	(II)*‡	(III)*‡	(IV)**‡	(I)*†	(II)*†	(III)*†	(IV)*†	(I)*†	(II)*†	(III)*†	(IV)**†
INE	0.0825*	0.0896**			0.4597*	0.3566**			3.5761*	3.5293*		
INE^2	-0.0002	-0.0002			-0.0005	-0.0005			-0.054*	-0.0576*		
INE^3									0.0002**	0.0002*		
INE'			-0.0274	-0.0286			1.0953*	0.9954*			1.5548	1.5534**
INE'^2			0.0023**	0.0023**			-0.0313**	-0.0287*			-0.0032	-0.0032
INE'^3			-0.00001**	-0.00001**			0.0003**	0.0002*				
VAR		-0.006726		0.0036		0.4249		0.5147		0.055347		0.0013
Constant	0.07753	0.081557	0.4822*	0.4656*	1.1799	0.3561	-0.4248	-2.0430	-11.3838	-11.2625	-4.2614	-4.2618
Adjusted R^2	0.310	0.311	0.518	0.517	0.214	0.261	0.206	0.285	0.193	0.196	0.269	0.265
p-val Ljung-Box(L=1)	0.008	0.011	0.000	0.000	0.212	0.344	0.892	0.819	0.719	0.410	0.206	0.205
Observations	407	407	407	407	270	270	270	270	171	171	171	171

* (**) Coefficient different from cero at 1% (5%) significance level

† White Heteroskedasticity-Consistent Standard Errors & Covariance

‡ Newey-West HAC Standard Errors & Covariance

Table 4 shows the results of the regression of RPV on the expected inflation (INE and INE') and inflation volatility and table 5 presents the results of the regression of RPV on the unexpected inflation (INO and INO') and inflation volatility. From table 4, it can be seen for Argentina and Brazil the INE-RPV relationship is non-convex, while the INE'-RPV one is non-convex just for Peru. On the other hand, table 5 shows that a convex relationship between unexpected inflation (both INO and INO') and RPV arises. Therefore, taken into account these results, it seems that the unexpected component of inflation has a clear convex effect on the RPV, while the results of expected inflation are sensitive to the specification of inflationary expectations. Finally, volatility is not significant in any case

TABLE 5

Dependent Variable: RPV
Estimated by Ordinary Least Squares

	Argentina				Brazil				Peru			
	(I)*‡	(II)*‡	(III)*‡	(IV)**‡	(I)*†	(II)*†	(III)*‡	(IV)*‡	(I)*‡	(II)*‡	(III)*‡	(IV)**‡
INO	0.01528	0.0179			0.2997	0.4987**			0.3966*	0.4958*		
INO^2	0.0013*	0.0012*			0.0413*	0.024**			0.0029*	0.0025*		
INO^3	0.000007*	0.000007*			0.0005	0.0002			-0.000003	-0.000002		
INO'			0.0259	0.0264			0.5805*	0.5389*			0.1599	0.2551**
INO'^2			0.0024*	0.0022*			0.0475*	0.0359*			0.0017*	0.0014*
INO'^3			0.00001*	0.00001*			0.0005*	0.0003*			0.000002*	0.000002*
VAR		0.004741		0.0099		0.5886*		0.6247**		0.1078*		0.1192
Constant	0.4735*	0.4423*	0.4448*	0.3779*	5.0811*	2.7575*	5.4550*	2.7055*	8.1807*	6.5296*	8.7508*	7.3752*
Adjusted R^2	0.673	0.673	0.623	0.630	0.179	0.260	0.095	0.220	0.839	0.876	0.846	0.857
p-val Ljung-Box(L=1)	0.000	0.000	0.000	0.000	0.262	0.237	0.006	0.015	0.000	0.000	0.000	0.000
Observations	407	407	407	407	270	270	270	270	171	171	171	171

* (**) Coefficient different from cero at 1% (5%) significance level

† White Heteroskedasticity-Consistent Standard Errors & Covariance

‡ Newey-West HAC Standard Errors & Covariance

Table 6 presents the results of regressions including jointly both components (expected and unexpected inflation). As far as for Argentina is concerned, a concave (convex) relationship between expected inflation and RPV in low (high) values of expected inflation for both specifications (INE and INE', and INO and INO') can be observed. This result holds for Brazil for the INE' and INO' specifications, while the INE-RPV relationship is linear and the INO-RPV one is convex. Finally, for Peru results are ambiguous. There is a convex (linear) relationship between INE (INO) and RPV, while with the alternative specification a linear relationship between INE' and RPV is statistically significant. In short, except in Peru, the unexpected component presents a convex relationship with the RPV.

TABLE 6

Dependent Variable: RPV Estimated by Ordinary Least Squares												
	Argentina				Brazil				Peru			
	(I)*‡	(II)*‡	(III)*‡	(IV)**‡	(I)*†	(II)*†	(III)*†	(IV)*†	(I)*†	(II)*†	(III)*†	(IV)**†
INE	0.0677*	0.0665*			0.9298**	0.7037			1.7279*	1.3702*		
INE^2	-0.001**	-0.0011**			-0.0275	-0.0197			-0.0203	-0.016182		
INE^3	0.00001*	0.00001*			0.0003	0.0002			0.00007**	0.00008*		
INE'			0.0648*	0.0642*			1.1658*	1.0673*			0.9319*	0.9161*
INE'^{2}			-0.0012*	-0.0012*			-0.0373*	-0.0341*			-0.0018	-0.0018
INE'^{3}			0.00001*	0.00001*			0.0003*	0.0003*			0.00001	0.00001
INO	0.0169	0.017466			0.1641	0.3346			0.3974	0.6013**		
INO^2	0.0002	0.000121			0.0276**	0.0189**			0.0009	-0.0012		
INO^3	0.00001*	0.00001*			0.0004**	0.0003			0.000001	0.00001		
INO'			0.0149	0.0143			0.5199*	0.5068*			0.5431	0.5537
INO'^{2}			0.0007*	0.0007*			0.029*	0.0233*			-0.0003	-0.0004
INO'^{3}			0.00001*	0.00001*			0.0003*	0.0003**			0.000004	0.000005
VAR		0.002398		0.0034		0.3929		0.4828		0.066*		0.0185
Constant	0.1844*	0.1787*	0.2039*	0.1871*	-0.5610	-0.8646	-0.8993	-2.3864	-3.6219	-2.3820	-0.4540	-0.4911
Adjusted R^2	0.744	0.743	0.752	0.752	0.283	0.313	0.262	0.331	0.906	0.916	0.916	0.916
p-val Ljung-Box(L=1)	0.000	0.000	0.000	0.000	0.968	0.933	0.414	0.656	0.169	0.107	0.215	0.235
Observations	407	407	407	407	270	270	270	270	171	171	171	171

* (**) Coefficient different from cero at 1% (5%) significance level
† White Heteroskedasticity-Consistent Standard Errors & Covariance
‡ Newey-West HAC Standard Errors & Covariance

To sum up, the relationship between RPV and the unexpected component of the inflation appears to be convex in Argentina and Brazil but the expected inflation presents a more ambiguous relationship with the RPV. Hence, our results show that the unexpected inflation is crucial to explain the convex relationship between inflation and RPV, and this conclusion is more relevant considering high inflation contexts where the unexpected component is relatively more important than the expected component[9].

5. Conclusions

This paper is focused basically on two issues concerning the RPV-inflation relationship. On one hand, previous literature has shown that such relationship is very sensitive to changes in the average inflation rate, finding evidence of concavity at very high inflation. This result leads us to analyse such relation in high inflation countries, with sundry inflation regimes: Argentina, Brazil and Peru. On the other hand, as there are different theoretical models that can explain the RPV-inflation relationship, we have tried to identify which explanation could fit better the evidence found for the aforementioned countries.

Our results differ from previous literature. Firstly, we find that changes in inflation regimes affect strongly the RPV-inflation relationship, and this result is robust to the two methodologies applied in this paper in order to obtain the inflation regimes. In all cases our evidence shows a convex relationship between inflation and RPV. Furthermore, this evidence is even stronger at higher inflation when Markov switching regression model is applied to determine different inflation regimes.

On the other hand, such convexity is mainly explained by unexpected inflation, which is not compatible with the menu costs model, since expected inflation has a key role to explain RPV in this approach. Moreover, our evidence shows that the uncertainty associated to very high inflation periods can be particularly relevant to understand the non neutrality of inflation in extreme price instability, while the expected component is sensitive to the expectations mechanism used. This is suggesting that in an environment of very changing and high inflation, the price decisions of economic agents is quite complex because there are not appropriate mechanisms to avoid the impact of inflation on relative prices, like a satisfactory model to form expectations on current inflation.

In short, the inflation-RPV relationship seems to depend crucially of the inflationary experience of the countries under study. Meanwhile previous findings show that such relation is concave, our results point out that it becomes convex in extreme inflation.

[9] In fact, in our specification of INE and INO we confirmed that unexpected inflation is relatively more important at higher inflation (this result was not included in the paper but it is available from authors upon request).

Appendix

Table 1: Inflation Regimes. Dabús' methodology

Country\ Regime	Argentina	Brazil	Peru
Moderate Inflation	January 1960-April 1970 April 1991-November 1993	March 1986-November 1986 August 1994-August 1996	
High Inflation	May 1970-January 1975 May 1976-June 1982 July 1985-June 1987 September 1988-March 1989 August 1989-November 1989 April 1990-March 1991	February 1974-December 1982	January 1980-February 1988 February 1991- April 1994
Very High Inflation	February 1975-April 1976 July 1982-June 1985 July 1987-August 1988	January 1983-February 1986 December 1986-July 1994	March 1988-January 1991
Hyper-inflation	April 1989-July 1989 December 1989-March 1990	*	*

* Although both countries experienced months of hyperinflation, a hyperinflation regime doesn't arise with this method because periods of hyperinflation lasted less than 3 months.

Table 2: Inflation Regimes. Markov's methodology

Country\ Regime	Argentina	Brazil	Peru
Moderate Inflation	January 1960-May 1975 August 1975-December 1975 May 1976-May 1981 August 1981-June 1982 August 1982 October 1982-January 1983 March 1983-July 1983 July 1985-September 1987 November 1987-February 1988 September 1988-February 1989 August 1989-November 1989 April 1990-July 1990 October 1990-January 1991 March 1991-November 1993	March 1974-November 1988 February 1989-May 1989 April 1990-September 1991 August 1994-August 1996	February 1980-December 1980 February 1981-February 1988 April 1988-June 1988 April 1989-March 1990 May 1990 September 1990-November 1990 February 1991-April 1994
High Inflation	July 1975 January 1976-February 1976 April 1976 June 1981-July 1981 July 1982, September 1982 February 1983 August 1983-May 1985 October 1987 March 1988-August 1988 March 1989 August 1990-September 1990	June 1989 October 1991-April 1992 July 1994	January 1981 March 1988 August 1988 November 1988 March 1989 April 1990 December 1990-January 1991
Very High Inflation	June 1975, June 1985 December 1989, February 1991	December 1988-January 1989 July 1989-December 1989 May 1992-June 1994	July 1988, October 1988 December 1988-February 1989 June 1990
Hyper-inflation	March 1976 April 1989-July 1989 January 1990-March 1990	January 1990-March 1990	September 1988 July 1990-August 1990

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