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Relative Prices and Inflation: New Evidence from Different Inflationary Contexts*

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Resumen

Este trabajo analiza la relación entre la inflación y la variabilidad de precios relativos, en la dirección de la segunda variable, en dos países con experiencias inflacionistas muy diferentes: Argentina y España. Para afrontar este objetivo, utilizando índices de precios desagregados (Índice de Precios al Por Mayor para Argentina e Índice de Precios al Consumo para España), delimitamos diferentes regímenes inflacionarios y estimamos un conjunto de regresiones para cada país. Nuestros resultados sugieren que existe evidencia en favor de la no neutralidad de la inflación (principalmente durante los períodos hiperinflacionistas) y no respaldan ni la aproximación de costes de menú ni la de extracción de señal. También detectamos cambios estructurales significativos en la relación dependiendo del regimen de inflación.

Palabras clave: inflación, variabilidad de precios relativos, regímenes de inflación, volatilidad de la inflación, inflación esperada e inesperada.

Abstract

This paper analyzes the relationship between inflation and relative price variability, in the direction of the latter, in two countries with very different inflationary experiences: Argentina and Spain. To address this objective, using disaggregated price indexes (Wholesale Price Index for Argentina and Consumer Price Index for Spain), we delimitate different inflationary regimes and compute a set of regressions for each country. Our results suggest evidence in favor of the non-neutrality of inflation (mostly in hyperinflation periods) and do not support neither the menu costs nor the signal extraction approaches. We also detect significant structural changes in the relationship depending on the inflationary regime.

Keywords: inflation, relative price variability, inflation regimes, inflation volatility, expected and unexpected inflation.

JEL classification: E31

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1. Introduction

Empirical evidence suggests that inflation and higher moments of the relative price changes distribution are strongly positively correlated. This fact supports the hypothesis of non-neutrality of inflation, moreover it denotes that inflation is costly since it affects the distribution of relative prices in the economy, distorting the information content of nominal price.

In particular, there is a vast empirical literature studying the relationship between inflation and relative price variability (RPV), the second moment of the relative price changes distribution, defined as the standard deviation of the individual rate of price change around the average inflation rate –that is, intermarket RPV-[1]. The empirical work dates back to Mills (1927), who provided a description of the United States (US) price system. The contributions of Vining and Elwertowski (1976) and, specially, Parks (1978) are the landmarks, since then a lot of empirical work has been done. Those authors and subsequent researchers found that for different countries inflation and intermarket RPV are positively correlated over time[2] -Parks (1978) for the Netherlands and US, Fischer (1981,1982) for US and Germany, Blejer and Leiderman (1981) and Palerm (1991) for Mexico, and Tommasi (1993) and Dabús (2000) for Argentina, among others-. In turn, other studies compare RPV-inflation relationship among several geographical areas. For example, Parsley (1996) and Debelle and Lamont (1997) for several cities of US, Fielding and Mizen (2000) for ten countries of European Union and Caraballo and Usabiaga (2004a) for the 17 regions of Spain, report a positive correlation between RPV and inflation as well.

As it can be seen, empirical evidence supports a positive relationship between RPV and inflation, but there is not a consensus about the causal

[1] Likewise, there is a relevant strand of the literature focused on intramarket RPV. This variable can be defined as the standard deviation of relative price changes of a given product across stores around the average inflation rate of that product. A number of authors have found evidence supporting a positive correlation between intramarket RPV and inflation: Domberger (1987) for the United Kingdom, Lach and Tsiddon (1992) for Israel, Amano and Macklem (1997) for Canada, and Parsley (1996) for some cities of United States (US). However, when economies are experiencing very high inflation rates, intramarket RPV can even decrease when inflation increases, as it has been shown by Dazinger (1987) and Van Hoomisen (1988) for Israel, Tommasi (1993) for Argentina and Caglayan and Filiztekin (2003) for Turkey.

[2] Nevertheless, Fischer (1981,1982) and Bomberger and Makinen (1993) assert that the relationship between inflation and RPV found for US is dominated by energy and food prices shocks.

mechanism that generates that relationship. A variety of theories can explain this empirical fact; the prevalent ones are menu costs and signal extraction models. The first one emphasizes the role of expected inflation while the second one is focused on the effects of unexpected inflation.

On one hand, menu costs model assumes that price adjustments are costly, which implies that firms respond using a (*S,s*) pricing rule. According to this rule, as changing prices is costly, the firm holds its nominal price constant and let inflation erode the real price of its products until it reaches the lower bound *s*. Then nominal price is adjusted such that the new real price is equal to the upper bound *S*. If inflation increases, the firms will widen the distance between the optimal *s* and *S*. 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. Therefore, menu costs models suggest a positive correlation between RPV and expected inflation.

On the other hand, signal extraction model states that as inflation is not always anticipated correctly, it creates “misperceptions” of absolute and relative prices generating an increase in RPV. Hence, increased unexpected inflation will raise RPV.

Empirical evidence in this area is mixed, in the sense that there are studies supporting menu costs model, signal extraction model, both or none of them. The existing literature is huge, in particular for US; the following table summarizes the results of some of the most relevant papers:

Author	Data	Results
Parks (1978)	US, 1930-1975	RPV increases mainly with unexpected inflation
Fischer (1981,1982)	US, 1930-1979	RPV increases with expected inflation and positive unexpected inflation but not with negative unexpected inflation
Tang and Wang (1993)	China, 1946-1949 (hyperinflation period)	RPV increases with expected inflation as well as with the absolute value of unexpected inflation
Aarstol (1999)	US, 1947-1997	Expected inflation and unexpected inflation, in particular when positive, are all positively related to RPV
Silver and Ioannidis (2001)	Nine European countries, 1981-1989	Coefficients for unexpected inflation are generally statistically significant and negative. When expected inflation is significant, the response of RPV to its changes is greater where expected inflation is rising
Miszler and Nautz (2004)	Germany, 1991-2003	Only unexpected inflation affects positively RPV. The impact of expected inflation disappears if a credible monetary policy stabilizes inflationary expectations

Finally, some authors attend to the inflation volatility as a determinant of RPV, specially in inflationary economies. In this sense, Logue and Willet (1976) and Blejer (1979) for several Latin American countries, Moura and Kadota (1982) for Brazil and Dabús (2000) for Argentina find a positive relationship between RPV and different measures of inflation volatility. This result holds for stable economies, as it has been shown for US by Chang and Cheng (2000) and we will show in this paper for Spain.

In short, there is a consensus on the positive correlation between inflation and RPV, but not on which factor is generating such correlation. This paper presents new evidence on that relationship, trying to see if the mechanisms that are causing it differ depending on the inflationary history of the economy analyzed. In order to address that, we study two economies with very different inflationary experiences: Spain, for the 1985-2001 period, and Argentina, for the 1960-1991 period. The first economy has been historically stable in the last fifty years, specially during the period studied in this paper, in which the monthly inflation rate oscillated in a narrow range between zero and 2%. On the contrary, Argentina shows a very rich inflationary history; in the last forty years its monthly inflation rate fluctuated from deflation to hyperinflation.

The empirical results obtained in this paper indicate that the relationship between inflation and RPV changes in extreme inflation; in fact RPV exploded for the hyperinflation period in Argentina. For both countries inflation volatility and unexpected inflation increase RPV, although this result must be interpreted in a different way in each case, as we shall see later. On the contrary, expected inflation affects positively RPV in Argentina but it is never significant in the case of Spain, denoting that inflation expectations play different roles in explaining the non-neutrality of inflation depending on the macroeconomic environment. Moreover, the inflation-RPV correlation exhibits significant structural changes across the different inflationary regimes, which verifies that determinants of RPV, and their relevance, are different at different inflation levels.

The remainder of the paper is organized as follows. Next section presents the main variables used in our analysis and the empirical methodology followed. Section 3 explains the method applied in order to determine the inflation regimes for each country. In section 4 we specify the main features of the data used. In section 5 we carry out a brief description of the statistics, and we report the results concerning to the inflation-RPV relationship, as well as the results referred to the structural change observed in this relationship. Finally, section 6 concludes.

2. Definition of variables and empirical methodology

2.1. Definition of variables

Our study is based on the monthly inflation rate, which is used to define different measures of inflation volatility and RPV. Moreover, the inflation rate is separated into expected and unexpected inflation using a forecast equation of inflation.

One one hand, for inflation volatility, three variables have been defined:

$$DIN_t = IN_t - IN_{t-1} \qquad (1)$$

$$ABDIN_t = \left| IN_t - IN_{t-1} \right| \qquad (2)$$

$$VARIN_t = \left| IN_t - (1/7) * \sum_{i=-3}^{3} IN_{t-i} \right| \qquad (3)$$

where IN_t is the inflation rate at time t. As it can be seen, DIN_t is the difference between the inflation rates of two consecutive months, $ABDIN_t$ is the absolute value of DIN_t, and $VARIN_t$ is a centred moving average of seven months of inflation. $VARIN_t$ tries to capture transitory deviations of current inflation from certain inflationary environment. In order to choose the lags included in $VARIN_t$, we defined the variable with three, four until twelve lags, we run the regression specified in equation (7), and we compared the R^2 and the significance of the explanatory variables obtained in each estimation. As the results were very similar for all of them, we included the minimum number of lags, given the fluctuations observed for inflation in Argentina[3].

RPV is a measure of the non-uniformity of the variations of individual prices, relative to the average inflation rate. It is obtained in quadratic terms, using the weighted sum of the monthly inflation rate of individual prices. At time t, RPV can be defined as follows:

$$RPV_t = \sum_i w_{it}\left(IN_{it} - IN_t\right)^2 \qquad (4)$$

where w_{it} denotes the weight of price i in the price index, IN_{it} the inflation rate of price i and IN_t the general inflation rate[4].

On the other hand, expected inflation, INE, is the inflation rate forecasted by the agents for the current period, and it is estimated by means of the ARMA model that fits the "best forecast" of inflation. The ARMA structure has been selected according to the Akaike-Schwarz criterion -the estimation with the lowest value of both tests-. The results suggest an AR(1) model for Argentina, and an ARMA(10,10) model for Spain. From our point of view these results are plausible, in the sense that in a stable economy as Spain agents could use long run information to forecast current inflation, while in an unstable and changing environment as Argentina only short run information should be useful. Finally, unexpected inflation, INO, is the forecasting error, and can be defined as the difference between current and expected inflation (INO=IN-INE).

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[3] In fact, the key factor is to determine how many months "around" the current inflation make a homogeneous period of inflation. As it has been said, for Argentina we select only three months, because given the great changes observed in its inflation rate, adding more lags could lead us to include months belonging to different inflationary contexts, and therefore there would be a risk of overestimating this measure. For Spain this problem is not so important, but as the results of the estimations are similar with three or more lags, we have chosen the same number of lags as for Argentina in order to compare the results.

[4] For Argentina a slight variation of equation (4) is used, because as it was stated in Dabús (1993) equation (4) is not the best measure for RPV in high inflation economies. In this context, the estimation of the coefficient of variation of the price change distribution is required, instead of the simple variance, because at high inflation the latter is spuriously correlated with the mean of the distribution -the inflation rate-. To avoid such problem, RPV for Argentina is defined as follows:

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

2.2. Empirical methodology

As it was stated in the introduction, the goal of this paper is to analyze the links between inflation and RPV. Firstly, in order to study the effects of the inflation rate and inflation volatility on RPV, a set of equations is estimated:

$$RPV_t = a + b_1 IN_t + b_2 DIN_t + e_t \qquad (5)$$

$$RPV_t = a + b_1 IN_t + b_3 ABDIN_t + e_t \qquad (6)$$

$$RPV_t = a + b_1 IN_t + b_4 VARIN_t + e_t \qquad (7)$$

According to the results obtained in previous contributions –see references in the introduction-, the inflation rate and inflation volatility affect RPV positively, therefore b_1, b_2, b_3 and b_4 are expected to be positive.

As far as expected and unexpected inflation is concerned, the following equation is estimated:

$$RPV_t = a + b_5 INE_t + b_6 INO_t + e_t \qquad (8)$$

In this case, there is neither theoretical nor empirical consensus on their effects on inflation. The sign and the significance of the coefficients can be interpreted as evidence in favour of menu costs model –if b_5 is positive and significant- or signal extraction model -if b_6 is positive and significant-.

Moreover, both models predict that RPV is affected by the magnitude of INE -menu costs models- and INO –signal extraction model- irrespective of the sign of both variables. In order to test it, equation (9) includes the absolute value of expected and unexpected inflation (ABINE and ABINO respectively):

$$RPV_t = a + b_7 ABINE_t + b_8 ABINO_t + e_t \qquad (9)$$

3. Inflationary regimes classification

This section classifies the different periods of inflation in several regimes. For Argentina, following a version of the criterion suggested by Leijonhufvud (1990) for high inflation economies, we have distinguished four regimes: moderate inflation when the monthly inflation rate is lower than 1%-2%, high inflation for the 2%-10% range, very high inflation for the 10%-50% range, and hyperinflation for values beyond 50%.

The methodology to determine such regimes is based on a procedure that divides the total period in different sub-periods of inflation[5]. A "smoothed-out" series from the original series of inflation is obtained as follows:

$$SIN_t = \left\{ \left[\frac{PI_t}{(1/12)\sum_{i=1}^{12} PI_{t-i}} \right]^{1/6} - 1 \right\} * 100 \qquad (10)$$

where SIN_t is the "smoothed-out" series of monthly inflation rate and PI_t is the monthly price index at period t. Discontinuities are detected in this series when variations of the "smoothed-out" inflation are larger than three standard deviations from the moving average of inflation, as follows:

$$SDESVIN_{t-1,t-12} = \left[\frac{\sum_{1}^{12} \left(SIN_{t-1} - MAVIN_{t-1,t-12} \right)^2}{12} \right]^{1/2} \qquad (11)$$

where SDESVIN is the standard deviation of the moving average of inflation, and MAVIN is the yearly moving average of inflation rate for the twelve previous months to the discontinuity. Thus, this procedure captures only persistent changes, disregarding transitory variations in inflation levels.

The next step is to detect changes in the regime of inflation if the following conditions are fulfilled: 1) $SIN_t > MAVIN_{t-1,t-12} + 3SDESVIN_{t-1,t-12}$, 2) the discontinuity holds for three or more consecutive months, and 3) the average inflation rate between two periods separated by such discontinuity are significantly different, which is checked by a simple test of difference of means. When discontinuities are detected, the months including the "critical points" that fulfil those conditions must be identified in the original inflation rate series. Finally, once the periods of inflation are obtained, they are grouped in different regimes.

According to the aforementioned methodology, in Argentina each regime contains the following periods:

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[5] For a more detailed explanation of this methodology see Dabús (1993). An alternative approach to delimitate inflationary regimes could be based on changes in the variance of the inflation series, for example using the ICSS algorithm developed by Inclan and Tiao (1994) and Sansó *et al.* (2004). In further research we intend to compare both approaches for data from several countries.

Inflation regime	Period
Moderate inflation	January 1960-April 1970
High inflation	May 1970-January 1975, May 1976-June 1982, July 1985-June 1987, September1988-March 1989, August 1989-November 1989, April 1990-February 1991
Very high inflation	February 1975-April 1976, July 1982-June 1985, July 1987-August 1988
Hyperinflation	April 1989-July 1989, December 1989-March 1990

Following the same criterion, for Spain the whole period is classified as moderate inflation -the test of difference of means was not significant in any case-. However, for a low inflation country like Spain, some changes in the criterion must be done. In fact, it can be observed sustained changes of the inflation level in the beginning of 1992, when the condition $SIN_t > MAVIN_{t-1,t-12} + SDESVIN_{t-1,t-12}$ was fulfilled. In order to consider the change in inflation in 1992, the total period has been divided into two periods, high and low inflation, for the September 1985-March 1992 and April 1992-December 2001 periods respectively.

Once the inflationary regimes were determined, we have looked for the most significant breaks in the inflation rate history for both countries. According to our methodology those breaks are: February 1975 for Argentina and 1992 for Spain. Finally, the total period has been divided into two sub-periods[6].

4. Data

The analysis is based on monthly data. For each country the price index available at the highest degree of dissagregation has been chosen, which is an advantage in order to calculate RPV[7]. According to this criterion, we have used the Wholesale Price Index (WPI) for Argentina and the Consumer Price Index (CPI) for Spain.

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[6] Given the size of each sub-period for Argentina, it is not possible to develop the analysis for each one.

[7] The degree of disaggregation can affect the estimations; therefore, in order to compare the results for both countries, homogeneity in the degree of disaggregation is required, otherwise different results can be obtained due just to the different kind of data used. Another distortion can be introduced in the results by the fact that we are using two different price indexes. On one hand, this problem is not avoidable because the same price index, with a similar degree of disaggregation, is not available for both countries. On the other hand, Caraballo and Usabiaga (2004b) carry out a similar study for Spain using two price indexes, Producer Price Index (PPI) and Consumer Price Index (CPI), with a similar degree of dissagregation (25 categories for PPI and 33 categories for CPI), and there are not remarkable changes in the estimations. Moreover, the estimations using CPI with different degree of dissagregation yield more relevant changes. Having these arguments into

As far as Argentina price series is concerned, they have been drawn from the statistical bulletins of the Instituto Nacional de Estadísticas y Censos, covering the period January 1960-February 1991. At the three-digit level of disaggregation in the International Standard Industrial Classification, we use 87 individual prices for the January 1960-June 1984 period and 64 for the July 1984-February 1991 period -the structure of WPI in Argentina changed in July 1984-.

For the Spanish case, the data cover the period September 1985-December 2001, and have been drawn from the Instituto Nacional de Estadística. We have used 57 categories of the CPI.

The methodology for the collection of data differs for both countries. In Spain most of price data are collected between the 1st and the 22nd day of each month. This methodology can generate spurious correlation between RPV and inflation in a high inflation context, but not under price stability[8]. Fortunately, in our high inflation case (Argentina) most of prices -prices of industrial and imported products[9]- are collected the same day of each month (the 15th), or are sampled as a monthly average from daily (or nearly daily) information -prices of agricultural products-. Hence, for Argentina, correlation between RPV and inflation should not be "contaminated" by the methodology of price collection.

As said, for both countries monthly data are used. For Argentina, as we have chosen WPI, there are not seasonality problems, because most of prices, and specially the prices of industrial and imported products, do not present a seasonal component. On the contrary, for the Spanish case, CPI presents an important seasonal component. In order to remove it, an X-12 ARIMA method is applied. Thus, all the estimation results presented along the paper are referred to non-seasonal variables for Argentina and seasonally adjusted variables for Spain.

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account, eventually it seems to be more appropriate using different price indexes with a similar degree of disaggregation.

[8] For example, if two prices are always equal, and every month one of those prices is sampled the first day and the other one the last day, the true variability of relative prices is zero. At low inflation a low RPV should be detected, but at high inflation a higher variability will be detected, which would be just the consequence of the periodicity of price collection.

[9] Data include 77 industrial and imported good prices, from a total of 87, for the 1960-1984 period, and 55, from a total of 64, for the 1984-1991 period.

5. Results

5.1. Preliminary analysis

The two countries studied in this paper show very different inflationary experiences. On one hand, Spain is a stable economy, with a monthly inflation rate ranging between zero and 2% approximately. On the other hand, Argentina is a very unstable economy, with sundry inflationary episodes, going from the moderate inflation of the sixties to the extreme inflation periods of the late eighties (see Figures 1 and 2, for Spain and Argentina respectively). Nevertheless, both economies share a common pattern: higher inflation is associated with higher RPV, a relationship which is even more evident for Argentina.

For the Spanish economy, as it was stated in section 3, two slightly different periods of high and low inflation can be distinguished: September 1985-March 1992 and April 1992-December 2001 respectively. Both inflation and RPV are lower in the second period. In Argentina, RPV is clearly increasing in inflation, in particular when the inflation rate increases suddenly. This is verified in the inflationary accelerations of 1962, 1975-76, 1985, and, specially, in the hyperinflations of 1989-1990. Indeed, RPV increases strongly in those cases, and reaches the highest values in the months of highest inflation. The months of hyperinflation seem to show a collapse of the price system, which implies evidence in favour of the hypothesis of non-neutrality of inflation.

There are two cases in which price variability decreases, denoting a coordination in the individual price adjustments.

On one hand, periods with gradual increases in inflation -for example in Argentina along the 1981-85 period-. This evidence seems to be consistent with the intuition that abrupt changes of the inflation rate are required to increase RPV. High inflation volatility should increase the range between prices that adjust jointly with the general inflation and those that are indexed taking into account past values of the inflation rate. In short, the lack of synchronization in price adjustments increases RPV. On the contrary, even at high levels, a gradual increasing in inflation would allow the agents to adapt to it, perhaps by means of indexation mechanisms, which may avoid staggering in price adjustments and therefore, even when inflation is increasing, RPV will be decreasing.

On the other hand, the second case is referred to periods of stability in which RPV remains at very low levels, for example in the Spanish lower inflation period and during the sixties in Argentina[10].

In short, higher inflation seems to be related to a more volatile and less predictable inflation rate, and to a higher RPV: the behaviour of relative prices and inflation changes at different inflation levels. This can be checked by examining the average values of these variables for each inflationary regime –see Table 1-. For all cases RPV is, on average, systematically higher at higher inflation, specially in Argentina. These results state an interesting difference from previous findings. Firstly, unlike Van Hoomisen (1988) for Israel, Palerm (1991) for Mexico and Tommasi (1993) for Argentina, we find a non-concave relationship between RPV and inflation. Moreover, price dispersion explodes in extreme inflation, therefore there is not evidence of unifying forces of price revisions at hyperinflation. This can be due to the high volatility and inflationary surprises verified in these situations. Indeed, inflation volatility (ABDIN and VARIN) and unexpected inflation increase systematically with the level of inflation, and particularly at hyperinflation.

5.2. The inflation-relative price relationship: the regression analysis

There are some issues to point out before running the regressions.

Firstly, stationarity of the series has been checked by means of the ADF test[11], for the total period and for the lower and higher inflation periods. It was applied to the original series in Argentina, and to the seasonally adjusted series in the case of Spain. In all cases we found that the series are stationary, except for Spanish RPV when the whole period is considered. In order to deal with this result, we just include lags of RPV in the estimations, as it is shown in Table 3. In turn, as the ADF test results show the presence of a deterministic trend in Spanish RPV, for the total and lower inflation periods, a trend term has been included in the respective estimations.

In second place, for Argentina, the White test shows the presence of heteroskedasticity in some regressions. This problem has been solved using the White heteroskedasticity-consistent variances and standard errors; nevertheless the results concerning the significance of the regressors did not change.

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[10] In other countries different results have been obtained. For instance, for Turkey, during the 1948-1997 period, Caglayan and Filiztekin (2003) find a lower effect of inflation on relative prices during the higher inflationary period.

[11] In order to select the number of lags, the Akaike criterion has been applied.

Thirdly, in order to tackle autocorrelation in the residuals, we have included lags of the endogenous variable in those estimations where they are required. However, the Breusch-Godfrey (BG) test shows that for some estimations the introduction of lags is not enough to remove autocorrelation[12]. Anyway, the BG test results are very sensible to the number of lags selected, so that the evidence of autocorrelation problems is not conclusive -see footnotes in Tables 2 and 3-.

In fourth place, multicollinearity problems can appear in estimations including inflation rate and inflation volatility measures, because both variables are closely related. As the correlation between explanatory variables can help us to know the relevance of this problem, we have calculated the correlation coefficient, obtaining that only for two cases it is bounded between 0.50 and 0.75 -correlation between IN and DIN for Spain and between IN and VARIN for Argentina-. Therefore, in these cases, results must be taken cautiously.

As far as the estimations is concerned, for both countries we carry out three kind of estimations: for the total period, and for the lower and higher inflation periods. Recall that, for Argentina, the lower inflation period goes from January 1960 to January 1975, and the higher one from February 1975 to February 1991. For Spain the higher inflation period covers the September 1985-March 1992 period, and the lower one the April 1992-December 2001 period.

Tables 2 and 3 present the results of the regressions for equations (5) to (9). In contrast to previous literature, we offer comparative evidence from different inflationary experiences. It can be seen that there are interesting differences between both countries at different inflation levels. In Argentina, for all regressions R^2 coefficients and the significance of the explanatory variables are higher in the higher inflation period. On the contrary, for the Spanish case, R^2 is generally higher in the lower inflation period, which is due to the significance of the negative trend; in addition to this, the inflation rate is significant only for the total period. These results suggest the existence of structural changes in the inflation-RPV relationship for both countries across different inflation regimes, as we shall check in the next sub-section.

[12] This result is observed specially in high inflation periods. It denotes that there are variables affecting RPV that have not been included in our equations, in particular real variables related to high economic volatility, like changes in real exchange rate and real wages –see, for example, Fischer (1981) and Dabús (1993) for further details-.

Some similarities between both countries arise. Firstly, as it has been shown in previous literature, inflation volatility affects RPV positively[13]. VARIN appears to be the best volatility measure to explain RPV, suggesting that changes in inflationary environment, rather than transitory variations in the inflation rate, affect RPV. Secondly, regressions including both expected and unexpected inflation indicate that the latter is generally significant, and with the expected sign, except for the Spanish lower inflation period. Moreover, ABINO is also significant, thereby not only unexpected inflation but its magnitude increase RPV. Thus, inflationary surprise seems to be a relevant factor in order to explain RPV, regardless of the average inflation rate, as it has been obtained for other countries. However, from our point of view, the interpretation of these results must be different in each case. In this sense, they can support the signal extraction approach in the Spanish higher inflation case, but they seem to be related to high economic instability in the chronic Argentine high inflation, and specially in extreme inflation. On the contrary, results concerning to expected inflation are different for both countries. While in Argentina it affects positively RPV, it is never significant in Spain. This difference is suggesting that inflation expectations play different roles, in order to explain the non-neutrality of inflation, depending on the macroeconomic context.

It seems that our results suggest that the signal extraction model is suitable just in stable economies, like Spain, implying that only inflation surprise is not neutral. But it does not work in unstable economies, like Argentina, where expected inflation increases RPV as well. Nonetheless, in our opinion, this finding is not supporting the menu costs model in inflationary economies, because at high inflation adjustment costs are trivial. The fact that both expected and unexpected inflation are significant in Argentina seems to be indicating the presence of important problems in order to forecast current inflation, as well as high macroeconomic volatility is making increasingly complex the price decisions for economic agents[14]. In fact, RPV exploded in the Argentine hyperinflation, which suggests that there are not successful mechanisms to avoid the impact of inflation on relative prices, like indexation or a “good” model to make expectations on current inflation. In other

[13] As we stated in the introduction, this result has been obtained both for inflationary economies –see Logue and Willet (1976), Blejer (1979), Moura and Kadota (1982) and Dabús (2000)- and stable economies –see Chang and Cheng (2000)-.

[14] In fact, the same result was obtained for the Chinese hyperinflation (1946-1949) –see Tang and Wang (1993)-.

words, our analysis suggests that agents cannot find an adaptive mechanism to minimize the inflationary surprise associated with those episodes.

In short, our findings are similar to those obtained in previous literature, in the sense that they suggest clearly that inflation is non-neutral, but they go further suggesting that non-neutrality is more evident at higher inflation, and particularly in extreme inflation. Moreover, the plausible causes for non-neutrality are different depending on the macroeconomic environment: for stable economies the explanations based on the signal extraction or the menu costs models can be meaningful, but they do not seem to be suitable for unstable economies. Finally, our results appear to support the signal extraction model rather than the menu costs approach, as it has been shown for other stable economies like Germany –see Miszler and Nautz (2004)-.

5.3. Structural change

The different results obtained in the estimations for the whole period and for lower and high inflation periods suggest that there can be structural changes in the RPV-inflation relationship. Firstly, applying the recursive residual estimation and the CUSUM test, we check for both countries if there is one or more structural changes. Once the breaks have been detected, the Chow test is applied in order to verify the results. Finally, we compare if the breaks detected in the RPV-inflation relationship with this methodology are the same found by means of the method used in section 3 to delimitate the inflationary regimes. We check for all cases that there is a structural change in that relationship when there is a change in the inflationary regime –recall that the most relevant breaks that we found were February 1975 for Argentina and March 1992 for Spain- as it is showed in Table 4.

As it can be seen in Table 4, structural changes are significant at 1% level of confidence, which seems to prove our hypothesis that the effects of inflation, its volatility and the components of expected and unexpected inflation are different at low and high inflation. In fact, as it has been mentioned, in general these changes are associated with higher significance of the explanatory variables, which supports the idea that the non-neutrality of inflation is more evident with higher economic instability.

In conclusion, the structural change seems to support the hypothesis that the determinants of RPV -and their relevance- change at different inflation levels, even in a narrow range of inflation, as in the Spanish case.

6. Concluding remarks

This paper analyzes the relationship between inflation and relative prices for two economies with very different inflationary history: Argentina and Spain. While the former shows high price instability, the latter is characterized by a low and stable inflation. Our findings support the hypothesis of the non-neutrality of inflation, which is more evident at high inflation, and particularly at extreme inflation (for example in both Argentine hyperinflations). Moreover, there is a non-concave relationship between RPV and inflation in Argentina, denoting that inflation affects RPV more than proportionally beyond certain threshold of inflation.

The main determinants of RPV are inflation, inflation volatility and unexpected inflation. VARIN is the best inflation volatility variable in order to explain RPV, which suggests that changes in the inflationary environment are more relevant affecting relative prices than transitory deviations of the inflation rate from its trend. Our results can support the signal extraction approach in low inflation; however, in extreme inflation they seem to be showing the presence of important problems in order to forecast the current inflation rate, as well as in order to take price decisions.

Comparing the results for both economies we find an interesting difference: expected inflation is only significant in the high inflation country (Argentina). Apparently, this result neither supports the menu costs approach -there are not nominal rigidities in high inflation- nor the signal extraction approach. Instead, this latter approach seems to be suitable for Spanish results, where only unexpected inflation is, in general, significant.

Finally, the inflation-RPV relationship exhibits significant structural changes across the different inflationary regimes, which seems to prove the hypothesis that the determinants of RPV, and their relevance, are different at different inflation levels.

This research can be deepened in several directions. A first extension is to include new economies in the sample, in order to check if our results hold. Another extension is to analyze the role of higher moments of the price change distribution, like skewness and kurtosis. This extension could determine if the inflation-RPV relationship is influenced by them, as suggested by Bryan and Cecchetti (1999). Finally, an interesting branch of research could study if the causality of that relationship changes with the regime of inflation.

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Figures and tables

Figure 1

Monthly inflation rate (IN) and relative price variability (RPV)
Spain, CPI, 1985.09-2001.12

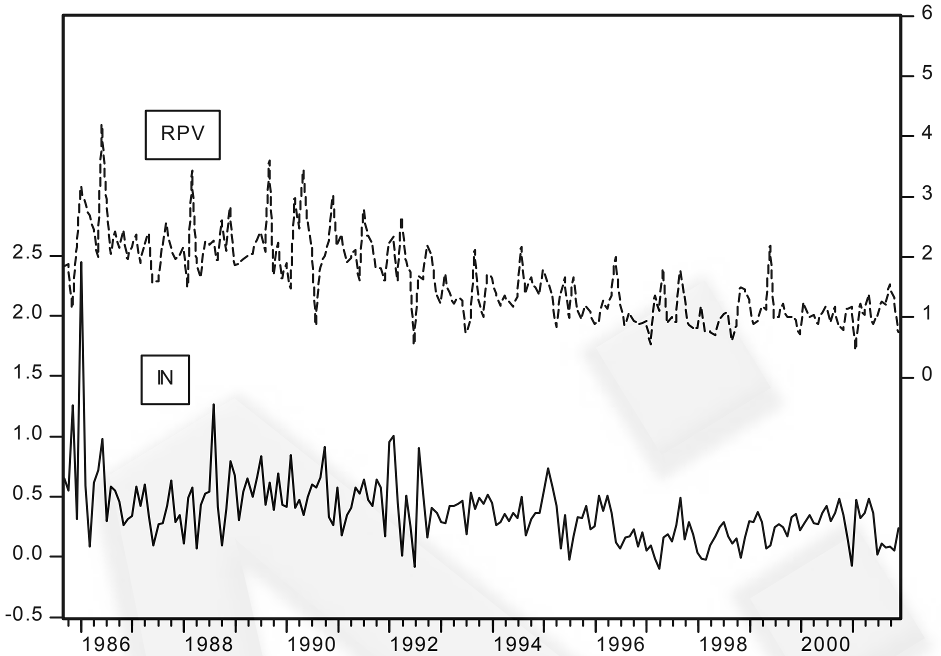

Figure 2

Monthly inflation rate (IN) and relative price variability (RPV)
Argentina, WPI, 1960.01-1991.02

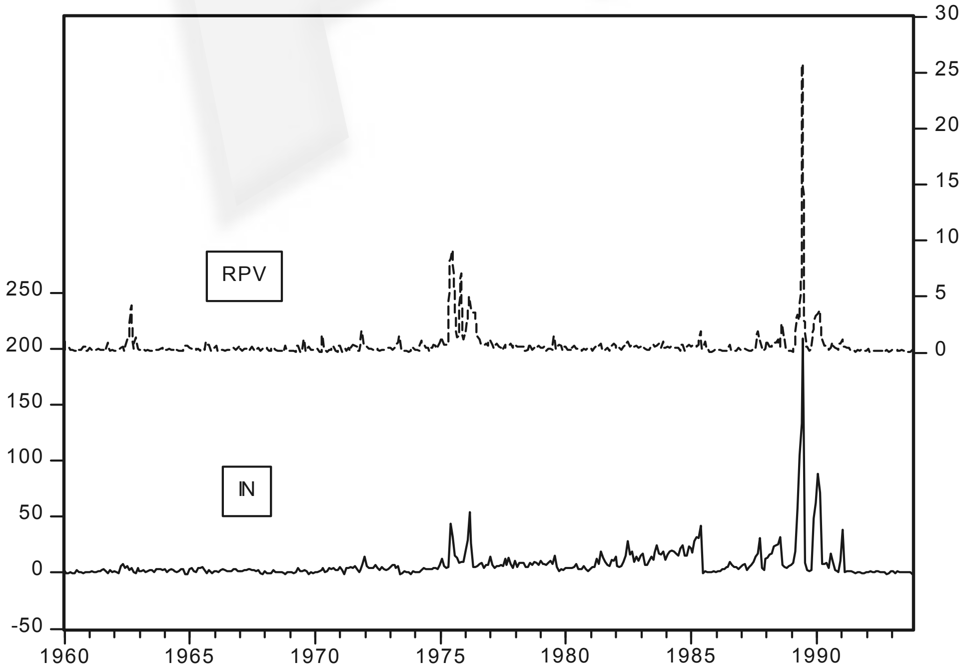

Table 1.A. Average values by regime of inflation
Argentina, WPI, 1960.01-1991.02 and Spain, CPI, 1985.09-2001.12

	Spain		Argentina	
Regimes/ Variables	Higher inflation period (1985.09-1992.03)	Lower inflation period (1992.04-2001.12)	Lower inflation period (1960.01-1975.01)	Higher inflation period (1975.02-1991.02)
IN	0.53	0.27	1.9	14.3
ABDIN	0.30	0.13	1.5	7.3
VARIN	0.19	0.10	1.1	7.1
ABINO	0.36	0.18	1.7	11.1
RPV	2.20	1.17	0.4	1.0

Table 1.B. Average values by regime of inflation
Argentina, WPI, 1960.01-1991.02

Regimes/ Variables	Moderate Inflation	High inflation	Very high inflation	Hyperinflation	July 1989 *
IN	1.4	5.5	18.3	96.8	209.1
ABDIN	1.3	4.6	6.4	36.6	75.6
VARIN	1.0	4.1	5.9	43.2	135.2
ABINO	1.2	2.4	5.9	10.1	16.7
RPV	0.3	0.5	1.2	6.4	25.7

* The highest inflation month of the Argentine hyperinflations.

Table 2.A. Regression results
Argentina: WPI, dependent variable: RPV, explanatory variables: volatility measures

Total period: 1960.01-1991.02					
Regression 1		**Regression 2**		**Regression 3**	
R^2	0.60	R^2	0.61	R^2	0.65
BG	0.00	*BG*	0.00	*BG*	0.00
CONSTANT	0.04 (0.53)	CONSTANT	0.04 (0.55)	CONSTANT	0.05 (0.41)
IN	0.08 (0.00)	IN	0.07 (0.00)	IN	0.05 (0.00)
DIN	-0.01 (0.01)	ABDIN	0.02 (0.00)	VARIN	0.06 (0.00)
Lower inflation period: 1960.01-1975.01					
Regression 4		**Regression 5**		**Regression 6**	
R^2	0.06	R^2	0.09	R^2	0.08
BG	0.03	*BG*	0.17	*BG*	0.07
CONSTANT	0.27 (0.00)	CONSTANT	0.21 (0.00)	CONSTANT	0.22 (0.00)
IN	0.05 (0.00)	IN	0.04 (0.01)	IN	0.04 (0.01)
DIN	-0.00 (0.91)	ABDIN	0.06 (0.01)	VARIN	0.06 (0.02)
Higher inflation period: 1975.02-1991.02					
Regression 7		**Regression 8**		**Regression 9**	
R^2	0.62	R^2	0.62	R^2	0.66
BG	0.00	*BG*	0.00	*BG*	0.00
CONSTANT	-0.20 (0.10)	CONSTANT	-0.18 (0.12)	CONSTANT	-0.16 (0.00)
IN	0.08 (0.00)	IN	0.07 (0.00)	IN	0.06 (0.00)
DIN	-0.01 (0.03)	ABDIN	0.02 (0.00)	VARIN	0.04 (0.00)

Notes:

* Autocorrelation is due to the presence of outliers in the abrupt increases of inflation rate of 1975 and both hyperinflations. Fortunately, autocorrelation problems in Argentina do not obey the structure of the residuals.

* For all tables of results presented in this paper, regressions were made by means of OLS. Values into brackets are referred to the p-value obtained when testing the null hypothesis that the coefficient estimated is significantly different from zero. R^2 refers to adjusted R^2. The specification test p-values reported are the BG test results for the presence of first order serial correlation.

Table 2.B. Regression results
Argentina: WPI, dependent variable: RPV, explanatory variables: expected and unexpected inflation

Total period: 1960.01-1991.02			
Regression 1		**Regression 2**	
R^2	0.60	R^2	0.55
BG	0.00	*BG*	0.00
CONSTANT	0.07 (0.27)	CONSTANT	-0.02 (0.81)
INE	0.08 (0.00)	ABINE	0.07 (0.00)
INO	0.08 (0.00)	ABINO	0.05 (0.00)
Lower inflation period: 1960.01-1975.01			
Regression 3		**Regression 4**	
R^2	0.06	R^2	0.08
BG	0.00	*BG*	0.00
CONSTANT	0.27 (0.00)	CONSTANT	0.18 (0.00)
INE	0.05 (0.03)	ABINE	0.03 (0.18)
INO	0.04 (0.00)	ABINO	0.09 (0.00)
Higher inflation period: 1975.02-1991.02			
Regression 5		**Regression 6**	
R^2	0.61	R^2	0.56
BG	0.00	*BG*	0.00
CONSTANT	-0.01 (0.28)	CONSTANT	-0.29 (0.04)
INE	0.08 (0.00)	ABINE	0.07 (0.00)
INO	0.08 (0.00)	ABINO	0.06 (0.01)

Table 3.A. Regression results
Spain: CPI, dependent variable: RPV, explanatory variables: volatility measures

Total period: 1985.09-2001.12					
Regression 1		**Regression 2**		**Regression 3**	
R^2	0.56	R^2	0.56	R^2	0.60
BG	0.02	*BG*	0.01	*BG*	0.09
CONSTANT	1.72 (0.00)	CONSTANT	1.75 (0.00)	CONSTANT	1.77 (0.00)
RPV(-1)	0.19 (0.00)	RPV (-1)	0.20 (0.00)	RPV(-1)	0.18 (0.01)
TREND	-0.01 (0.00)	TREND	-0.01 (0.00)	TREND	-0.01 (0.00)
IN	0.42 (0.01)	IN	0.26 (0.06)	IN	0.27 (0.05)
DIN	-0.11 (0.37)	ABDIN	0.14 (0.33)	VARIN	0.47 (0.03)
Higher inflation period: 1985.09-1992.03					
Regression 4		**Regression 5**		**Regression 6**	
R^2	0.01	R^2	0.01	R^2	0.07
BG	0.09	*BG*	0.07	*BG*	0.29
CONSTANT	1.76 (0.00)	CONSTANT	1.83 (0.00)	CONSTANT	1.83 (0.00)
RPV(-1)	0.11 (0.35)	RPV(-1)	0.10 (0.39)	RPV(-1)	0.09 (0.43)
IN	0.39 (0.13)	IN	0.20 (0.35)	IN	0.17 (0.46)
DIN	-0.10 (0.58)	ABDIN	0.168 (0.39)	VARIN	0.56 (0.09)
Lower inflation period: 1992.04-2001.12					
Regression 7		**Regression 8**		**Regression 9**	
R^2	0.18	R^2	0.19	R^2	0.20
BG	0.11	*BG*	0.15	*BG*	0.14
CONSTANT	1.79 (0.00)	CONSTANT	1.74 (0.00)	CONSTANT	1.72 (0.00)
TREND	-0.01 (0.00)	TREND	-0.01 (0.00)	TREND	-0.01 (0.00)
IN	0.25 (0.29)	IN	0.12 (0.52)	IN	0.18 (0.35)
DIN	-0.15 (0.48)	ABDIN	0.41 (0.10)	VARIN	0.74 (0.05)

Note:

* For Tables 3A and 3B, lags of the endogenous variable were included when the unit root test indicated the presence of non-stationarity, and to deal with autocorrelation. The trend term (TREND) was included when it was significant according to that test. Following the parsimony principle we just include the lowest number of lags required in each case.

Table 3.B. Regression results
Spain: CPI, dependent variable: RPV, explanatory variables: expected and unexpected inflation

Total period: 1985.09-2001.12			
Regression 1		**Regression 2**	
R^2	0.57	*R^2*	0.56
BG	0.15	*BG*	0.36
CONSTANT	1.84 (0.00)	CONSTANT	1.82 (0.00)
RPV(-1)	0.23 (000)	RPV (-1)	0.21 (0.00)
TREND	-0.00 (0.00)	TREND	-0.01 (0.00)
INE	-0.02 (0.84)	ABINE	-0.07 (0.57)
INO	0.37 (0.00)	ABINO	0.51 (0.00)
Higher inflation period: 1985.09-1992.03			
Regression 3		**Regression 4**	
R^2	0.04	*R^2*	0.02
BG	0.21	*BG*	0.39
CONSTANT	2.13 (0.00)	CONSTANT	2.05 (0.0)
INE	0.01 (0.92)	ABINE	-0.02 (0.92)
INO	0.38 (0.04)	ABINO	0.49 (0.08)
Lower inflation period: 1992.04-2001.12			
Regression 5		**Regression 6**	
R^2	0.18	*R^2*	0.20
BG	0.05	*BG*	0.06
CONSTANT	2.01 (0.00)	CONSTANT	1.93 (0.00)
TREND	-0.00 (0.00)	TREND	-0.00 (0.00)
INE	-0.21 (0.33)	ABINE	-0.25 (0.26)
INO	0.01 (0.97)	ABINO	0.43 (0.11)

Table 4: Structural change
Dependent variable: RPV

Regressions/Regimes	Argentina Lower to higher inflation (1960.01-1975.01 to 1975.02-1991.02)	Spain Higher to lower inflation (1985.09-1992.03 to 1992.04-2001.12)
RPV=f(IN)	1	1
RPV=f(IN, DIN)	1	1
RPV=f(IN,ABDIN)	1	1
RPV=f(IN,VARIN)	1	1
RPV=f(INE,INO)	1	1
RPV=f(ABINE,ABINO)	1	1

Note:
1: Structural change was verified at the 1% level.