INFLATION AND THE INFORMATIVENESS OF PRICES
Microeconomic Evidence from High Inflation

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ABSTRACT

I study the effect of inflation on the ability of economic agents to forecast real prices, with microeconomic data from Argentina, 1990-1992. The evidence favors the view that inflation degrades the informational content of real prices. Several rules for forecasting real prices are shown to perform worst at higher inflation. This suggests that inflation (at least high-inflation) has "IO" effects usually ignored in macroeconomic assessments of the effects of inflation.

Preliminary results on some of the issues dealt with in this paper, appeared in Tommasi (1993). I received valuable comments and suggestions from Larry Ball, Willem Buiter, Julio Rotemberg, Mattew Shapiro, Anna Schwartz, John Taylor and other participants at the NBER Monetary Economics meeting. I am also indebted to Stanley Fischer, Simon Potter, Keunkwan Ryu, and Hilary Sigman for helpful suggestions, and to Saul Lach and Dani Tsiddon for valuable insights when discussing some of these issues. Martin Kaufman provided excellent research assistance and comments. All errors are my own.

INTRODUCTION

Inflation, we are told, affects the workings of the price system. Friedman (1977), in his Nobel Lecture, hypothesized that increased volatility of inflation reduces the efficiency of market prices as coordinators of economic activity via an "increased amount of noise." Fischer (1981) argued that "inflation is associated with relative price variability that is unrelated to relative scarcities and hence leads to misallocations of resources." As Ball and Romer (1992) stress, prices have two roles: guiding allocations and providing information. Both roles are clearly intertwined, and several authors have argued that inflation, by affecting information, worsens the allocation of resources. For example, Reagan and Stultz (1993) argue that price instability raises the costs of contracting and lowers economic efficiency. Huizinga (1993) argues that relative price uncertainty can reduce investment - uncertainty about the net present value of investment projects can make firms reluctant to incur costly, irreversible capital outlays. Tommasi (1992) argues that as current prices become poor predictors of future ones, agents optimally decide to be less informed, and more inefficient transactions occur - for instance, inefficient firms may be able to survive in an environment of price ignorance.

An extensive literature has linked aggregate inflation and inflation uncertainty with measures of "relative price variability" (RPV). Cukierman (1983), Marquez and Vining (1984), and Palerm (1990) survey the "macro" literature, while Weiss (1993) reviews the more recent "micro" findings. That empirical literature used measures of price variability that, although interesting in their own right,[1] did not directly address the question of the informational content of prices.

In this paper, I try to look directly into the informational content of real prices under different inflation regimes (with microeconomic evidence of a high inflation case: Argentina 1990-1992.) The evidence favors the view in Carlton (1982), that "inflation degrades the informational content of real prices."

The price is an indication of an unobservable characteristic of the good being transacted or of the seller. Such characteristics are important because they can affect the ex-post value of today's purchase and the value of repeated purchase from the same supplier. Given that my data set consists of grocery prices I concentrate on the latter, the information that today's prices provide about future prices. Operationally, I study the forecastability of real prices under different inflation regimes. The reader may wonder why is this necessary if we already know that higher inflations tend to be associated with increased RPV. As stated before, there is not a one to one correspondence between the measures of RPV employed in the literature and the informativeness of prices. Imagine a world in which half the sellers (those located in streets that run North-South) increased their prices by 20% in odd periods, while the other half did so in even periods. If this has been the situation for a long time, and it is hence known by buyers, measured relative price variability will be 10% although the prices observed today will be fully informative about the future. Imagine at the other end that every seller throws a coin to decide whether or not to increase his nominal price by 10%. In that case RPV will be only 5%, but today's prices will be much less revealing than in the previous example.

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[1]See Hartman (1991) for a critique of some of this literature.

A. THE DATA

The data used in this study consist of weekly price quotes from 5 supermarkets within the same neighborhood in the Federal District of Buenos Aires, Argentina, collected by the Secretaria de Comercio. The original sample contained 15 products, from which I selected 10 with low number of missing values: butter, coffee, flour, laundry detergent, oil, peas, tea, tomato sauce and yerba (a typical Argentine beverage, similar to tea.) Each good is completely homogeneous across stores, a particular brand/quality; for instance, "coffee" is a particular brand and size of instant coffee. The series run for 46 weeks in 1990 (February-December), two sets of 12 weeks in 1991 (January-April and September-December), and 30 weeks in 1992 (April-November). Statistics for aggregate inflation are provided in Table 1.[2] Figure 1 plots the weekly inflation rate for the sample period.

[2]In preliminary work, I have experimented using different constructions for the aggregate price index and for inflation: one from an independent inflation sample (from Instituto de Politica Economica y Social), and another using intrasample data with CPI weights, without substantive changes in the results. In the paper I report the data using the non-weighted intrasample measure of inflation.

Table 1

Period (weeks)	Average Weekly % Inflation	
Feb-May (15)		8.80
1990 (45) May-Aug (15)	3.63	1.08
Aug-Dec (15)		1.22
1991 Jan-April (12)	3.88	
Sept-Dec (12)	0.03	
1992 (30) Apr-June (15)	0.29	0.24
Aug-Nov (15)		0.46

The annual inflation rate in Argentina was of the order of 5000% in 1989, 800% in 1990, 100% in 1991, and 15% in 1992. On March 20, 1991 the government adopted a fixed exchange rate with the U.S. dollar. The "Convertibility Law" was the corner-stone of a new and desperate stabilization program devised to put an end to a history of almost 50 years of rates of inflation well above international standards which climaxed in two hyperinflation accelerations during April-July 1989 and December 1989-March 1990.

In most of the paper, I will be looking at the behavior of individual prices across inflation "regimes". In what follows, I use average inflation to characterize each period, but in this as in most inflation experiences, inflation variability -- and quite likely inflation uncertainty -- are positively correlated to average inflation.[3] The "regimes" I use are: February-May 1990 (average π_t = 8.80, standard deviation π_t = 16.51), May-August 1990 (1.08,1.59), August-December 1990 (1.22,1.37), January-April 1991 (3.88,6.81), September-December 1991 (0.03,0.98), and April-November 1992 (0.29,1.08).

[3]See Ball and Cecchetti (1990), Evans (1991) and Evans and Wachtel (1993) for recent studies of the links between inflation rate and inflation - and regime - uncertainty.

In the next section, I explore the impact of macroeconomic instability, as measured by different inflation environments, on the ability of economic agents to forecast future prices, using several forecast rules.

B. INFLATION AND THE INFORMATIVENESS OF PRICES

1. Autocorrelations of real prices

As a first forecast rule, following the literature on consumer research (Winer 1986), we look at an extrapolation of past real prices.[4] In the next section we will look at forecast rules that take explicitly into account the intermittent change in nominal prices that emerges from the cost of price adjustment literature.

Let P_{ijt} be the price of good i in store j at time t. Let P_t be the price index at time t, $P_t = \sum_{i=1}^{10} \sum_{j=1}^{5} P_{ijt}$. Also, let $Z_{ijt} = \ln \frac{P_{ijt}}{P_t}$, be a measure of real price.

The time series properties of the 50 series Z_{ijt} were analyzed by looking at the partial autocorrelations. This suggested describing its behavior by the AR(1) process:

[4]Literature on consumer research generally assumes (with reasonable empirical success) that consumers extrapolate the past observed price, adjusting for trend, in this case aggregate inflation. In most of the analysis I will be assuming knowledge of average inflation. In high inflation situations, people tend to be quite informed about the evolution of the exchange rate, and estimates of aggregate inflation are released at high frequency (that is the reason why the data being used have been collected). Also, insofar as price takers have to forecast real prices with imperfect information about aggregates, I am ignoring an extra informational difficulty in favor of the hypothesis of this paper: higher inflation environments make forecasting of real prices very difficult. More on this later.

$$(1)\ Z_{ijt} = \rho_{ij} Z_{ijt-1} + \varepsilon_{ijt}.$$

Table A1 provides the values of ρ and t-statistics for each product-store pair for each time period. Correlation coefficients tend to be lower in periods of higher inflation. Table 2 and Figures 2 and 3 summarize this information.

Table 2
Correlation of Real Prices over Time
(10 goods X 5 stores = 50 cases)

	90I	90II	90III	91I	91II	92
Inflation (%)	8.80	1.08	1.22	3.88	0.03	0.29
Average ρ	.33	.69	.65	.60	.78	.73
% cases signif. (.05)	28	82	78	68	88	92
Average MSE	.125	.050	.080	.139	.036	.040

NOTE: in this and all subsequent tables:
90I: 15 weeks (Jan-May 1990)
90II: 15 weeks (May-Aug 1990)
90III: 15 weeks (Aug-Dec 1990)
91I: 12 weeks (Jan-Apr 1991)
91II: 12 weeks (Sep-Dec 1991)
92: 30 weeks (Apr-Nov 1992)

The information in tables A1 and 2 suggests that the higher the aggregate macroeconomic instability (inflation), the harder it is to make predictions about future values of real prices.[5] Still, ρ provides only information about the slope of a

[5]A similar finding was reported in Tommasi (1993, section 5). There, aside from

regression of Z_{ijt} on Z_{ijt-1}. It may be the case that a smaller slope does not necessarily mean less information. If agents knew for sure that the deviation of tomorrow's price from some average price will be exactly 33% of today's deviation, there will be full information in spite of $\rho=.33$. This suggests looking at the forecast error from such AR(1) rule. To do that, we look at the standard error of the regression or mean squared forecast error: (or Standard Error of the Regression, SER)

$$(2)\ MSE_{ij} = \left\{\sum_t (Z_{ijt}-\hat{Z}_{ijt})^2/(T-K)\right\}^{1/2}$$

where K stands for degrees of freedom, and $\hat{Z}_{ijt}=\rho Z_{ijt-1}$.

The values of MSE_{ij} for the 50 cases are reported in table A1. The last row in Table 2 presents the average MSE for each time period (inflation regime). The evidence indicates forecast errors increasing in the inflation rate, consistent with a negative effect of inflation on information.

Given that all the products were sold in the same stores (supermarkets), it may be the case that buyers do not care about the prices of individual items, but at the price of a "bundle" they purchase. In that case, what matters is the predictability of the price of the bundle. To analyze the impact of inflation on the price of a composite commodity, I constructed a price index per store, P_j, and regressed the equivalent of equation (1), now on the composite, as opposed to individual goods. I worked with both a weighted average (using weights from CPI) and unweighted average. I report in Tables A2 and 3 the results for the unweighted bundle; the results with weights are similar.

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having a shorter sample, the emphasis was on the deviation of the price at a particular store with respect to the product average. Following the search literature, I showed that the ability of buyers to identify "low price sellers" was declining in inflation.

Table 3
Correlation of Real Prices over Time
(bundle of goods, 5 stores)

	90I	90II	90III	91I	91II	92
Inflation (%)	8.80	1.08	1.22	3.88	0.03	0.29
Average ρ	.65	.84	.87	.79	.84	.90
Average MSE	.041	.020	.021	.028	.017	.015

Notice that, not surprisingly, there is much less volatility at the level of "bundle" than at the level of individual product. To some extent, this is just an artifact of aggregation.[6] Once more, the evidence indicates a worsening of forecasts at higher inflation rates.

2. (S,s) Pricing Rules

So far we have looked at correlations of real prices over time, and at second moments of these linear predictors. Of course, it may be the case that price expectations are formed differently. For instance, stores may follow a particular pricing rule, and consumers may be aware of that and form their expectations

[6]For details on this, see section 2.1 "The effects of aggregation" in Lach and Tsiddon (1990). I experimented with "random" bundles (using different goods from different stores) and the results are similar to those in tables A2 and 3.

accordingly. A sizable theoretical and empirical literature emphasizes the presence of nominal price rigidities at the microeconomic level (and its implications both at the micro and macro level.)[7] The most common pricing rule in the literature, is the (S,s) pricing policy, analogous to the solution to the dynamic inventory problem (Scarf 1959).[8] Firms set nominal prices to induce an initial real price S, and then let inflation erode its real price up to s, before changing the nominal price again. The bounds are chosen to minimize the loss of being away from an optimal real price plus the cost of the nominal change.

If economic agents in our environment have read any of this literature (remember that Argentines are amongst the most economics-literate people), they will be aware that firms might be following an (S,s) pricing policy. Hence, we look at (S,s) price forecast rules.

Define real prices as $R_{ijt}=P_{ijt}/P_t$. We will be assuming that for each period (inflation regime), seller j selects the bounds S_{ij} and s_{ij} within which the real price of product ij will be allowed to fluctuate. In constructing consumers' estimates I make assumptions about information quite favorable to the agent (in the sense of assuming that they know more than I really think they know.) I assume that they "know" or

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[7]Mankiw (1985), Akerlof and Yellen (1985), Parkin (1986) and Blanchard and Kiyotaki (1987) argue that frictions in price adjustment at the level of individual firms have important implications for the effect of aggregate demand on aggregate activity, one of the central questions in macroeconomics. See Mankiw (1990) and Caplin (1993) for recent surveys of theoretical efforts to integrate nominal rigidities at the micro level into macro relationships, and Weiss (1993) for a recent survey of empirical studies of pricing policies by individual firms, as well as for further references.

[8]Sheshinski and Weiss (1977) and (1983) are the classical reference. Caplin and Spulber (1987), Caballero and Engel (1991), and Caplin and Leahy (1991) address the question of aggregation; i.e., the behavior of the aggregate price level and aggregate output in economies populated by firms following (S,s) pricing policies. Cecchetti (1986), Lach and Tsiddon (1992), and Fisher and Konieczny (1993) are empirical studies of (S,s) policies at the microeconomic level. Cecchetti (1985) provides a methodology for measuring frequency of price changes in order to test the relevance of assuming prices to be set for discrete periods of time at overlapping intervals.

estimate the bounds to be the order statistics $\hat{S}_{ij}=\max(R_{ijt})$, and $\hat{s}_{ij}=\min(R_{ijt})$ for each period under analysis.[9] Also, I assume that consumers (and firms) know the realization of aggregate inflation at any point in time. This is obviously not true, but explicit consideration of the difficulties of predicting real prices in an environment of aggregate uncertainty could only strengthen the point of the paper: the higher the macro uncertainty, the harder it is to forecast real prices.

2.1. (S,s) Rules with One Price Change

Imagine that sellers are following an (S,s) rule and that consumers know the realization of the aggregate inflation rate.[10] In this subsection we assume that (consumers form their forecast believing that) nominal prices change at most once between observations. In the next subsection we extend to more general forecasts.

The forecast will consider two possibilities. If inflation this period was quite low or if last real price observation was quite high, we expect the nominal price to be the same of last observation, and hence the real price will be $R_{ijt-1}(P_{t-1}/P_t)$. If

[9]See Flinn and Heckman (1982) for the fast convergence properties of these estimators. Other estimations, such as minimization of mean squared error were explored, without substantial changes in the results. In any case, one may wonder about the appropriateness of the use of a highly sophisticated econometric apparatus in trying to understand the informational problems faced by economic agents in high inflation environments.

[10]Presumably the bounds are chosen optimally as a function of the inflation regime. Notice that (S,s) policies are actually optimal only under rather restrictive assumptions, (Caplin and Sheshinski, 1987) but they are analytically convenient and research has usually proceeded under those restrictive assumptions, or simply assumed the use of (S,s) as convenient if suboptimal rules (Blanchard 1990.) I am assuming that each period under analysis represents an inflation regime, i.e., the same inflation process. This seems a reasonable assumption for all the periods under analysis (1990 was split into three relatively homogeneous sub-periods, 1992 is quite stable) except for the first 12 weeks in our 1991 sample.

inflation was high enough or last observation low enough, we expect a nominal price change. Let $\tau \in (t-1,t)$ be the exact moment at which the real price hits s, so that

$$s = R_{ijt-1}(P_{t-1}/P_{\tau}),$$

and

$$P_{\tau} = R_{ijt-1}(P_{t-1}/s).$$

At that moment, the nominal price is adjusted to induce a real price S. From τ to ι, it depreciates by (P_{τ}/P_{ι}). Hence

$$\hat{R}_{ijt-1} = S(P_{\tau}/P_{\iota}) = \frac{S}{s}\frac{P_{t-1}}{P_t} R_{ijt-1}$$

So that the forecast of real price will be given by

$$(3) \quad \hat{R}_{ijt} = \begin{cases} R_{ijt-1}(P_{t-1}/P_t) & \text{if } R_{ijt-1}(P_{t-1}/P_t) \geq \hat{s}_{ij} \\ (\hat{S}_{ij}/\hat{s}_{ij})(P_{t-1}/P_t)R_{ijt-1} & \text{if } R_{ijt-1}(P_{t-1}/P_t) < \hat{s}_{ij} \end{cases}$$

Table A3 reports the Mean Squared forecast Error

$$MSE_{ij} = \left\{\sum_t (R_{ijt}-\hat{R}_{ijt})^2/(T-K)\right\}^{1/2}$$

and Mean Average forecast Error (a criterion less sensitive to outliers)

$$MAE_{ij} = \left\{\sum_t |R_{ijt}-\hat{R}_{ijt}|/(T-K)\right\}^{1/2}$$

from forecast rule 3.

Table 4 summarizes the MSE and MAE information. The MSEs and MAEs of each product/store were normalized by the mean (hence expressed in percentage, unit free, terms) before averaging.

Table 4

(S,s) Rule with One Price Change

	90I	90II	90III	91I	91II	92
Inflation (%)	8.80	1.08	1.22	3.88	0.03	0.29
Average % MAE	.165	.050	.049	.060	.032	.016
Average % MSE	.217	.068	.079	.079	.051	.041

Analogous to the findings of previous sections, forecast errors are increasing in the inflation rate.

2.2. Other (S,s) Rules

The results of table 4 can be criticized on the grounds that an (S,s) algorithm that allows for only one price change will tend to induce a bias to excessive errors in cases of very high inflation. (If weekly inflation is larger than the percentage difference between S and s, stores will change prices more than once a week, and hence the error from forecast rule (3) will be too large.)

To account for that possibility, recursive versions of (3), allowing for 2 and 3 price changes were studied. (Given that the lowest (S,s) range was of the order of 20% and that the highest inflation was of 40%, more than 3 price changes seemed unnecessary.) Those rules did not represent a substantial improvement over the simpler one, and the results also showed errors to be larger in episodes of higher inflation.

One could also argue that even if firms were following textbook (S,s) rules, it seems unlikely that price taking agents (buyers) in these markets will go over such sophisticated computations. In order to compare the performance of relatively simpler rules, the following option was explored:

(S,s) with "bounded rationality" Rule: *In a first stage, use forecast rule* (3). *If the forecasted R is greater than or equal to* $\hat{s}_{ij}$, *use that forecast. Otherwise, forecast R to be the mid-point of the band,* (S+s)/2.

The MSEs and MAEs from this rule for the 50 product/stores were computed. The unit-free averages are reported in table 5.

Table 5

(S,s) Rule with "bounded rationality"

	90I	90II	90III	91I	91II	92
Inflation (%)	8.80	1.08	1.22	3.88	0.03	0.29
Average % MAE	.148	.051	.050	.067	.031	.016
Average % MSE	.186	.081	.079	.092	.049	.042

Once more, predictive power is lost at higher inflation rates. Comparing with table 4, this rule does a little better at very high inflation. I discuss a more general comparison across forecast rules in section 4.[11]

[11]Notice that I have used only one sided (S,s) rules. It is possible that firms

3. The Excess Variability of Relative Prices[12]

Excess price variability is likely to have negative effects on the workings of the price system for at least two reasons, relating to the two roles of prices: allocation and information. First, the allocational role of prices is affected if prices are away from fundamentals. Second, if current prices are less revealing about future ones (i.e., its informational role is affected,) further distortions arise (Ball and Romer 1992, and Tommasi 1992). Most of the paper so far has concentrated on the second point: inflation diminishes the information about future real prices contained in current ones. In this section, I present a measure of the deviation of real prices at any point in time from their "correct" level.

According to Fischer (1986), in order to assess the (negative) impact of inflation-induced price variability on the workings of the price system, one wants a measure of divergence of the price of the good from its "correct" price. In order to construct such a measure, I assumed the "warranted" price for each good in each episode to be the average $R_{ij}=\sum R_{ijt}/T$ of that period. From there, I constructed as measure of excess price variability, the coefficient of variation of R_{ijt} around R_{ij}. The same

can be following 2-sided rules. The likelihood of that depends on the relative importance of the common upward drift vis-a-vis the importance of idiosyncratic shocks and possibility of deflation. Intuitively, it is more likely that firms follow 2-sided rules during episodes of low inflation. In that case, my estimates of forecast errors might be upward biased in the low inflation cases, working again my hypothesis.

[12] I am indebted to Stanley Fischer for suggestions that lead to this section.

exercise is performed at the level of product average R_i (as opposed to product/store R_{ij}.) The numbers are provided in table A3 and summarized in table 6.

Table 6

Excess Variability of Real Prices
Coefficients of variation

$$CV_{ij}=[\sum_t (R_{ijt}-R_{ij})^2]^{1/2}/R_{ij}$$

	90I	90II	90III	91I	91II	92
Inflation (%)	8.80	1.08	1.22	3.88	0.03	0.29
Average CV_{ij}	.154	.068	.072	.108	.059	.076
Average CV_i	.115	.049	.049	.038	.036	.038

The plots in Figure 4 suggest, not surprisingly, excess price variability increasing in the inflation rate.

4. Comparison of Forecast Rules

It turns out that the measure of excess variability of relative prices CV_{ij} is equivalent to the MSE of a forecast rule where the price consumers expect to find at any point in time is the period average R_{ij}. Hence, we have used 4 different forecast rules. In this section I provide a brief comparison across forecast rules.

Table 7 summarizes the averages of MSE for the 4 forecast rules in the 6 episodes under analysis.

Table 7
Average Mean Squared Error
Different Forecast Rules

π_t	Period	AR(1)	Ss(1)	Ss+br	Ct.
8.80	90I	.125	.217	.186	.154
1.08	90II	.052	.068	.081	.068
1.22	90III	.086	.079	.079	.072
3.88	91I	.139	.079	.092	.108
0.03	91II	.038	.051	.049	.059
0.29	92	.040	.041	.042	.076

NOTE:
AR(1): %MSE from table 2
Ss(1): %MSE from table 4
Ss+br: %MSE from table 5
Ct.: CV_{ij} from table 6 (MSE from a constant prediction equal to the mean R_{ij})

The information, plotted in figure 5 shows that all the forecast rules perform worse at higher inflation. Also, in terms of relative performance, AR(1) seems the best on average, with (S,s) rules performing reasonably well at low inflation but poorly at high inflation.

This provides some preliminary evidence in favor of the view (in Leijonhufvud 1991, Heiner 1983 and Heymann an Leijonhufvud 1993) that as the macroeconomic environment becomes more complex (increased price instability) simpler expectation formation rules start performing relatively better than more sophisticated rules based on economic models.

5. The Durability of Price Information

In the context of equilibrium models of imperfect price information with intertemporal purchases, such as those in Benabou (1993), Fishman and Rob (1991), McMillan and Morgan (1988), and Tommasi (1992), one very important parameter is the duration of real prices -- the number of periods that a real price is below a particular threshold. Fishman and Rob (1991) and Tommasi (1992) show that consumer welfare and economic efficiency are increasing in that duration. The same result is obtained by Ball and Romer (1992) in a different (non-search) context.

The intuition is the following. Imagine a consumer who buys a particular product once a week. In a context of unchanging real prices, the buyer will search for an adequate supplier (defined by a reservation acceptance price) the first time, and stick to purchasing there forever. In a changing environment, it is optimal (under some conditions) to set a reservation acceptance price and keep purchasing from the same supplier as long as his real price is below that threshold. An increase in real price instability harms consumers by lowering the value of the information they have costly acquired. The equilibrium implications of price instability are lower consumer welfare and a less effective selection of adequate trading partners.

To provide some evidence on price durability, I computed the number of consecutive weeks in which each real price is below a certain threshold. I did so for several thresholds, I report here the average number of weeks each price is below the product mean. Since these durations are dependent on length of the sample due to truncation, I restrict the analysis to the three longer comparable periods: the first and last 30 weeks of the 1990 sample, and the 30 weeks of the 1992 sample.

These averages, for each product/store are reported in table A4 Table 8 reports the store averages, as well as overall averages for each of the three periods.

Table 8

Duration of Real Prices

Period	% π_t	**Average**	Store 1	Store 2	Store 3	Store 4	Store 5
90A	4.87	**1.069**	1.12	1.06	1.09	1.08	1
90B	1.15	**2.265**	2.36	3.06	2.26	1.74	1.91
92	0.29	**4.780**	4.96	4.33	4.93	3.83	6.05

The durability of real prices is decreasing in inflation. It is worth noting that, as explained below, part of the variability in low inflation times comes from the presence of mark-down sales. It is likely that these sales (1) represent a benefit to consumers and (2) are advertised in such a way that price information (in low-inflation times) is even better than reflected by these numbers.[13]

[13]Also, the truncation of the series is likely to bias downward the estimates of duration, particularly for periods of longer durations (lower inflation.)

6. Mark-Down Sales:

There is an old (vague) theme going back to Okun (1975 and 1981) and Carlton (1982): "inflation has Industrial Organization effects." High inflation introduces several distortions in the way firms conduct business (see the accounts in Heymann and Leijonhufvud 1993 and references there.) One of the most noticeable effects of post-stabilization price stability in a country like Argentina, is the appearance of mark-down sales, catalogs, price advertising, and credit plans for the purchase of consumer durables. Practices that are taken for granted in a country like the U.S., are a "luxury" of low inflation times in Argentina. In this section I provide some preliminary evidence on one of those effects.

The sample we use states when the reported quotation is claimed to be "on sale." As a check, I verified that in almost all of the cases the reported prices represented the minimum prices in their cross- sections, and also nominal price decreases from their previous level.

Figure 6 shows the number of sales, together with the weekly inflation rate for the sample. As expected, there are no sales during high-inflation episodes and they reappear with "stability." Possible explanations are that: (1) announcing P_{ij} provides little information if P is unknown, and (2) it is very hard to compromise the maintenance of a nominal price for a long enough period to make a "sale" feasible.

Insofar as the practice of mark-downs is welfare-improving for buyers (and sellers), we have and additional instance where inflation alters the transaction technology and hence diminishes welfare.

CONCLUSION

Paul Krugman has argued that economics has a dirty little secret: We don't know why inflation is costly. This paper provides microeconomic evidence that sheds some light on the mechanisms by which real world inflations affect the heart of market economies: the price system. The evidence suggests that the informational content of real prices diminishes with inflation. Recent (and old) literature argues that the instability of real prices has efficiency costs.

This work needs to be extended in several directions. First, we did not attempt here any explanation of the findings. More theoretical (and more theoretically-grounded empirical) work is needed. Also, our sample is relatively small and un-representative. Broader coverage and similar studies with data from other countries -with different inflationary experiences- are necessary.

Finally, firm and market level studies of the impact of inflation in the organization of markets are badly needed.

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TABLE A1: Correlation of Real Prices

GOOD	Period		STORES				
Butter	90-1	Coef.	-0.155	0.53	0.42	0.14	0.18
		t	-0.56	2.2	1.6	0.51	0.65
		SER	0.1	0.099	0.05	0.078	0.084
	90-2	Coef.	0.6	-0.06	0.77	0.96	0.27
		t	2.6	-0.21	5.2	11.5	1.2
		SER		0.035	0.032	0.02	0.03
	90-3	Coef.	0.51	0.13	0.37	0.51	0.3
		t	2.6	0.52	1.5	3.0	1.2
		SER	0.03	0.029	0.04	0.03	0.04
	91-1	Coef.	0.18	0.77	0.6	-0.08	0.83
		t	0.6	3.7	2.4	-0.25	4.4
		SER	0.034	0.06	0.06	0.055	0.024
	91-2	Coef.	1.01	1.0	1.0	0.86	0.94
		t	12.2	102.0	20.0	7.0	12.0
		SER	0.003	0.002	0.01	0.01	0.02
	92	Coef.	0.76	1.0	0.83	0.83	0.86
		t	6.5	31.5	12.2	7.9	9.1
		SER	0.023	0.017	0.01	0.01	0.03
Coffee	90-1	Coef.	0.42	0.7	0.45	0.94	0.85
		t	1.66	3.5	1.8	8.1	5.7
		SER	0.1	0.11	0.13	0.048	0.07
	90-2	Coef.	0.22	0.69	0.75	0.76	0.5
		t	0.88	3.5	5.2	5.7	2.25
		SER	0.067	0.057	0.04	0.036	0.03
	90-3	Coef.	0.54	0.55	0.86	0.9	0.86
		t	2.5	2.2	5.9	9.6	4.8
		SER	0.056	0.089	0.058	0.03	0.04
	91-1	Coef.	0.5	0.67	0.75	0.76	0.91
		t	1.7	2.6	3.2	3.2	7.5
		SER	0.05	0.07	0.06	0.04	0.019
	91-2	Coef.	0.8	0.8	0.97	1.05	0.71
		t	4.3	3.9	25.0	15.9	4.4
		SER	0.06	0.05	0.015	0.03	0.06
	92	Coef.	0.58	0.8	0.8	0.7	0.7
		t	4.2	9.0	8.7	5.1	5.7
		SER	0.03	0.02	0.02	0.05	0.034
Flour	90-1	Coef.	0.53	0.02	0.5	0.39	0.31
		t	2.3	0.08	2.0	1.55	1.4
		SER	0.1	0.2	0.12	0.11	1.075
	90-2	Coef.	0.39	0.3	0.69	0.43	0.77
		t	1.5	1.8	3.9	3.0	4.9
		SER	0.065	0.08	0.04	0.04	0.05
	90-3	Coef.	0.38	0.19	0.77	0.87	0.54
		t	1.8	0.75	5.3	5.9	2.4
		SER	0.05	0.06	0.06	0.058	0.096

Table 1A (cont.)

GOOD	Period		STORES				
	91-1	Coef.	0.38	0.63	0.51	0.7	0.46
		t	1.52	2.2	1.6	3.0	1.6
		SER	0.037	0.063	0.065	0.066	0.097
	91-2	Coef.	0.74	0.73	0.02	0.8	0.84
		t	3.4	3.4	0.07	4.1	4.4
		SER	0.075	0.06	0.08	0.06	0.06
	92	Coef.	0.5	0.7	0.5	0.8	0.9
		t	3.8	4.3	3.1	7.9	10.7
		SER	0.02	0.02	0.03	0.03	0.03
Laundry Detergent	90-1	Coef.	-0.13	0.76	0.64	0.29	0.65
		t	-0.47	3.9	3.5	1.14	3.2
		SER	0.064	0.08	0.06	0.02	0.087
	90-2	Coef.	0.86	1.07	0.89		0.9
		t	6.15	8.2	7.5		7.3
		SER	0.015	0.9022	0.05		0.015
	90-3	Coef.	0.59	0.68	0.96		0.8
		t	2.8	2.7	10.9		4.7
		SER	0.05	0.06	0.023		0.05
	91-1	Coef.	0.49	-0.27	0.78	0.7	0.49
		t	1.64	-0.24	3.88	3.2	2.3
		SER	0.4	1.11	0.34	0.4	0.4
	91-2	Coef.	1.04	0.97	1.01	0.5	0.6
		t	16.4	9.8	17.8	1.83	2.4
		SER	0.003	0.02	0.02	0.05	0.02
	92	Coef.	0.9	1.04	0.88	0.76	0.81
		t	12.7	24.5	9.9	6.4	6.4
		SER	0.02	0.01	0.04	0.02	0.04
Oil	90-1	Coef.	0.4	0.5	0.16	0.3	0.28
		t	1.75	2.2	0.66	1.2	1.1
		SER	0.09	0.096	0.05	0.055	0.06
	90-2	Coef.	0.79	0.5	-0.15	0.46	0.75
		t	3.1	2.4	-0.6	1.9	4.5
		SER	0.03	0.04	0.024	0.06	0.05
	90-3	Coef.	0.3	0.12	0.65	0.85	0.83
		t	2.1	0.6	3.4	6.6	5.5
		SER	0.017	0.045	0.037	0.03	0.03
	91-1	Coef.	0.58	0.67	0.5	0.79	0.93
		t	2.24	3.5	0.26	4.2	8.3
		SER	0.58	0.025	0.04	0.05	0.02
	91-2	Coef.	0.13	0.7	0.73	0.9	0.5
		t	0.53	3.6	3.4	9.7	1.8
		SER	0.05	0.04	0.06	0.03	0.02
	92	Coef.	0.8	0.88	0.88	0.76	0.79
		t	7.2	9.4	9.4	7.4	6.9
		SER	0.04	0.03	0.03	0.03	0.05

Table 1a (cont.)

GOOD	Period		STORES				
Peas	90-1	Coef.	0.67	0.62	0.63	0.54	0.37
		t	3.05	2.8	2.8	2.3	1.5
		SER	0.095	0.16	0.12	0.14	0.16
	90-2	Coef.	0.77	0.97	0.96	0.66	0.93
		t	5.5	13.1	9.9	3.3	9.4
		SER	0.05	0.039	0.054	0.08	0.05
	90-3	Coef.	-0.4	1.0	0.97	0.02	1.0
		t	-1.5	12.3	11.3	0.09	13.4
		SER	0.038	0.09	0.066	0.044	0.06
	91-1	Coef.	0.087	0.75	0.9	0.58	0.68
		t	0.34	4.18	9.44	1.98	2.87
		SER	0.29	0.33	0.37	0.29	0.29
	91-2	Coef.	0.76	0.7	1.02	0.5	0.76
		t	3.6	2.8	9.4	2.0	3.6
		SER	0.1	0.1	0.1	0.02	0.02
	92	Coef.	0.9	0.88	0.94	0.93	0.9
		t	8.7	10.2	14.6	11.7	8.7
		SER	0.06	0.05	0.04	0.045	0.057
Rice	90-1	Coef.	0.34	0.07	0.38	1E-05	0.01
		t	1.3	0.26	1.5	0.0003	0.04
		SER	0.15	0.13	0.079	0.07	0.09
	90-2	Coef.	0.9	0.99	0.82	0.98	1.0
		t	7.8	11.8	6.8	16.7	11.6
		SER	0.023	0.025	0.018	0.015	0.025
	90-3	Coef.	0.3	0.83	0.71	0.83	0.78
		t	1.2	5.6	3.8	5.9	4.9
		SER	0.58	0.077	0.09	0.05	0.087
	91-1	Coef.	0.6	0.54	0.71	0.53	0.87
		t	2.4	2.0	2.8	1.9	5.2
		SER	0.036	0.075	0.046	0.077	0.05
	91-2	Coef.	0.57	0.66	0.78	0.87	0.8
		t	2.2	2.6	3.7	5.7	5.0
		SER	0.02	0.02	0.03	0.046	0.036
	92	Coef.	0.64	0.9	0.91	0.65	0.93
		t	4.4	11.8	10.6	5.0	12.1
		SER	0.03	0.01	0.015	0.03	0.03
Tea	90-1	Coef.	0.26	0.37	-0.06	-0.007	0.12
		t	0.98	1.5	-0.23	-0.03	0.42
		SER	0.116	0.21	0.13	0.16	0.13
	90-2	Coef.	0.31	0.96	0.7	0.52	0.87
		t	0.92	6.7	3.1	1.6	6.2
		SER	0.35	0.053	0.08	0.11	0.06
	90-3	Coef.	0.69	0.94	0.69	0.8	0.68
		t	3.9	7.4	4.8	12.8	4.3
		SER	0.04	0.026	0.05	0.04	0.057
	91-1	Coef.	0.55	0.81	0.42	0.34	0.5
		t	2.5	4.2	1.4	1.1	1.8
		SER	0.03	0.05	0.1	0.07	0.07

Table 1A (cont.)

GOOD	Period		STORES				
	91-2	Coef.	0.97	0.83	0.98	1.0	0.96
		t	63.4	16.4	35.6	41.9	20.7
		SER	0.002	0.002	0.007	0.005	0.007
	92	Coef.	0.9	0.93	0.9	0.9	0.8
		t	11.9	13.9	10.7	13.7	6.9
		SER	0.017	0.018	0.04	0.02	0.05
Tomato	90-1	Coef.	-0.14	0.001	-0.33	-0.25	0.19
		t	-0./53	0.003	-1.3	-0.92	0.72
		SER	0.096	0.14	0.08	0.12	0.11
	90-2	Coef.	0.7	0.76	0.68	0.58	0.7
		t	2.8	4.1	1.86	2.8	3.8
		SER	0.063	0.06	0.06	0.055	0.056
	90-3	Coef.	0.79	0.89	0.67	0.74	0.94
		t	4.6	5.5	3.9	4.1	8.7
		SER	0.08	0.12	0.97	0.08	0.05
	91-1	Coef.	0.7	0.55	0.8	0.72	0.67
		t	4.7	2.6	6.6	3.3	3.1
		SER	0.04	0.09	0.08	0.06	0.08
	91-2	Coef.	0.18	0.56	0.9	0.87	0.65
		t	0.6	1.96	7.3	3.4	2.5
		SER	0.09	0.05	0.05	0.05	0.05
	92	Coef.	0.44	0.5	0.4	0.23	-0.01
		t	2.6	3.0	2.5	1.1	-0.06
		SER	0.06	0.07	0.05	0.055	0.39
Yerba	90-1	Coef.	0.57	0.33	0.39	0.8	0.51
		t	2.5	1.25	1.5	4.9	2.13
		SER	0.068	0.11	0.04	0.044	0.09
	90-2	Coef.	0.74	0.39	0.83	0.84	0.83
		t	4.26	1.4	3.7	5.3	5.4
		SER	0.03	0.05	0.04	0.039	0.035
	90-3	Coef.	0.63	0.82	078	0.87	0.84
		t	3.0	5.6	5.7	7.9	7.0
		SER	0.04	0.044	0.03	0.028	0.023
	91-1	Coef.	0.7	0.8	0.63	0.73	0.58
		t	2.8	5.0	2.6	2.9	2.2
		SER	0.04	0.05	0.07	0.06	0.06
	91-2	Coef.	0.9	0.9	0.91	0.94	0.64
		t	14.9	10.0	6.9	14.4	6.5
		SER	0.01	0.01	0.04	0.012	0.026
	92	Coef.	0.67	0.39	0.72	-0.2	0.45
		t	4.8	2.27	6.2	-1.15	2.7
		SER	0.18	0.18	0.24	0.19	0.23

TABLE A2: Correlation of Store Bundles

Period		STORES				
1990 15 weeks Feb.-May	RO. MSE	0.58 0.044	0.61 0.046	0.41 0.041	0.89 0.031	0.77 0.044
1990 15 weeks May-Aug.	RO MSE	0.49 0.027	0.86 0.022	0.96 0.021	0.97 0.015	0.91 0.016
1990 15 weeks Aug.-Dec.	RO MSE	0.05 0.023	0.97 0.029	0.93 0.024	0.94 0.017	1.01 0.014
1991 15 weeks Jan.-April	RO MSE	0.46 0.018	0.96 0.014	0.77 0.048	0.83 0.039	0.94 0.02
1991 12 weeks Sept.-Dec.	RO MSE	0.67 0.018	0.82 0.016	0.97 0.014	0.97 0.019	0.79 0.017
1992 30 weeks Apr.-Nov.	RO MSE	0.87 0.016	0.96 0.011	0.83 0.013		0.84 0.022

TABLE A3: Excess Variability of Relative Prices

BUTTER (CVij)

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.118	0.125	0.086	0.126	0.114	0.084
90II	0.060	0.079	0.093	0.070	0.072	0.070
90III	0.073	0.087	0.073	0.082	0.074	0.070
91I	0.069	0.062	0.083	0.074	0.065	0.058
91II	0.030	0.022	0.025	0.025	0.023	0.024
92	0.018	0.027	0.026	0.034	0.033	0.019

COFFEE

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.099	0.152	0.127	0.127	0.091	0.092
90II	0.049	0.027	0.041	0.081	0.068	0.022
90III	0.022	0.046	0.060	0.070	0.095	0.021
91I	0.063	0.060	0.039	0.046	0.074	0.050
91II	0.036	0.015	0.052	0.078	0.042	0.025
92	0.051	0.057	0.052	0.056	0.022	0.027

LAUNDRY DETERGENT

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.261	0.219	0.233	0.254	0.217	0.192
90II	0.081	0.083	0.082	0.122	0.068	0.076
90III	0.077	0.118	0.056	0.103	0.111	0.073
91I	0.063	0.048	0.044	0.019	0.073	0.027
91II	0.043	0.043	0.096	0.066	0.038	0.052
92	0.051	0.078	0.021	0.027	0.016	0.024

PEAS

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.114	0.224	0.163	0.104	0.160	0.078
90II	0.132	0.061	0.031	0.080	0.039	0.033
90III	0.041	0.038	0.063	0.061	0.088	0.039
91I	0.045	0.025	0.056	0.075	0.449	0.027
91II	0.019	0.043	0.027	0.124	0.076	0.036
92	0.073	0.059	0.024	0.054	0.034	0.027

TOMATO SAUCE

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.122	0.116	0.092	0.097	0.149	0.055
90II	0.054	0.080	0.043	0.099	0.111	0.057
90III	0.079	0.069	0.097	0.094	0.115	0.047
91I	0.100	0.066	0.098	0.065	0.079	0.059
91II	0.070	0.092	0.179	0.156	0.093	0.107
92	0.088	0.042	0.058	0.062	0.070	0.055

Table A3 (cont.)

FLOUR

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.142	0.249	0.195	0.214	0.138	0.171
90II	0.020	0.086	0.045	0.105	0.095	0.059
90III	0.066	0.055	0.056	0.046	0.074	0.027
91I	0.052	0.060	0.069	0.048	0.046	0.017
91II	0.013	0.009	0.011	0.008	0.008	0.009
92	0.026	0.20	0.074	0.024	0.021	0.023

OIL

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.199	0.202	0.203	0.155	0.182	0.176
90II	0.078	0.078	0.060	0.073	0.052	0.054
90III	0.067	0.060	0.106	0.092	0.097	0.079
91I	0.052	0.059	0.049	0.306	0.034	0.025
91II	0.012	0.030	0.027	0.008	0.011	0.010
92	0.020	0.069	0.085	0.082	0.085	0.050

RICE

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.115	0.169	0.163	0.192	0.124	0.226
90II	0.050	0.045	0.029	0.049	0.092	0.051
90III	0.099	0.121	0.129	0.125	0.135	0.100
91I	0.076	0.304	0.050	0.072	0.102	0.046
91II	0.098	0.069	0.051	0.086	0.123	0.031
92	0.100	0.097	0.034	0.098	0.115	0.077

TEA

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.115	0.252	0.259	0.155	0.216	0.147
90II	0.157	0.102	0.077	0.012	0.032	0.039
90III	0.084	0.052	0.045	0.023	0.033	0.018
91I	0.049	0.071	0.099	0.082	0.104	0.026
91II	0.033	0.043	0.063	0.126	0.058	0.048
92	0.023	0.034	0.034	0.059	0.079	0.037

YERBA

	Store 1	Store 2	Store 3	Store 4	Store 5	CVI
90I	0.029	0.085	0.042	0.067325	0.12805	0.04296
90II	0.041	0.046	0.056	0.044801	0.066252	0.02568
90III	0.022	0.020	0.029	0.043873	0.049335	0.01642
91I	0.076	0.058	0.050	0.308714	1.187889	0.04446
91II	0.062	0.008	0.021	0.447315	0.008059	0.01709
92	0.027	0.079	0.052	0.191918	0.936448	0.04387

TABLE A4: Duration of Real Prices

GOOD 1

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	2.166667	1.625	1.857143	1.833333	1.0
90B	1.66667	2.0	2.142857	1.888889	1.25
92	6.5	2.375	5.0	6.25	6.25

GOOD 2

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	2.714286	4.4	4.0	1.666667	1.777778
92	3.833333	3.285714	2.714286	2.5	5.25

GOOD 3

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	2.0	1.555556	1.5	1.3	1.625
92	6.25	6.25	6.5	3.0	4.0

GOOD 4

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	2.857143	4.166667	2.857143	2.5	2.5
92	5.0	3.5	3.142857	5.0	6.5

GOOD 5

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	1.333333	1.818182	1.5	1.272727	1.181818
92	4.6	3.666667	6.0	3.5	6.0

GOOD 6

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	3.5	5.0	1.6	2.0	2.125
92	3.0	2.857143	4.8	3.0	14.0

Table A4 (cont.)

GOOD 7

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.1	1.1	1.1	1.1	1.1
90B	3.285714	3.285714	2.714286	1.777778	2.375
92	3.75	9.0	6.25	3.833333	3.833333

GOOD 8

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	2.333333	2.222222	2.5	2.0	2.222222
92	4.4	3.5	3.2	2.857143	3.666667

GOOD 9

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	2.285714	2.5	1.4	1.1	2.0
92	3.285714	5.75	3.0	2.714286	5.0

GOOD 10

Period	Store 1	Store 2	Store 3	Store 4	Store 5
90A	1.0	1.0	1.0	1.0	1.0
90B	1.636364	3.666667	2.375	1.888889	2.0
92	9.0	3.142857	8.666667	3.666667	6.0

FIGURE 1
Weekly Inflation Rate

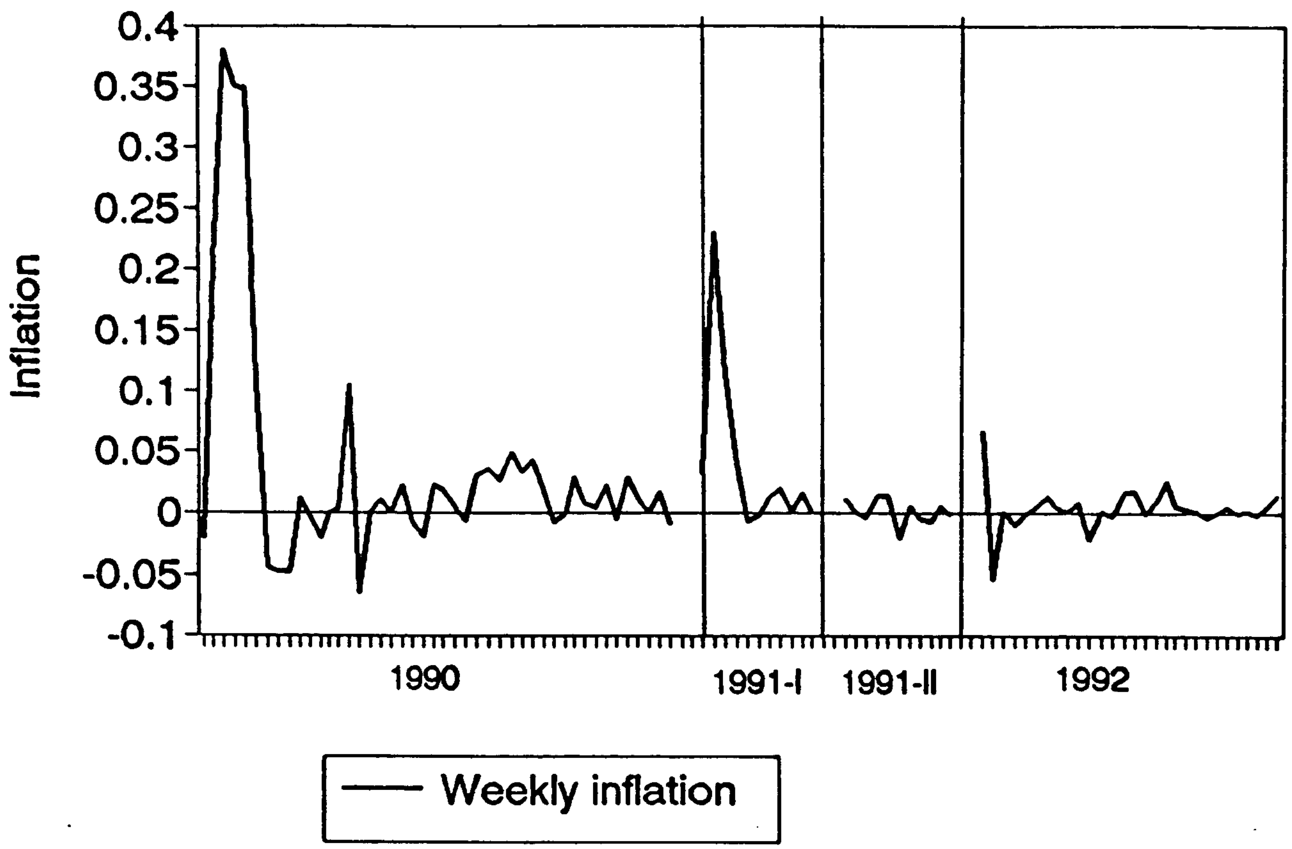
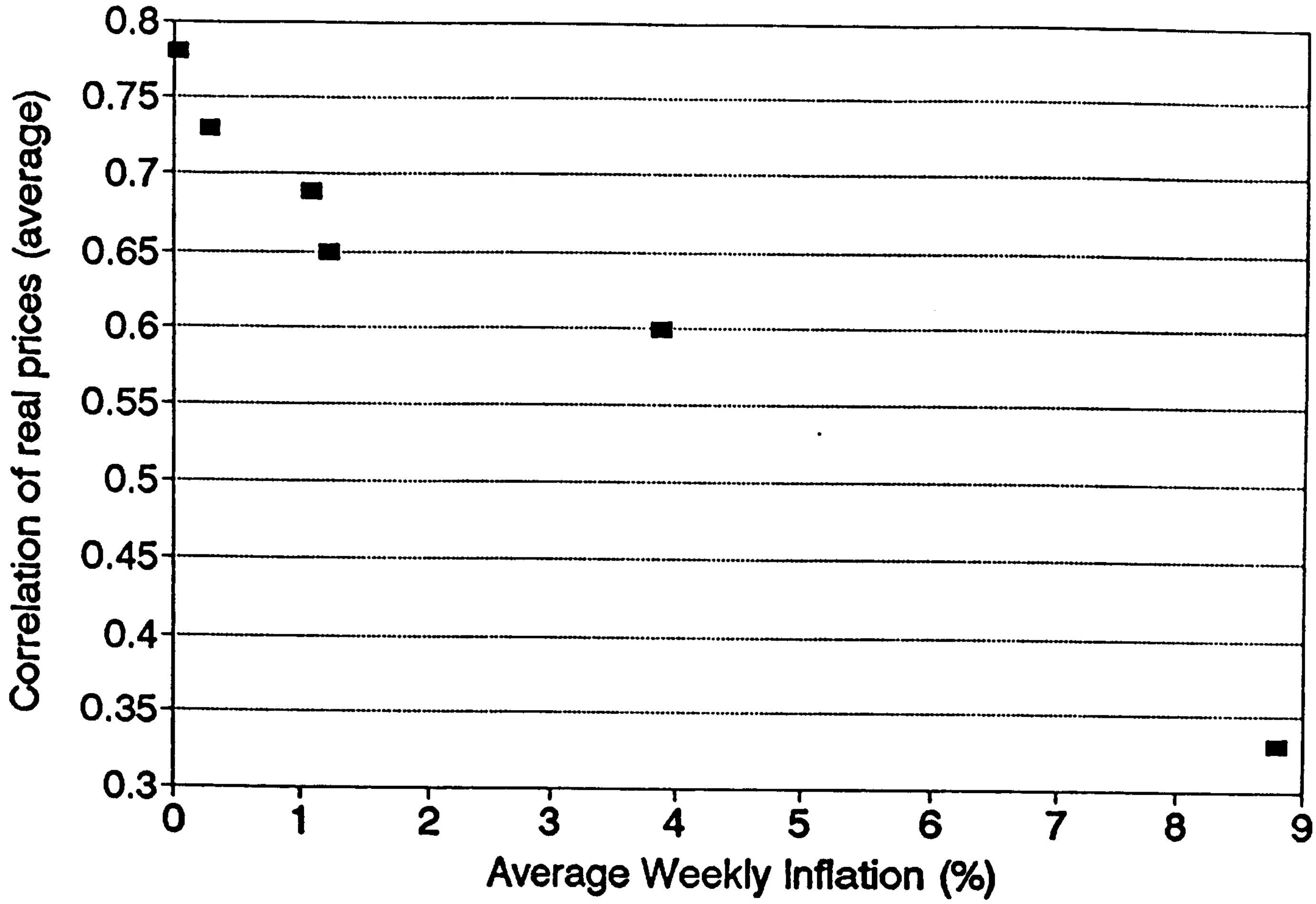
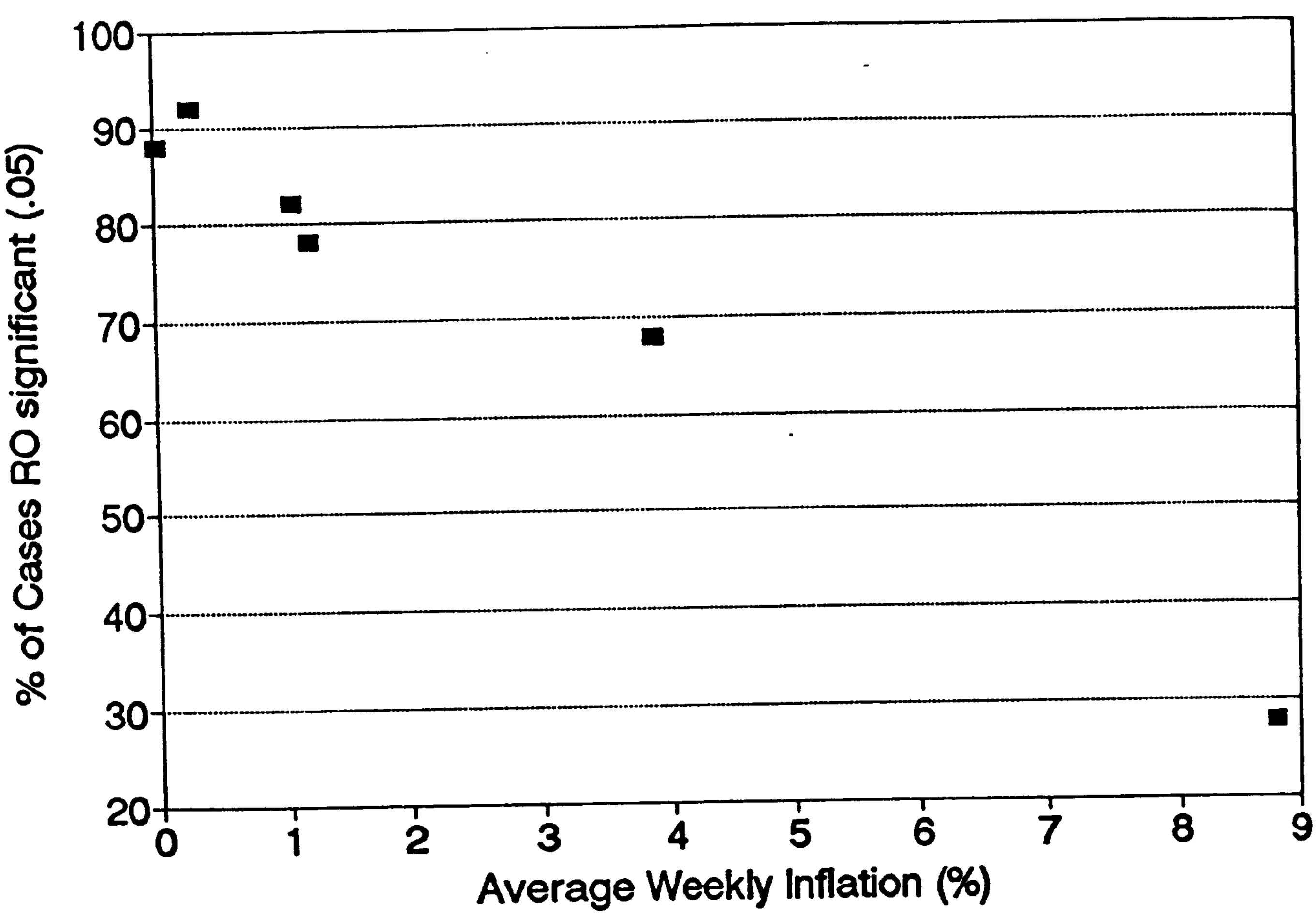


FIGURE 2



Correlation of real prices (average)
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0
1
2
3
4
5
6
7
8
9
Average Weekly Inflation (%)

FIGURE 3



100
90
80
70
60
50
40
30
20
0
1
2
3
4
5
6
7
8
9
% of Cases RO significant (.05)
Average Weekly Inflation (%)

FIGURE 4

Excess Price Variability

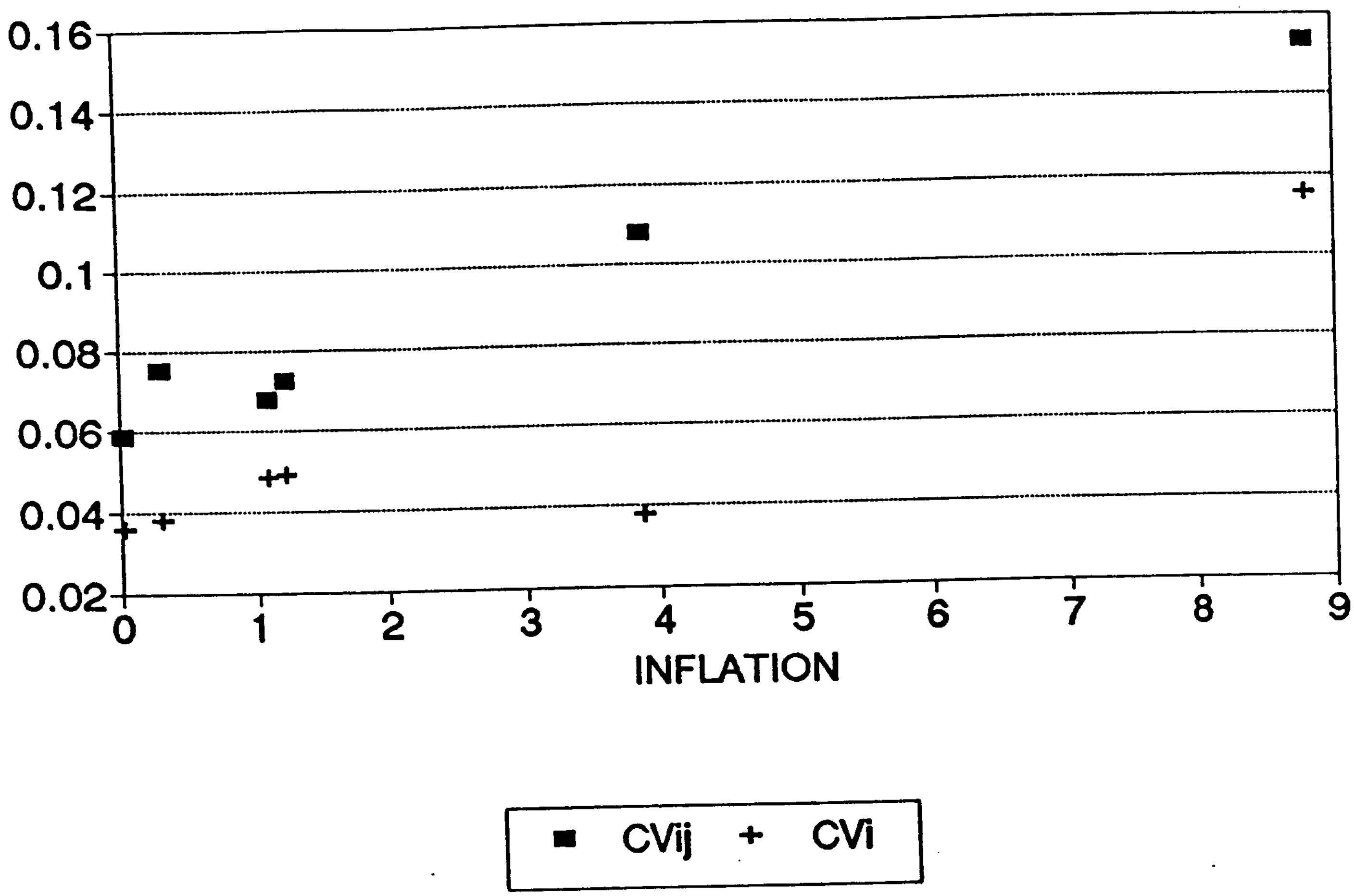


FIGURE 5

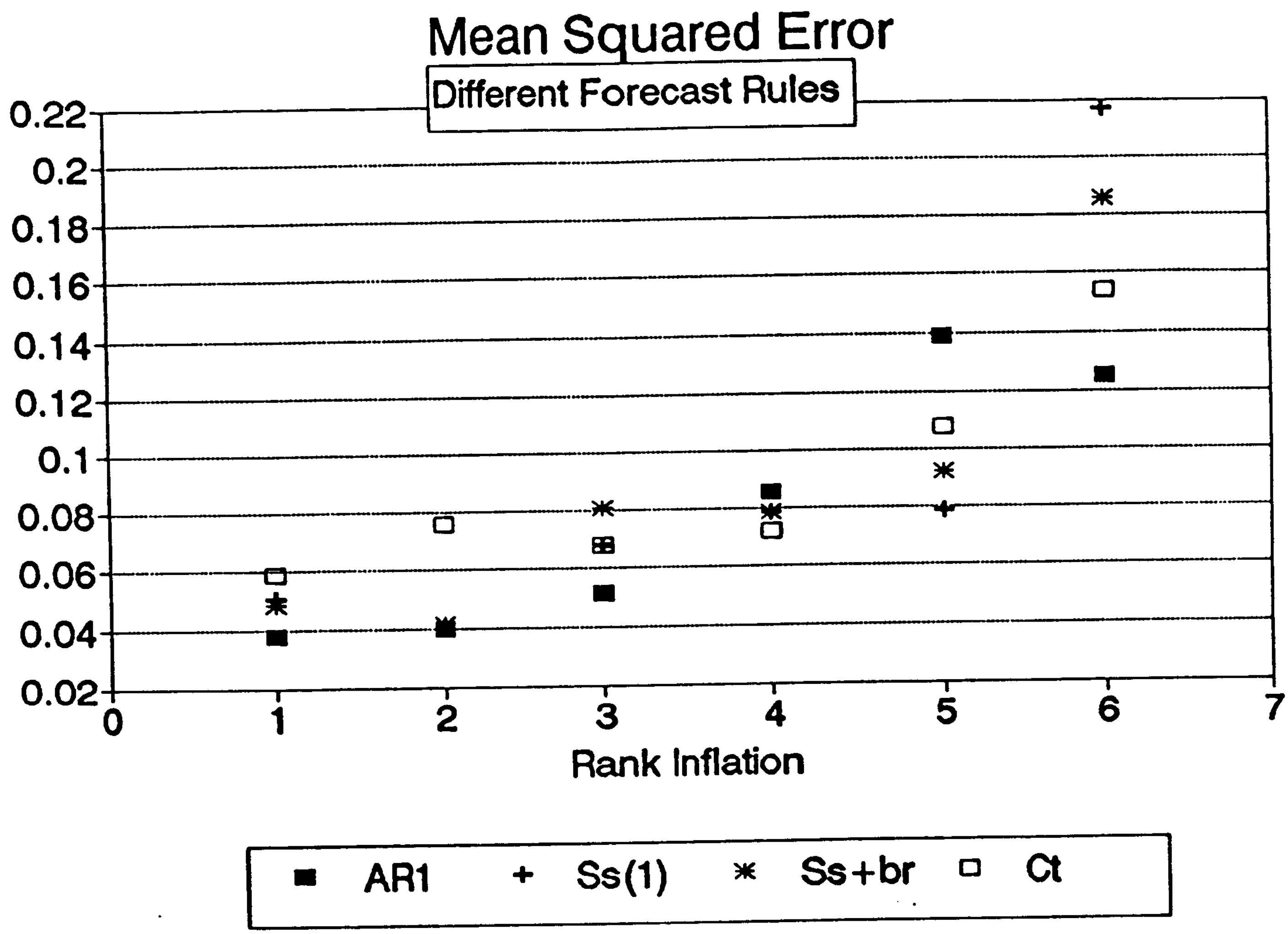

Mean Squared Error
Different Forecast Rules
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1
2
3
4
5
6
7
Rank Inflation
AR1
Ss(1)
Ss+br
Ct

FIGURE 6
MARK-DOWN SALES