INFLATION AND RELATIVE PRICES

EVIDENCE FROM ARGENTINA

by

Mariano Tommasi

Working Paper #661
Department of Economics
University of California, Los Angeles
May 1992

INFLATION AND RELATIVE PRICES

EVIDENCE FROM ARGENTINA*

Mariano Tommasi

Department of Economics

UCLA

*This paper is based on Chapter 2 of my Dissertation at the University of Chicago . I am indebted to Lester Telser and Yoram Weiss for valuable comments, and to Theresa Van Hoomissen, Angel Palerm and Jim Conklin for allowing my access to their unpublished research. Thanks are also due to Gary Becker, Sherwin Rosen, Ken Sokoloff and Mario Tommasi. The Bradley Foundation and the UCLA Academic Senate provided support. All errors are my own.

Abstract

The paper analyzes the effects of inflation at the microeconomic level, using weekly grocery prices from Argentina 1990, at the level of individual store. The paper is mainly directed to explore the informational consequences of high inflation, from the perspective of repeat buyers. The findings support the fact that higher inflations are associated with diminished informativeness of current prices about future ones.

The evidence is also helpful in evaluating theories that address the relationship between inflation and relative price dispersion and variability. The evidence suggests that price-setting technologies --and other transaction technologies such as the use of mark-downs-- are not invariant to the inflation regime.

INTRODUCTION

A look at the Handbook of Monetary Economics (1990) leaves one with the impression that inflation is a relatively minor problem. The prevailing wisdom that can be gleaned from any popular newspaper or magazine is quite different. Such a divergence of views can be explained by the different meanings given to the word "inflation" . Most technical writings implicitly define inflation in a narrower sense than the general public does. The definition, "a general increase in the price level," does not incorporate many characteristics of actual inflationary experiences, such as: inflation uncertainty, relative price variability, inflation-proof activities, government measures to curb inflation, and many other distortions that tend to be correlated with higher rates of growth of the price level.

This paper provides microeconomic evidence that furnishes a link between inflation as it is narrowly defined and some of the phenomena mentioned above. In particular, I try to describe a high-inflation environment from the perspective of a price-taking consumer. The main conclusion is that higher inflation is associated with a decreased durability of real-price information. In Tommasi (1991), I embed this finding in an equilibrium search model: a product market in which all the conditions for perfect competition are met, except for costless information. Search costs and agent heterogeneity induce price dispersion and local monopoly power for sellers. Inflation-related shocks, by lowering the durability of real prices, move the economy away form perfect competition by increasing monopoly power. This has the following welfare implications: 1) higher real prices paid by consumers, 2) lower productivity, and 3) survival of less efficient producers. All of these implications are consistent with popular (non-technical) notions of inflation.

These results contrast with the analysis in two related works: Benabou (1988) and Fischer (1986). Benabou, building on the work on adjustment costs by Sheshinski and Weiss (1977 and 1983) predicts a positive effect of inflation on consumer welfare in a search market. Sheshinski and Weiss introduced the notion of "menu cost"; that is, a cost of changing nominal prices. Such a cost makes the continuous adjustment of nominal prices (to maintain real ones constant) a suboptimal strategy. The optimal thing to do is to follow an (S,s) rule, allowing the real price to fall to s, before adjusting nominal price to reach the real level S. They show that the range (S-s) is increasing in inflation. Their welfare analysis concentrates on sellers (they just postulate a demand curve) and the conclusion is that firms are hurt by being away from their profit maximizing point due to inflation. Benabou (1988) closes their analysis by providing an explicit search-theoretic analysis of the consumer problem. The increase in price dispersion induces consumers to be more informed in equilibrium. This is a standard result in search theory: a spread is beneficial given the possibility of truncating the undesirable part of the distribution. The increased search intensity reduces prices on average (a fall in the price of this commodity relative to labor, the numeraire) and increases consumer welfare.

Consumers in Benabou's world are short lived; they are in the market just once. It is for that reason that one important effect of inflation is missing. Inflation affects relative price variability (rates of change of prices over time are more dispersed across markets and across sellers within a market) as I show in this paper. Benabou (1988) concentrates in the contemporaneous cross-sectional effect of inflation, while my theoretical paper concentrates on the intertemporal behavior of prices. The evidence in this paper and in the empirical literature reviewed below tends to support the

notion that the main dimension affected by inflation is the intertemporal one.

Even after recognizing the association between inflation and relative price variability, the welfare implications are not clear in the previous literature. It is a folk theorem among some economists that inflation-induced "excess" price variability generates inefficiencies in resource allocation. Fischer (1986, Chapters 1, 2, and 3) casts doubts on that claim. He shows that price variability can be welfare improving. He exploits the quasiconvexity of the indirect utility function in the price vector: substitution towards goods whose prices are relatively low increases welfare. The analysis is carried out on the assumption of perfect information. As soon as we recognize that information is not a free good, it can be proved (Tommasi 1991) that the net effect of price variability can be welfare decreasing in the case of variability across different goods, and that it is indeed welfare decreasing in the case of variability across sellers of the same good.[1] In this way, the folk theorem is formalized.

Although this paper is mainly directed to show the informational consequences of high inflation, the evidence here is also helpful in evaluating theories that try to explain the inflation-price variability relationship. The reason for not framing the study as a test of those theories is that none of the popular theories ("information" and "adjustment costs") does have an unequivocal prediction for the inflation-variability (Danziger 1987) or inflation-dispersion[2] (Tommasi 1991) relationships. My own

---

[1]In our sample (weekly data from Argentina in 1990) intramarket variability represents 90% of overall variability,

[2]Throughout this study the term "relative price variability" (RPV) refers to the tendency of relative prices to change over time, which is usually proxied by the cross-sectional standard deviation of **rates of change** of prices around an average inflation rate. This will be distinguished both

reading of the evidence below, is that price-change technologies (and other transaction technologies) are really endogenous. In a high inflation country like Argentina, (inferior) technologies that save on "menu costs" are adopted. This endogeneity can be seen as reinforcing the explanation in Ball, Mankiw and Romer (1988) for the steeper Phillips curve in these countries.[3]

The remainder of the paper is organized in eight sections. Section 1 reviews the related empirical literature. Section 2 describes the data to be used. The empirical results for relative price variability and for intramarket price dispersion are presented in Sections 3 and 4. Section 5 shows that the degree of intertemporal correlation of real prices is diminishing in inflation. Section 6 presents some preliminary evidence on another effect of high inflation: the absence of advertised mark-downs. Section 7 looks at the behavior of price changes, in particular the degree of synchronization in the timing of price changes across firms and across goods for a given firm. Section 8 concludes.

---

theoretically and empirically from "dispersion ", a cross-sectional dispersion of prices around an average price at a point in time. This latter measure is only a meaningful concept at the intraproduct level. As explained in the next section, there has been some confusion of the two concepts in both the empirical and the theoretical literature.

[3]They exploit the endogenous timing of price changes in a staggered equilibrium, for a <u>given</u> cost of changing nominal prices.

1. Previous Empirical Studies

There is a huge literature, going back to Glejser (1965) and Parks (1978) that looks into the relation between inflation and the variability of relative prices across different goods. For an excellent recent survey see Palerm (1991). The main conclusion from those studies is that both expected and unexpected inflation are positively correlated to relative price variability, as measured by the standard deviation of the rates of change of individual prices around the average inflation rate.

More recently, inspired by Fischer (1981), there have been a move towards more disaggregated evidence. Domberger (1987) analyses RPV <u>within</u> markets, defining markets as activity headings in the UK's SIC. His intra good analysis refer to different goods within one activity heading. There, once again, inflation and RPV appear positively correlated. The first study that takes prices of the same good across different stores is Van Hoomissen (1988). Using monthly data from Israel, for the period 1971-1984, she also finds that RPV, this time at the intra good level, is increasing in inflation . This paper reproduces those findings, inter and intra good, with weekly data from Argentina 1990. There are two problems with the theoretical argument in the Van Hoomissen paper, to be discussed in more detail later. She posits a search theoretic model in which inflation, by lowering consumers' information will imply higher price dispersion in equilibrium. The problem of that argument is that is based on another sort of folk result, which is not really general. It is shown in MacMinn (1980), Carlson and McAfee (1983) and Tommasi (1991) that there is no unambiguous implication from diminished consumer information to cross-sectional price dispersion. another paper which follows this unwarranted conclusion is Reinsdorf (1991). There, the reasoning is that

surprise inflation increases real reservation prices, inducing consumers to accept worst offers, "hence" supporting smaller price dispersions. The other problem of the Van Hoomissen paper is that the theoretical prediction is framed in terms of the cross-sectional dispersion of prices at one point in time, but tested against RPV. A more adequate measure of price dispersion is used in her (1988b) paper, in Reinsdorf (1991) and in Conklin (1989), and in this paper. The findings in this area are inconclusive, but most of the studies (including this one) tend to suggest a positive, but weak relationship.

This paper looks directly into the informational assumptions present in Van Hoomissen (1988a) and Tommasi (1991). The findings here support their claim that higher inflations are associated with diminished informativeness of current prices about future ones.

2. Data Description and Variance Decomposition

The data set used for this study contains observations on the prices of 15 products in 5 supermarkets within the same neighborhood in the Federal District of Buenos Aires, collected by the Secretaria de Comercio. The frequency of observation is weekly (46 weeks from February to December 1990), a dimension not studied before, which is particularly useful for the analysis from the perspective of repeat buyers. The products are homogeneous groceries, each of them is a particular brand/quality, for instance "coffee" is a particular brand and size of instant coffee. Also an independent measure of weekly inflation is used in order to verify that the results obtained using

the within sample measure are not induced by the small sample size. That measure is constructed from data provided by IPES, another institution that constructed its own price index in 1990, a high inflation year in Argentina, when there was demand for estimates of the inflation rate at frequencies higher than monthly. The correlation between this measure of inflation and the one calculated from the sample was 0.89. Figure 1 shows the latter (DP).

Let P_{ijt} be the price of good i at store j in time period t. There are I goods and n_i is the number of stores selling good i. Let P_i be the average price of good i across the n_i stores carrying it.

$$P_{it} = \frac{1}{n_i} \sum_{j=1}^{n_i} P_{ijt} \tag{1}$$

Let P_t be the price index. I have looked at both weighted and unweighted measures, without significant changes in the findings, and only the latter is reported here,

$$P_t = \frac{1}{\sum_{i=1}^{I} n_i} \sum_{i=}^{I} \sum_{j=1}^{n_i} P_{ijt} \tag{2}$$

It is clear from equation (2) that there are two dimensions of aggregation when constructing a price index: first across sellers of any given product and then across products. We will analyze the behavior of panel data at the disaggregated level of store, in particular its evolution over time across different inflationary regimes. To do that, it is helpful to decompose the variance of individual observations around the average, as follows:[4]

---

4 $$\Sigma_i\Sigma_j(P_{ij}-P)^2 = \Sigma_i\Sigma_j[(P_{ij}-P_i)+(P_i-P)]^2$$
$$= \Sigma_i\Sigma_j(P_{ij}-P_i)^2+\Sigma_i\Sigma_j(P_i-P)^2+2\Sigma_i\Sigma_j(P_{ij}-P_i)(P_i-P)$$

But

$$\sum_i \sum_j (P_{ijt}-P_t)^2 = \underbrace{\sum_i \sum_j (P_{ijt}-P_{it})^2}_{\text{WITHIN}} + \underbrace{\sum_i n_i \ (P_{it}-P_t)^2}_{\text{BETWEEN}} \qquad (3)$$

This decomposition is analogous to the one in Domberger (1987). In that paper i referred to a product within an activity heading j, rather than to a store selling a product j. The first term on the right of (3) is the variance <u>within</u> good: deviation of individual sellers' prices with respect to product average. The second term captures the variance <u>between</u> goods: the deviation of individual products around the overall mean P_t. Equation (3) refers to the cross-sectional variance of prices at one point in time. The same decomposition is valid for the variance of rates of change over time; we only need to replace the P's by its growth rates[5]. This latter dimension is the one to be studied first.

$$\Sigma_i \Sigma_j (P_{ij}-P_i)(P_i-P) = \Sigma_i (P_i-P) \Sigma_j (P_{ij}-P_i)$$

Notice that, from (1):

$$\Sigma_j (P_{ij}-P_i) = 0 \qquad \text{for all } i$$

So that

$$\Sigma_i \Sigma_j (P_{ij}-P)^2 = \Sigma_i \Sigma_j (P_{ij}-P_i)^2 + \Sigma_i n_i (P_i-P)^2$$

[5]The share of intragood (within) variability on the overall variability of DP_{ijt} is around 90% for our sample and seems to be increasing in the aggregate inflation rate, consistently with the findings in Lach and Tsiddon (1990).

3. Relative Price Variability

This section looks at the variability of relative prices, both across goods and across sellers for any given good. Both dimensions are found to be positively related to inflation.

Let DP_{it} be the rate of growth of price i at time t:

$$DP_{it} = \ln(P_{it}) - \ln(P_{it-1}) \tag{4}$$

and DP_t the average (within sample) inflation rate across products:

$$DP_t = \frac{1}{I} \sum_i DP_{it} \tag{5}$$

I use σ_t, the standard deviation of product specific inflation rates around the mean, as a measure of interproduct price variability.

$$\sigma_t = \left[\frac{1}{I} \sum_i (DP_{it}-DP_t)^2 \right]^{1/2} \tag{6}$$

Figure 1 shows the behavior of DP_t and σ_t for the sample period. Inflation averaged 4% per week in the 46 weeks of the sample, which includes episodes of deflation. We interpret this surprising behavior as part of the high inflation world. This is an environment of price uncertainty, where some overshooting occurs: Sellers overestimate the increase in nominal demand, and in the face of very low sales, have to adjust downward. For that reason, I explored specifications using the absolute value of inflation, to check whether price decreases also imply relative price variability. This is confirmed by the data.[6] The best fitting relationship is given by

[6]For the intra-good counterpart, see the V- shaped plots in Figure 2.

$$\text{VARIABILITY} = 0.024 + 1.65\,|\text{INFLA}| - 3.84\,\text{INFLA}^2 \qquad R^2=.51$$

$$(0.28) \qquad (0.80)$$

where the numbers in parentheses are standard errors.

This confirms previous findings: inflation and RPV appear positively correlated . There are two additional features that will reappear at the more disaggregated level: 1) episodes of deflation are also associated with high relative price variability, and 2) plotting variability against inflation we obtain a concave picture . The latter, also present in other studies (Van Hoomissen 1988, Palerm 1990) suggests the presence of some unifying forces in pricing at very high inflation. I elaborate on this in the concluding section.

We turn now our attention to the more disaggregated analysis, of variability "within", i.e., across individual stores carrying the same good. It is well known[7] that price differences above and beyond those justified by differential "service" do exist across sellers of homogeneous goods. The question we try to address is whether the pattern of intertemporal variability observed across goods as a function of inflation, is also present at the intramarket level.

For each product i, P_{ijt} is the price in store j, DP_{ijt} is its rate of change, DP_{it} the average rate of change across stores, and σ_{it} the standard deviation of store specific rate of price change around the product average.

$$DP_{ijt} = \ln(P_{ijt}) - \ln(P_{ijt-1}) \tag{7}$$

$$DP_{it} = \frac{1}{n_i} \sum_j DP_{ijt} \tag{8}$$

[7]See Stigler (1961), Marvel (1976), Pratt et al (1979), Mathewson (1983), Dahlby and West (1986), Van Hoomissen (1988b), and Abbott (1989).

$$\sigma_{it} = \left[\frac{1}{n_i} \sum_j (DP_{ijt} - DP_{it})^2 \right]^{1/2} \qquad (9)$$

Summary statistics are given in Table 1.

It is likely that the error terms across equations are not independent (mainly because we have the same stores across goods). This suggests the use of Seemingly Unrelated Regression Estimators. Such procedure requires the same number of observations across equations. Since only 25 weeks of prices of tuna were available, this product was independently analyzed by OLS. The system containing the other 14 equations was estimated applying SUR. This had the expected effect of reducing the standard deviation of the estimates, increasing the significance of the coefficients.

As expected, the best results were obtained using the absolute value of inflation. The quadratic specification gives the best fit, with a negative coefficient on inflation squared.

The results are reported in the first columns of Table 2 and some representative plots are presented in Figure 2. As stated before, inflation has the effect of making <u>intramarket</u> relative prices more volatile;deflation episodes produce similar effects. Furthermore, there is some evidence of "concavity"[8] at very high inflation. Since a positive correlation between σ and DP as defined in (8) and (9) may result to some extent from having only 5 stores, I used the independent measure of inflation to check the validity ofthe results. Being the same regressor across equations, it prevents from using SUR. The OLS estimates are in the last columns of Table 2. All of the coefficients except one are significant at the 1% level, what suggests that the relationship is not a spurious one.

---

[9]At the highest inflation weeks, variability was not as high as a linear relation would predict. As explained in the Concluding Comments, this may be just a statistical artifact given the endogenous frequency of price changes.

[9]In our sample (weekly data from Argentina in 1990) intramarket variability represents 90% of overall variability,

4. Cross-Sectional Dispersion of Prices

I look here into the association of inflation with the contemporaneous discrepancies between the prices offered by different sellers of the same good. I do not attempt to use these results as test of a particular theory since, as explained, the two popular theories don't have unequivocal predictions in this matter. A positive relation <u>might</u> be predicted from a menu-cost model. The presence of a cost of adjusting nominal prices induces firms to maintain the nominal price unchanged (while real price declines) for a certain period. At higher inflation levels, the flotation band of real price widens. In a monopolistically competitive market <u>if the timing of firms' price adjustment is independent</u>,[10] we should observe cross-sectional variance of real prices increasing in inflation. Another link between inflation and price dispersion is forwarded by Van Hoomissen (1988). Inflation causes information to depreciate more rapidly, inducing agents to hold smaller information stocks. From there, it is inferred that a wider dispersion will obtain. Along similar lines, Reinsdorf (1991), predicts that <u>surprise</u> inflation will reduce reservation prices and "hence" dispersion (the opposite conclusion). Their implications hinge on a "missing link" that relates diminished information with price dispersion. That intuition seems to have originated from Stigler's 1961 seminal paper. That was a partial analysis of the buyers' side. Equilibrium search theory implies that real prices will be decreasing in the degree of consumer information, but that effect is not necessary larger at the upper end of the distribution, hence

---

[10]This relates to whether staggering or synchronization is the equilibrium outcome. See Ball and Romer (1989) and references there.

there is no general conclusion with regard to cross-sectional dispersion.[11] With that caveat in mind, we proceed to the estimation.

The procedure here is very similar to the one in the previous section. The measure of price dispersion used is the coefficient of variation (CV_{it}) of prices p_{ijt}. Since in the Argentine case the price level "explodes" over certain periods, variances of goods' prices (across j) explode as well. Such movement does not capture real price dispersion, but is an artifact of units of nominal prices. The coefficient of variation is the standard deviation as a percentage of the mean price of a good and does not have this problem:

$$CV_{it} = \frac{n_i^{1/2}}{\sum_j P_{ijt}} \left[\sum_j (P_{ijt}-P_{it})^2\right]^{1/2} \qquad (10)$$

where $P_{it} = 1/n_i \sum_j P_{ijt}$.

The Zellner estimator is used for the same reason given in the section on RPV. The best fitting equations are again those with the absolute value of inflation, and are reported in the left half of Table 3.[12] Representative plots are presented in Figure 3. Inflation does seem to have the effect of increasing price dispersion, and the squared term has a negative coefficient in the multiple regression. In this case, though, levels of significance are quite low. This is in line with the findings of Van Hoomissen (1988b) for Israel and Conklin (1989) for Argentina. Reinsdorf (1991) for the Volcker disinflation of 1980-82 finds an inverse relation.

---

[11] See MacMinn (1980), Carlson and McAfee (1983) and, for an specific application to inflation, Tommasi (1991).

[12] Once again, the rest of the table provides a check using the independent series for inflation.

5. Correlation of Real Prices over Time

The issue studied in this section is the effect of inflation on the correlation of real prices (product and store specific) over time. This is particularly important for the literature on repeat purchase. We try to test the assertion that the informativeness of current prices about future prices is diminished by inflation. Previous exploratory work on a small comparative sample between USA and Argentina showed such a correlation being significantly higher for the US. Here, I look at the "time series" from Argentina. I divide the 45 weeks of the 1990 sample into three 15-weeks periods : the first one of high inflation, and the other two of (by Argentine standards) low inflation. Weekly inflation averaged 8.8% during the first period, 0.8% in the second, and 1.2% at the end of the year.[13] If, consistently with the previous analysis, we want to consider deflation as part of the inflationary phenomenon, the <u>absolute</u> value of inflation averaged 11.3%, 2.1% and 1.5% respectively.

Let P_{ijt} be the price of good i in store j, P_{it} be the product average and z_{ijt} be a measure of the real price (actually of the deviation from mean in real terms, a way of characterizing into high and low- priced stores):[14]

$$z_{ijt} = \frac{P_{ijt} - P_{it}}{P_{it}} \quad . \tag{11}$$

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

---

[13]The averages were 9.3%, 0.7% and 1.1% using the alternative inflation series.

[14]Other, more aggregate, normalizations were explored without substantial changes in the findings.

$$z_{ijt} = \rho\, z_{ijt-1} + \varepsilon_{jt} \qquad (12)$$

Table 4 provides the values of ρ and t-statistics for each product-store pair in periods 1 (high inflation) and 3 (low inflation). Period 2 looks very similar to period 3 and is omitted (except for tuna) to make the table more readable. The last column gives an average of ρ per product across stores. These averages show that the correlation coefficients are higher for the low inflation period in all of the cases. The value of ρ is of the order of 30% at high inflation and of 65-70% at high inflation. The hypothesis that "inflation affects the stability of real prices and hence depreciates consumer information" is borne out by the data. Table 5 summarizes this information.

TABLE 5

ARGENTINA 1990

	January-May	May-August	August-December
Average weekly inflation(%)	8.82	0.80	1.17
Average ρ	.30	.63	.67
% of cases where ρ is signif at .05	28	82	78

6. The Absence of Sales

Economists from high-inflation countries (like Argentina or Israel), when exposed to more stable economies (like the US), are shocked to observe the amount of information consumers have about prices. The almost non-existence

of catalogs, price advertising and "mark-down sales" in high inflation situations is a manifestation of this phenomenon. It is also an indication that "menu costs" are really endogenous. In inflationary environments, technologies that minimize such costs are adopted.

The absence of sales at high inflation can be rationalized in two (complementary) ways. In relation to the model in Tommasi (1991), consumers have very little information about prices, hence it is harder to convey the message that you are offering a real bargain. Additionally, it is very costly to compromise the maintenance of a nominal price for a long enough period to make a "sale" feasible.

It is true that, even in Argentina, stores can build a reputation for low prices. It is also clear that such a process is more difficult than in a stable environment. The information conveyed by the claim "We charge low prices" is less convincing than the one of "We will charge x dollars for the next 2 weeks".

The sample that I am using states when the reported quotation is claimed to be "on sale". As a check, I verified that in all of the cases the reported prices represented the minimum prices in their cross-section at the respective points in time, and also nominal price decreases from their previous level.

Figure 4 shows the number of sales, together with aggregate inflation for the period. As expected, there are no sales during the high inflation episode and they reappear after "stabilization".

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

7. Price Changes

Most of this paper concentrates on the microeconomic description of a high-inflation environment from the perspective of a buyer, as an input to the search- theoretic literature. Only passing attention was given to the seller price-setting decision, the main focus of the cost of adjustment literature. This section focuses on the size, frequency and correlation of price changes. This preliminary work tries to provide some evidence on the nature of pricing at high inflation, in order to illuminate the relationship between inflation in the macroeconomy and microbehavior.

For this section, I use a subsample of the 7 goods for which there was not a single missing observation over the 46 week period. The information for these 35 observations (5 stores) is summarized in Table 6. This table shows how many of these prices increased, stayed unchanged, and decreased, together with the aggregate inflation rate in each week. The last two columns show the average and the standard deviation of the distribution of price changes ($\ln P_t - \ln P_{t-1}$), for the case of price increases.

The number of nominal price reductions is substantial and these reductions are quite synchronized, at least during the first part of the year. As explained before, this relates to the high macroeconomic uncertainty of the period. The occurrence of these price decreases seems to indicate that "menu costs" strictly interpreted, were relatively unimportant when compared with potential losses due to an inadequate relative price. This is not surprising if we think that these costs are endogenous to the level and variability of inflation. In such interpretation, Argentina should have one

of the most "efficient" price change technologies.

The price increase column provides information that could be used to evaluate the literature on endogenous staggering This is an important question for the effects of monetary shocks.(see Chapter 8 in Blanchard and Fischer 1989, Ball and Romer 1989 and references there). One measure of the degree of synchronization (Lach and Tsiddon 1990) is given by the standard deviation of the proportion of stores changing price each period. At full synchronization it will be at its maximum (close to 0.5) and in full staggering should be zero. The estimated value is 0.23. Taking into account that the high aggregate instability of the period induces a bias towards synchronization, this number can be interpreted as suggestive of some staggering. Whether this is the outcome of Ss rules, of other adjustment cost or just related to the arrival of information, we cannot answer at this point. The highly irregular intertemporal pattern of inflation makes the sample not very adequate to analyze the extant cost of adjustment models, which are formulated either for the constant inflation case (Sheshinski and Weiss 1977, Benabou 1988) or for very specific stochastic formulations (Sheshinski and Weiss 1983, Caplin and Sheshinski 1987). Lach and Tsiddon have a more stable inflation sample, so that they can better frame their analysis in terms of those theories. Further theoretical and empirical work is necessary to study an unstable experience like the Argentine one.

Another interesting cut into the data is given in Table 7. Since all the products were sold in the same stores (supermarkets), we can look into the correlation of price changes across goods sold in any store. Table 7 provides the weekly inflation rate together with the number of products whose price was increased and those whose price was decreased (out of 7 goods in the sample), for each of the 5 stores. This is a helpful exercise in trying to better

understand which is the nature of the "adjustment costs" that prevent a continuous adjustment of every price. Following Shehinski and Weiss (1990), we can think of two extremes: "menu costs", where there are important economies of scale across products (you just print a new catalogue or menu, so that the marginal cost of changing one more price is almost zero), or "decision costs", were the price change technology is linear in the number of goods. Menu costs will tend to induce bunching (synchronization) in pricing, while the CRS technology will tend to generate staggering. The analysis of Table 7 shows evidence of staggering,[15] favoring the "decision cost" interpretation. The appearance of bunching in the first part of the sample is again a consequence of the high aggregate variability.

7. Conclusion

This paper provides evidence in support of the view that inflation diminishes the durability of price information. This is concluded from an analysis of the time series properties of real prices at the store level. At higher inflation, forecast power diminishes substantially. Also, inflation is found to be positively correlated with inter and intra-product price variability and (weakly) with intra-product price dispersion.

Interestingly, we find that the squared inflation term is negative in the regressions of dispersion and, mainly, variability. This could be an statistical artifact given the frequency of observation. At high inflation levels the observation period becomes "too long" when compared with the

[15]The methodology consisted of looking at the correlation of each column, as in Lach and Tsiddon (1990).

frequency of changes, hence hiding intraperiod price variability. Variability (at high inflation) tended to decreased as I tried using less frequent observations.[16] Yet, the fact that we have few observations in the decreasing portion of the variability-inflation curve makes the evidence insufficient to draw a clear-cut conclusion.

This leaves open the possibility of a "genuine" tendency towards unification of prices at highest inflation levels. In Tommasi (1991) I provide reasons for how inflation in the macroeconomy might be reflected as idiosyncratic shocks to the firms in a micro-market. There, the inflation-induced cost shock is the only information taken into account for pricing (aside from demand conditions). In a situation of very high inflation, the pace of price changes is faster than the availability of aggregate information, so that signal extraction problems of the Lucas type become more relevant. The intuition is that in those cases, the weights in the pricing decision will be shifted from the past idiosyncratic cost shocks to the expectations about future inflation (to avoid capital losses), and thus some predictor of inflation will be used. In an economy like Argentina, natural candidates are the evolution of the exchange rate, announcements about macroeconomic policies, and new information about the relative strength of different pressure groups. Since these signals are commonly observed, and since forward looking behavior is relatively more important in high inflation situations, firms' pricing decisions tend to be more similar.

Future work will try to formalize this idea in an empirically oriented way, in order to better understand the behavior of real price distributions in cases of high and unstable inflation as the recent Argentine experience. In

---

[16] A similar finding is reported in Palerm (1990).

particular, further modeling is necessary to address the ways in which inflation affects price dispersion and the dynamic interaction between aggregate instability and microbehavior.

There are other directions in which this empirical effort should be pursued. An important one is the effect of macroeconomic instability on market structure and performance. A first step is taken in Benabou (1991), where the behavior of markups is analyzed with time series for the US. Cross sectional evidence will useful to uncover the long run microeconomic effects of macroeconomic instability.

REFERENCES

Abbott, Thomas (1989). "Price Dispersion in US Manufacturing." Bureau of the Census, Center for Economic Studies Discussion Paper. October.

Ball, Laurence, and David Romer (1987). "The Equilibrium and Optimal Timing of Price Changes." Review of Economic Studies 56:179-198.

Ball, Laurence, G. Mankiw and D. Romer (1988). "The New Keynesian Economics and the Output-Inflation Trade-off." Brookings Papers of Economic Activity 1: 1-65.

Benabou, Roland (1988). "Search, Price Setting and Inflation." Review of Economic Studies 55: 353-376.

Benabou, Roland (1991). "Inflation and Markups: Theories and Evidence from the Retail Trade Sector." MIT Working paper 587. August.

Blanchard, Olivier, and Stanley Fischer (1989). Lectures on Macroeconomics. Cambridge: MIT Press.

Caplin, Andrew and E. Sheshinski (1987). "The Optimality of (S,s) Pricing Policies." The Hebrew University Working Paper 166.

Carlson, John, and R. McAfee (1983). "Discrete Equilibrium Price Dispersion." Journal of Political Economy 91: 480-493.

Conklin, James (1989). "High Inflation, Information and Price Dispersion: Recent Evidence from Argentina. Mimeo. Stanford.

Dahlby, Bev, and Douglas West (1986). "Price Dispersion in an Automobile Insurance Market." Journal of Political Economy 94: 418-438.

Danziger, Leif (1987). "Inflation, Fixed Cost of Price Adjustment, and Measurement of Relative Price Variability". American Economic Review 77: 704-713.

Glejser, H. (1965). "Inflation, Productivity and Relative Prices: A Statistical Study." Review of Economics and Statistics 47: 761-780.

Handbook of Monetary Economics (1990). B. Friedman and F. Hahn, (eds.). Amsterdam: North-Holland.

Domberger, Simon (1987). "Relative Price Variability and Inflation: A Disaggregated Analysis." Journal of Political Economy 95: 547-566.

Fischer, Stanley (1981). "Relative Shocks, Relative Price Variability, and Inflation." Brookings Papers Econ. Activity 2: 381-431.

Fischer, Stanley (1986). Indexing, Inflation, and Economic Policy. Cambridge: MIT Press.

Lach, Saul, and Daniel Tsiddon (1990). "The Behavior of Prices and Inflation: An Empirical Analysis of Dissagregated Price Data." Dept. of Economics Working Paper No 224, Hebrew University.

Mac Minn, Richard (1980). "Search and Market Equilibrium." Journal of Political Economy 88: 308-327.

Marvel, Howard (1976). "The Economics of Information and Retail Gasoline Price Behavior: An Empirical Analysis." Journal of Political Economy 84: 1033-1059.

Mathewson, Frank (1983). "Information, Search and Price Variability of Individual Life Insurance Contracts." Journal of Industrial Economics 32: 131-148.

Palerm, Angel (1990). "Price Formation and Relative Price Variability in an Inflationary Environment: Mexico, 1940-1984." Ph.D. Dissertation, University of California Los Angeles.

Parks, Richard (1978). "Inflation and Relative Price Variability." Journal of Political Economy 86: 79-95.

Pratt, John, David Wise and Richard Zeckhauser (1979). "Price Differences in Almost Competitive Markets." Quarterly Journal of Economics 93: 189-211.

Reinsdorf, Marshall (1991). "New Evidence on the Relation Between Inflation and Price Dispersion." Mimeo. Bureau of Labor Statistics. February.

Sheshinski, Eytan, and Yoram Weiss (1977). "Inflation and Costs of Price Adjustment." Review of Economic Studies 44: 287-304.

Sheshinski, Eytan, and Yoram Weiss (1983). "Optimum Pricing Policy under Stochastic Inflation." Review of Economic Studies 50: 513-529.

Sheshinski, Eytan, and Yoram Weiss (1990). "Staggered and Synchronized Price Policies Under Inflation: The Multiproduct Monopoly Case." The Hebrew University Working Paper 234. September.

Stigler, George (1961). "The Economics of Information." Journal of Political Economy 69: 213-225.

Tommasi, Mariano (1991). "The Consequences of Inflation: Effects of Price Instability on Search Markets." UCLA Working Paper 655.

Van Hoomissen, Theresa (1988a). "Price Dispersion and Inflation: Evidence from Israel." Journal of Political Economy 96: 1303-1314.

Van Hoomissen, Theresa (1988b). "Search, Information and Price Dispersion in Inflationary Circumstances: Theory and Evidence", mimeo, SUNY Stony Brook.

FIGURE 1

Inflation and RPV 1990

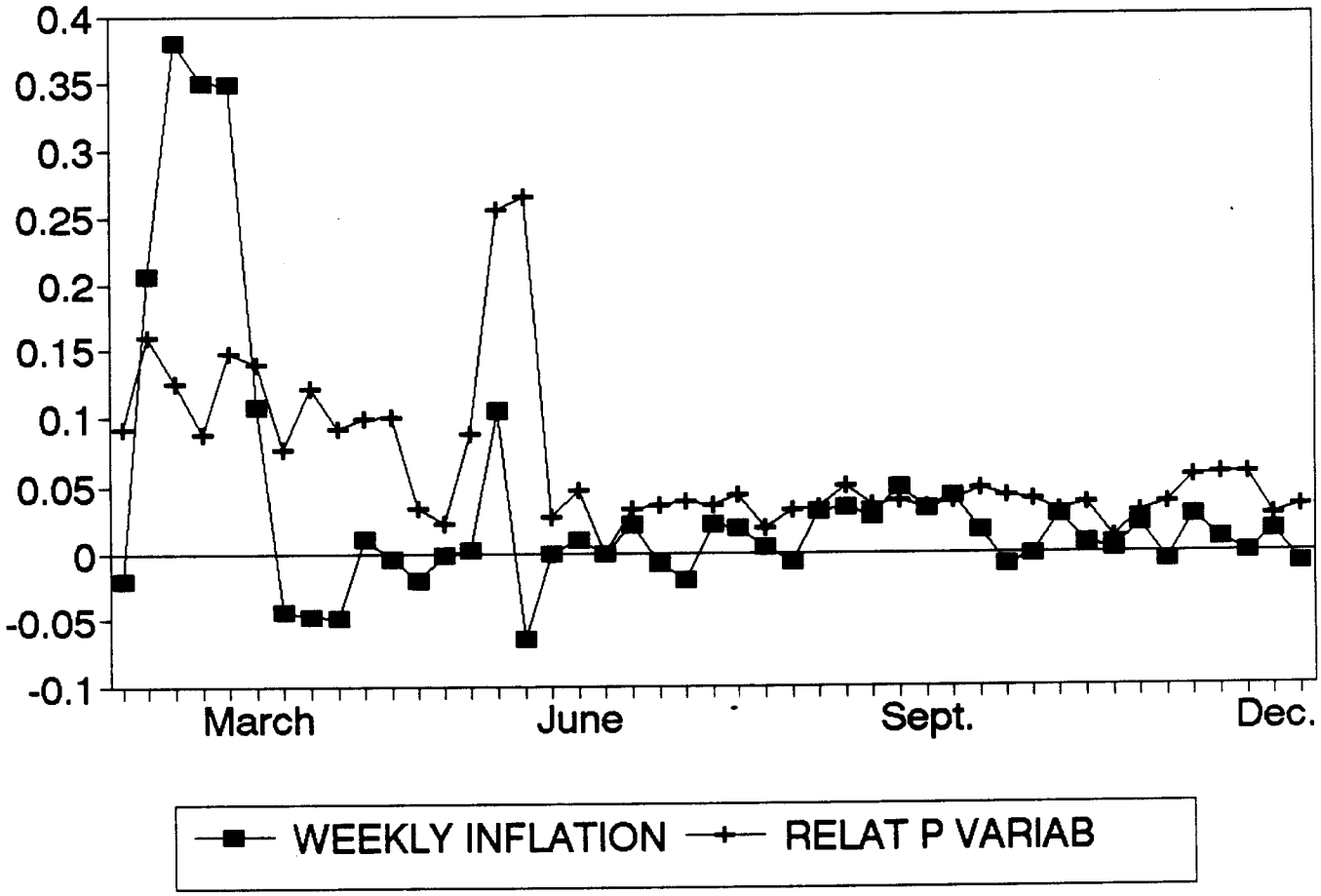

FIGURE 2

A:PEAS

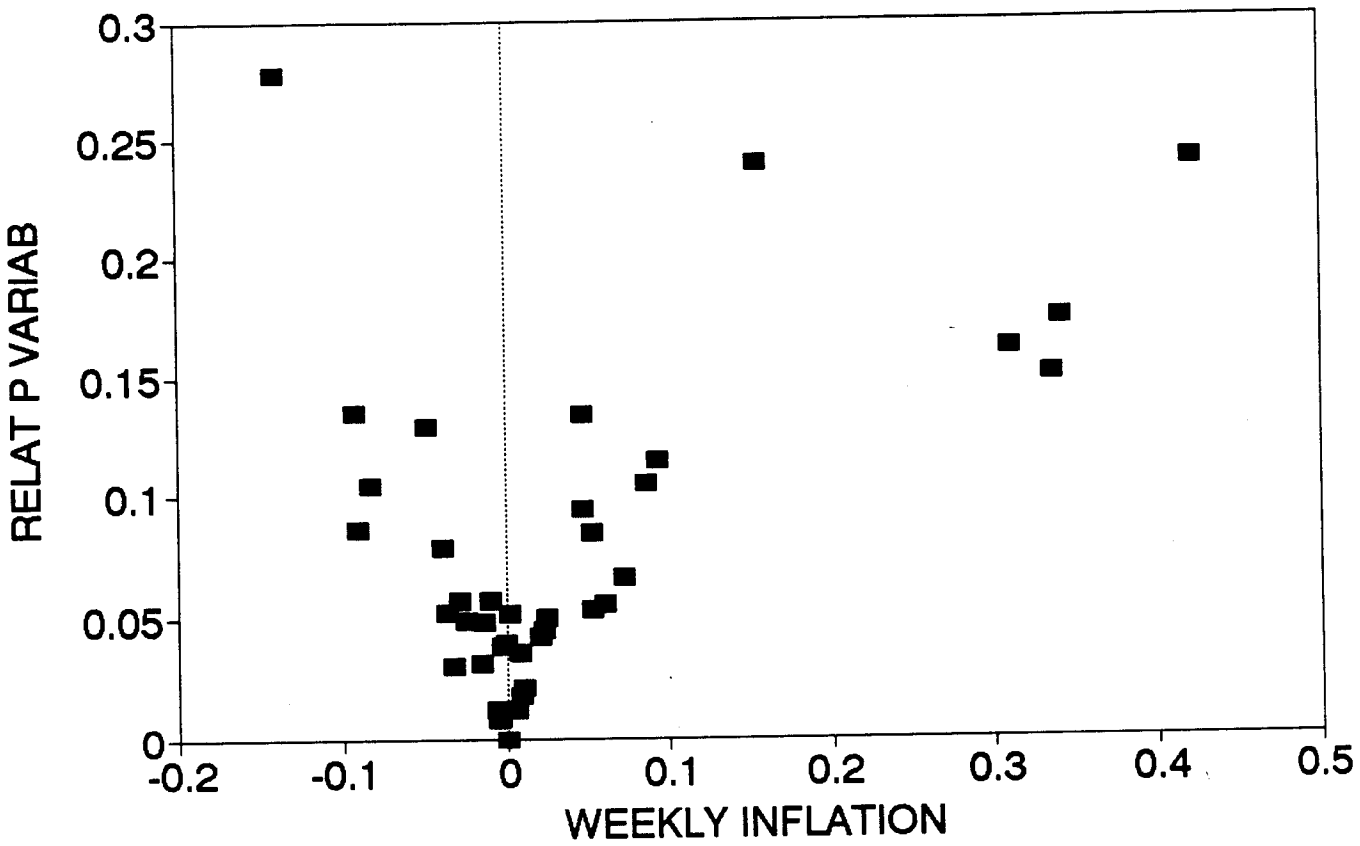

FIGURE 2

B:COFFEE

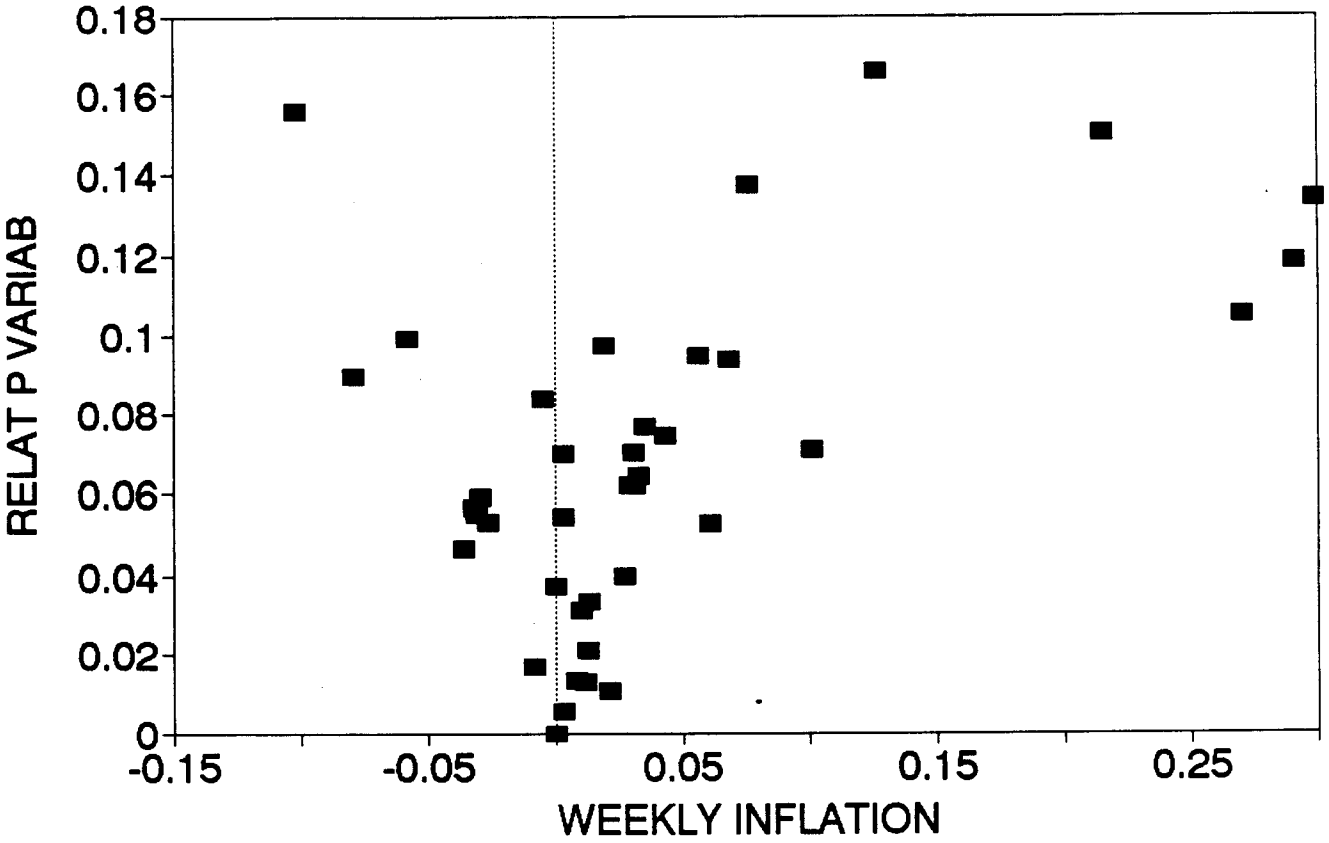

FIGURE 2

C:LAUNDRY DET.

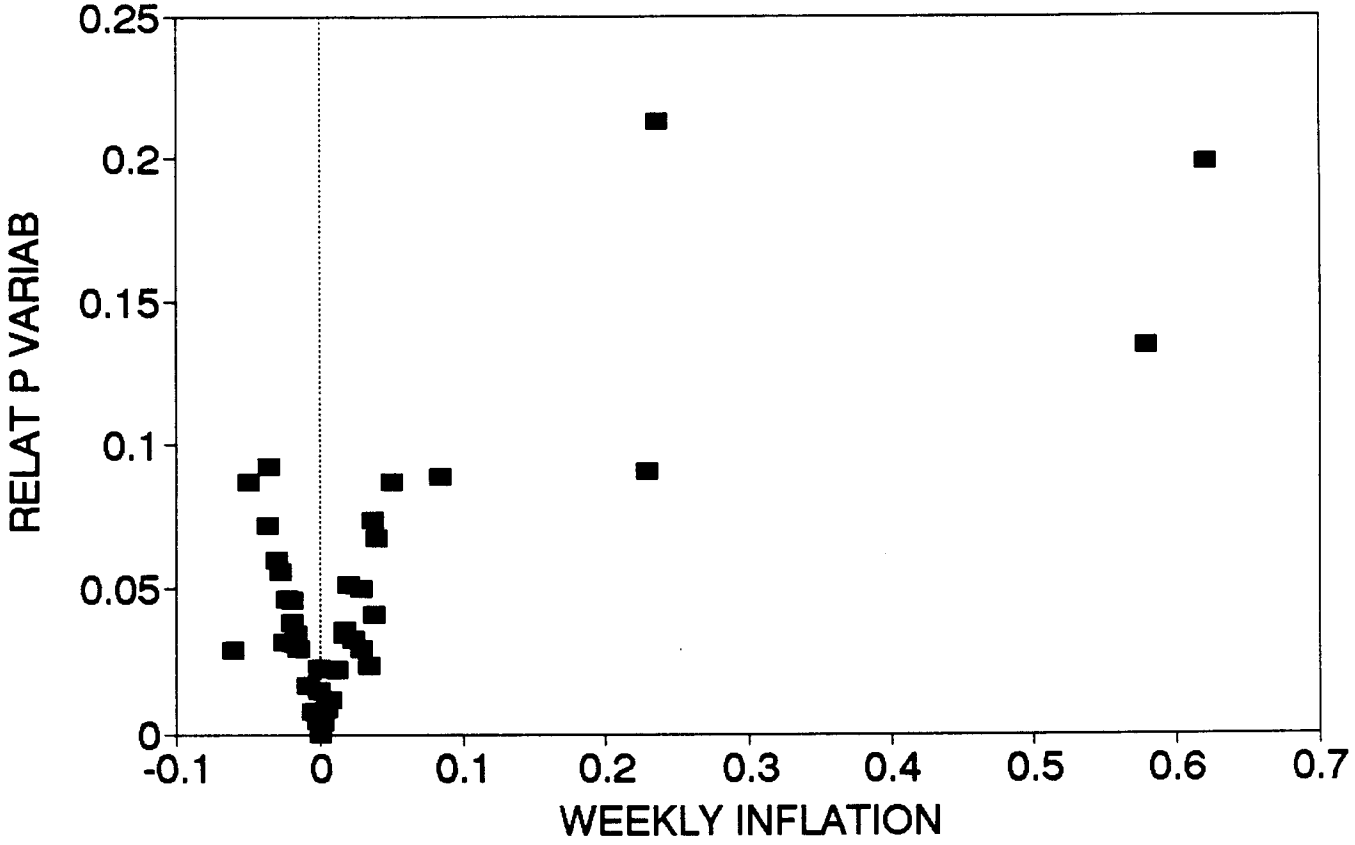

FIGURE 2

D:FLOUR

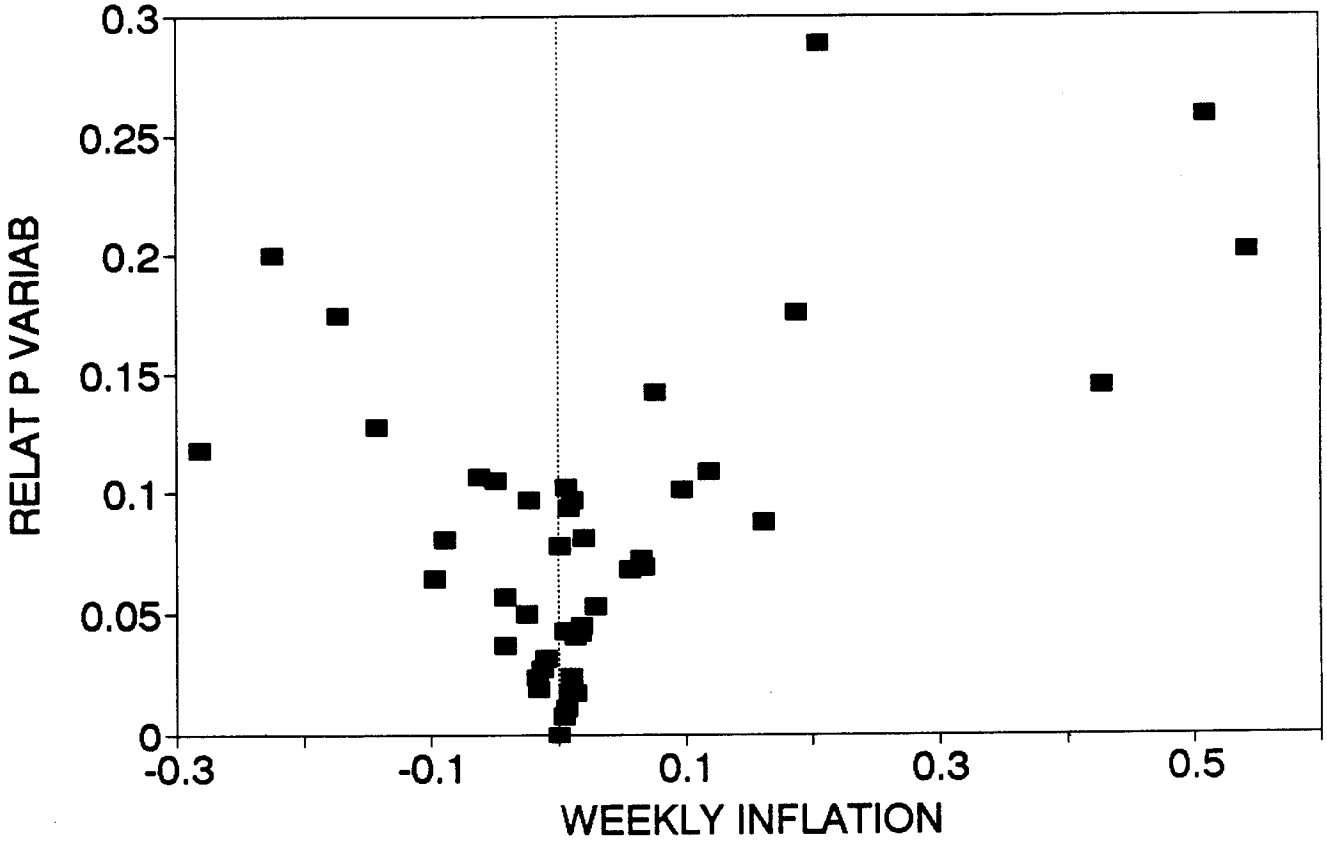

FIGURE 3: Price Dispersion

Across Stores - A: PEAS

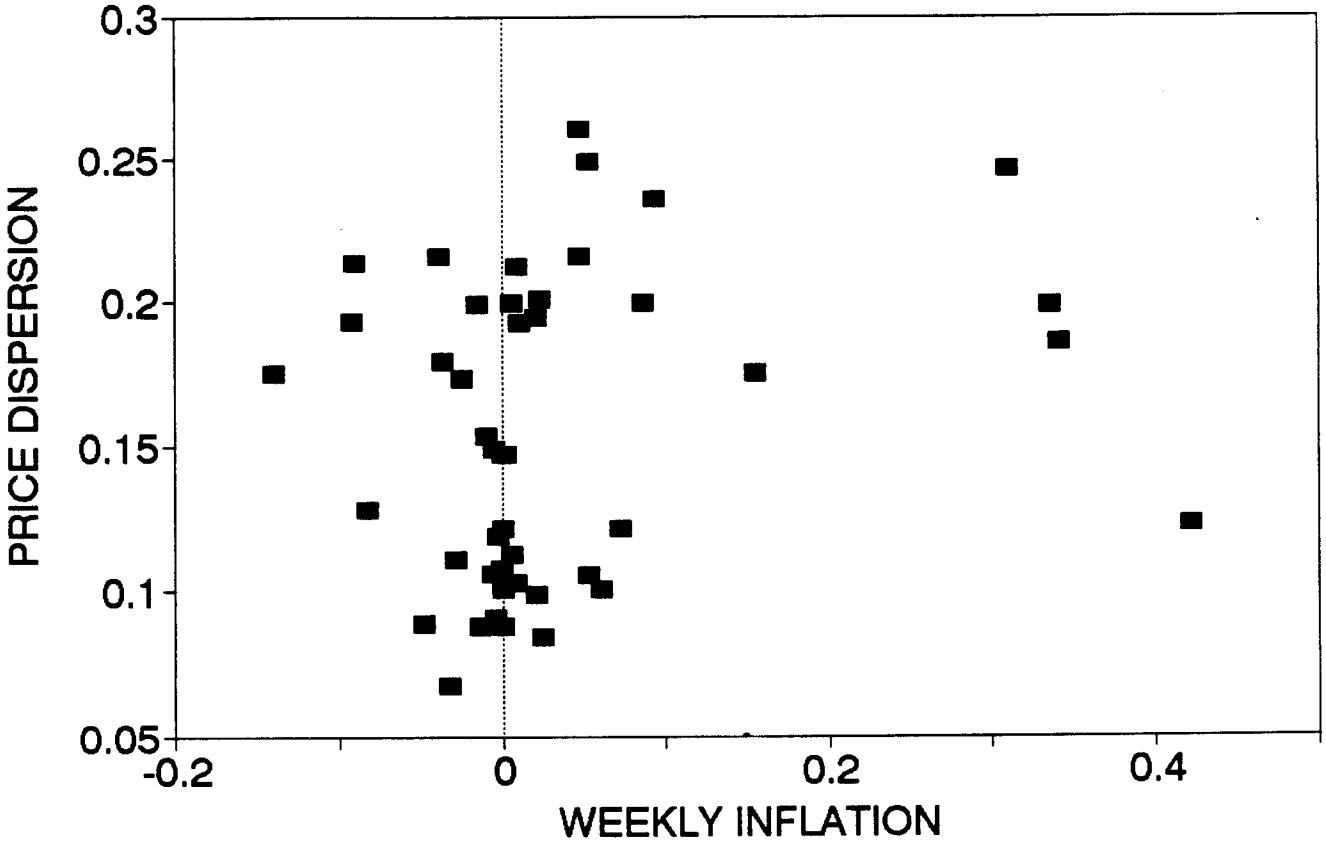

FIGURE 3

B: COFFEE

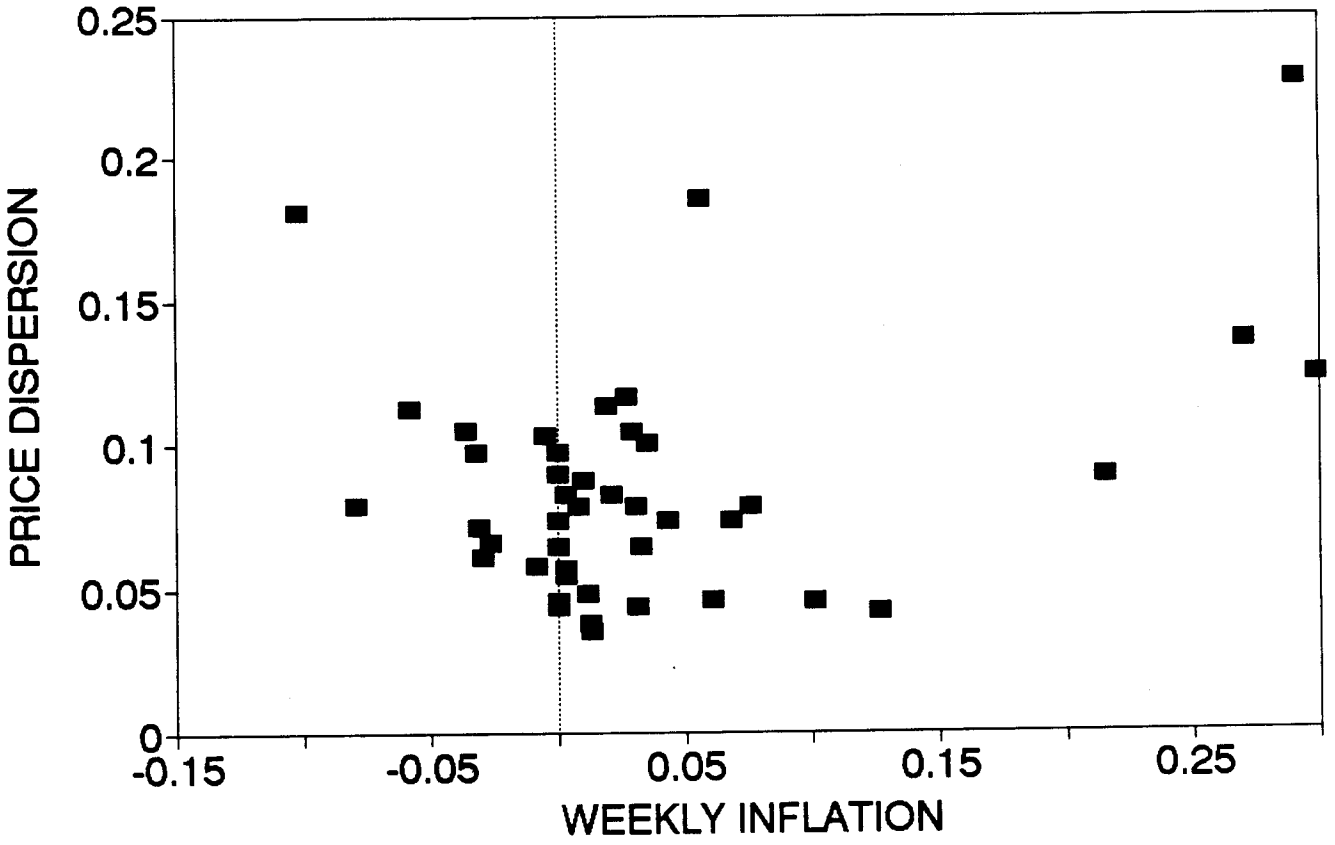

FIGURE 3

C: LAUNDRY DET.

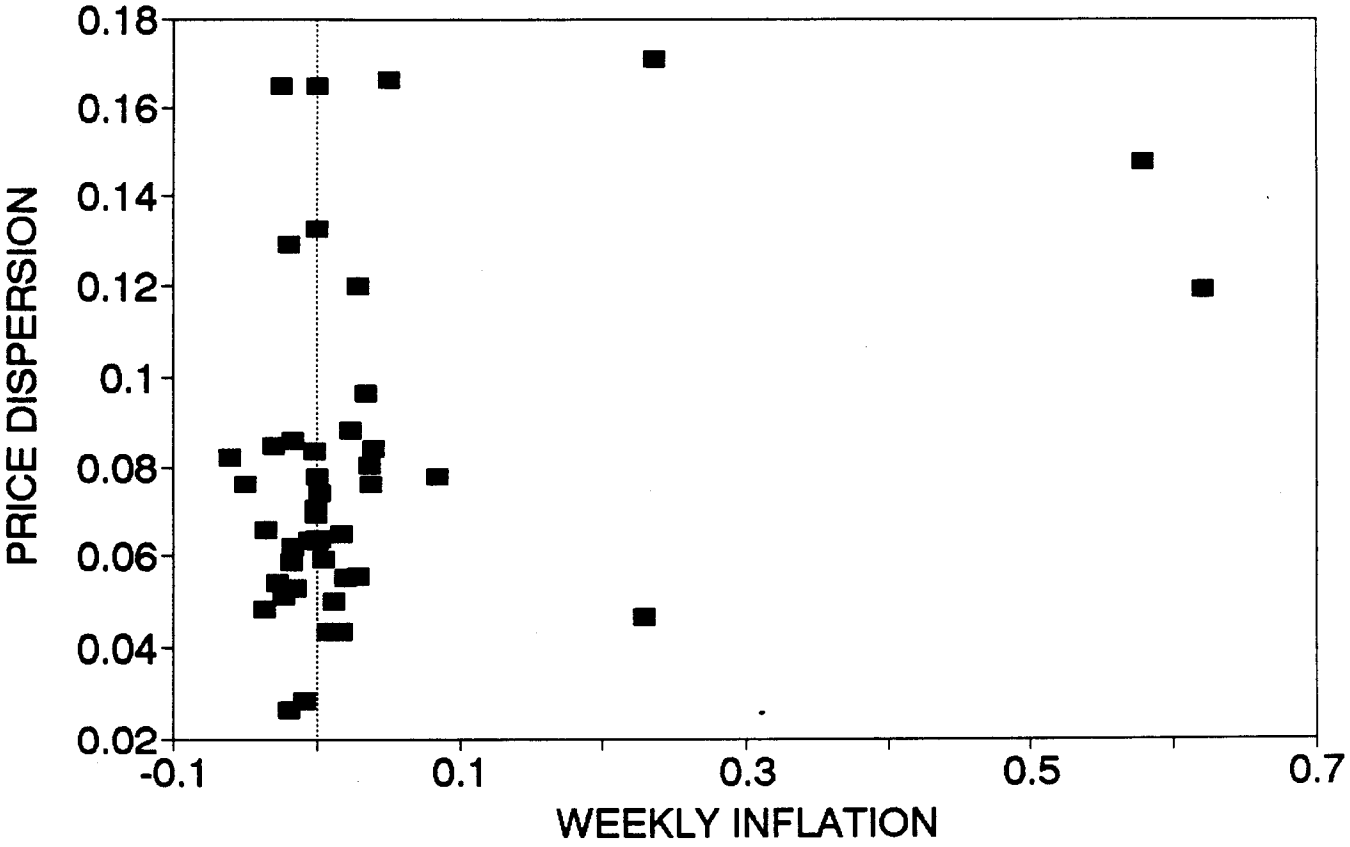

FIGURE 3

D: FLOUR

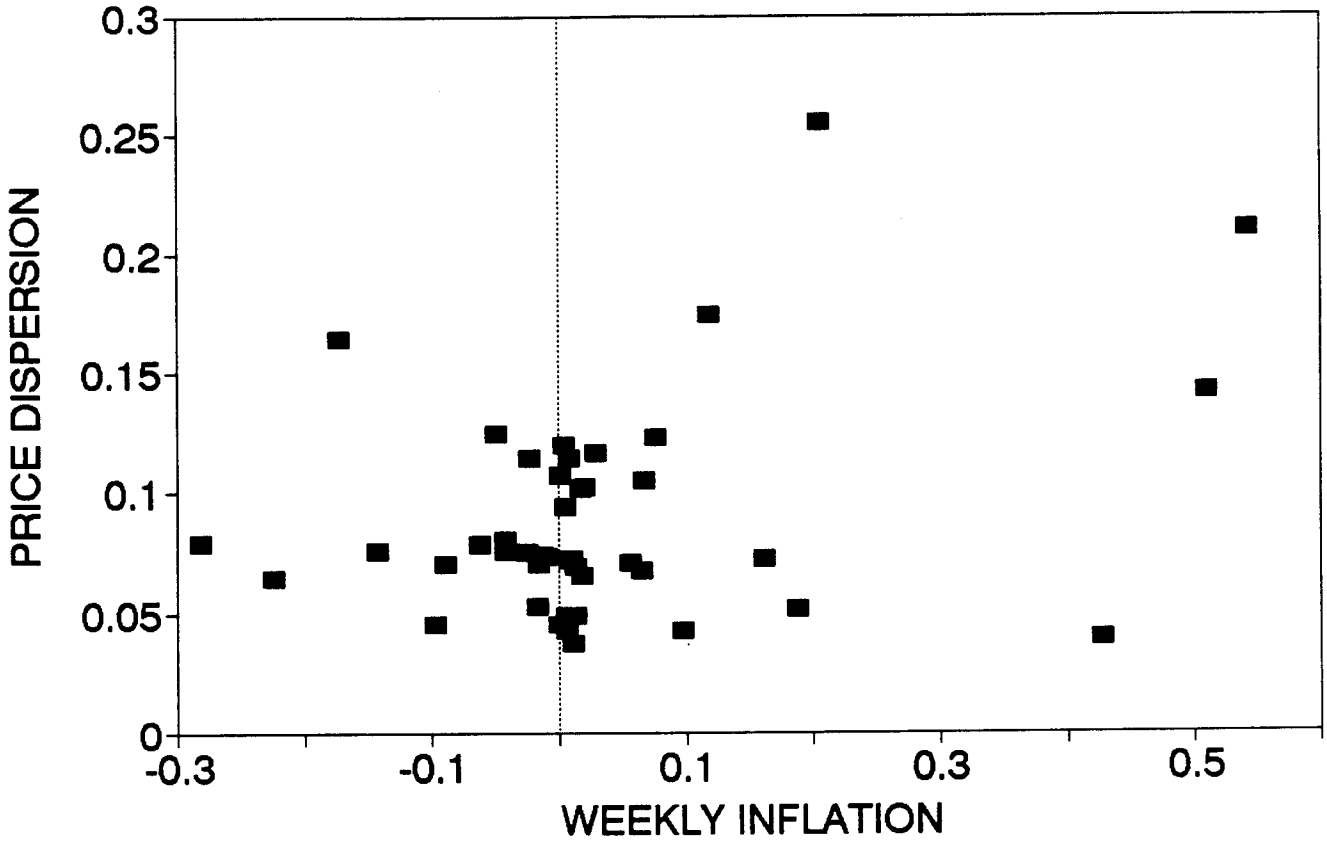

FIGURE 4
Mark-Down Sales

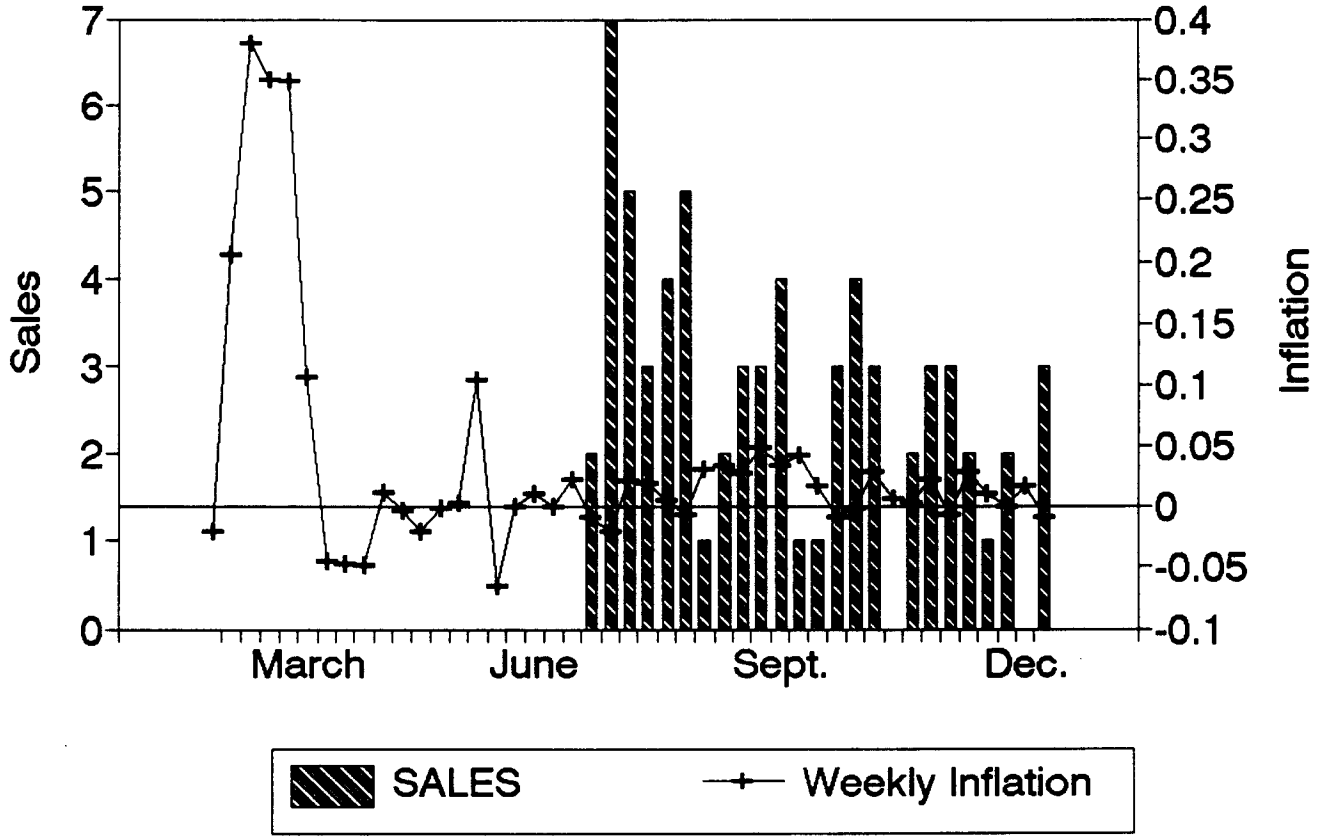

TABLE 1

SUMMARY STATISTICS
DPit: (average rate of price change)
σit: (standard deviation of rates of change across stores)
(45 weeks)

	DPit (mean)				σit (standard dev.)			
GOOD	Mean	St.D	Min	Max	Mean	St.D	Min	Max
Butter	.043	.100	-.169	.387	.051	.045	.000	.202
Coffee	.033	.086	-.102	.299	.059	.046	.000	.166
Ddorant	.034	.087	-.093	.361	.031	.042	.000	.126
Flour	.030	.155	-.282	.543	.084	.066	.000	.288
Laundry Det.	.038	.134	-.061	.621	.046	.047	.000	.213
Oil	.029	.107	-.166	.377	.050	.035	.000	.123
Orange Juice	.045	.099	-.042	.456	.051	.043	.000	.185
Peas	.034	.113	-.139	.421	.072	.067	.000	.278
Powder Milk	.035	.093	-.075	.527	.026	.030	.000	.119
Rice	.043	.143	-.211	.530	.063	.069	.000	.321
Soap	.036	.134	-.270	.628	.040	.056	.000	.254
Tea	.036	.146	-.336	.506	.083	.088	.000	.286
Tomato Sauce	.037	.102	-.067	.438	.088	.070	.000	.323
Tuna (a)	.052	.133	-.103	.414	.077	.069	.000	.308
Yerba	.037	.095	-.065	.362	.042	.039	.000	.177

Note: (a) 25 weeks

TABLE 2

PRICE VARIABILITY ACROSS SELLERS

Weekly Data Argentina 1990. Dependent Variable STDEV(DPij)
(45 weeks)

GOOD	Seemingly Unrelated Regression Estimates				OLS Estimates		
	constant	| DPi |	DPi2	R2	constant	| infla |	R2
Butter	.022 (3.45)	.645 (4.46)	-.929 (-2.14)	.51	.020 (2.86)	.354 (5.26)	.38
Coffee	.017 (3.52)	1.406 (10.59)	-3.588 (-7.59)	.73	.046 (6.81)	.264 (4.00)	.25
Deodorant	.001 (.47)	1.285 (17.93)	-2.99 (-13.05)	.83	.021 (3.25)	.218 (3.53)	.21
Flour	.037 (4.90)	.793 (7.31)	-.925 (-4.12)	.66	.059 (7.19)	.501 (6.25)	.46
Laundry Detergent	.016 (4.15)	.853 (10.55)	-.976 (-7.16)	.76	.027 (4.85)	.363 (6.60)	.49
Oil	.029 (5.06)	.520 (4.00)	-.920 (-2.51)	.32	.025 (3.87)	.195 (3.13)	.17
Orange Juice	.015 (2.84)	1.240 (9.96)	-2.54 (-8.24)	.60			
Peas	.026 (4.16)	.915 (11.16)	-.366 (-5.19)	.71	.052 (5.44)	.418 (4.56)	.31
Powder Milk	.011 (2.96)	.356 (7.85)	-.228 -7.41	.51			
Rice	.017 (3.16)	.805 (9.47)	-.737 (-4.00)	.82	.007 (1.10)	.642 (9.80)	.68
Soap	.011 (2.82)	.830 (11.09)	-.860 (-6.30)	.80			
Tea	.017 (2.53)	1.308 (11.48)	-1.935 (-6.83)	.80	.033 (2.57)	.595 (4.70)	.32
Tomato Sauce	.041 (5.27)	.936 (5.42)	-.768 (-1.78)	.73	.059 (8.22)	.586 (8.39)	.61
Tuna (a)	.029 (1.92)	.654 (2.14)	-.430 (-.56)	.61	.059 (3.84)	.234 (2.07)	.12
Yerba	.016 (2.85)	.986 (6.06)	-2.16 (-4.54)	.42	.033 (5.37)	.178 (2.97)	.15

Note: t-statistics are in parentheses
(a) OLS estimate. 25 weeks

TABLE 3

PRICE DISPERSION ACROSS SELLERS

Weekly Data Argentina 1990. Dependent Variable CVi
(45 weeks)

GOOD	Seemingly Unrelated Regression Estimates				OLS Estimates		
	constant	| DPi |	DPi2	R2	constant	| infla |	R2
Butter	.035 (7.07)	.168 (1.52)	.26 (.84)	.42	.021 (3.52)	.278 (4.89)	.34
Coffee	.074 (11.65)	.178 (1.14)	.232 (.40)	.23	.074 (12.68)	.221 (3.88)	.24
Deodorant	.054 (9.16)	.491 (3.15)	-1.101 (-2.19)	.19	.059 (9.39)	.140 (2.31)	.09
Flour	.082 (10.35)	.024 (.22)	.173 (.74)	.10	.079 (11.05)	.192 (2.75)	.13
Laundry Detergent	.072 (11.81)	.273 (2.20)	-.332 (-1.60)	.09	.070 (12.80)	.212 (3.98)	.25
Oil	.041 (9.77)	.409 (4.43)	-.904 (-3.46)	.24	.027 (4.39)	.145 (2.44)	.10
Orange Juice	.065 (10.19)	.463 (3.06)	-1.19 (-3.22)	0			
Peas	.15 (16.67)	.064 (0.59)	.007 (.08)	.01	.150 (16.63)	.278 (4.89)	.03
Powder Milk	.053 (12.19)	.200 (3.73)	-.142 -3.91	.19			
Rice	.070 (10.20)	.140 (1.25)	.092 (.37)	.28	.021 (3.69)	.405 (7.32)	.54
Soap	.053 (8.37)	.431 (4.11)	-.697 (-3.67)	.18			
Tea	.081 (10.33)	.175 (1.42)	.231 (.74)	.32	.041 (4.04)	.407 (4.04)	.26
Tomato Sauce	.084 (7.87)	.443 (2.07)	-.878 (-1.65)	.07	.092 (9.84)	.172 (1.88)	.05
Tuna (a)	.112 (7.18)	-.341 (-1.08)	1.610 (2.00)	.36	.099 (8.04)	.203 (2.26)	.15
Yerba	.61 (15.64)	-.081 (-.82)	.515 (1.76)	.12	.057 (15.19)	.104 (2.86)	.14

Note: t-statistics are in parentheses
(a) OLS estimate. 25 weeks

TABLE 4
INTERTEMPORAL CORRELATION OF PRICES
RHO in (12)

STORE / GOOD	A	B	C	D	E	mean
Butter (1)	.18 (.62)	.20 (.72)	.42 (1.60)	-.18 (-.64)	.54 (2.30)	.23
(2)	.48 (2.31)	.26 (1.20)	.35 (1.39)	.45 (2.07)	.25 (1.04)	.36
Coffee (1)	.93 (7.86)	.85 (5.69)	.48 (1.97)	.42 (1.63)	.71 (3.64)	.68
(2)	.91 (8.99)	.84 (5.39)	.83 (6.53)	.57 (2.73)	.56 (2.22)	.74
Flour (1)	.39 (1.50)	.29 (1.40)	.48 (1.91)	.52 (2.28)	-.06 (-.19)	.32
(2)	.89 (6.41)	.52 (2.23)	.69 (4.95)	.32 (1.34)	.15 (.63)	.51
Laundry Det. (1)	.83 (5.81)	.68 (3.42)	.81 (5.80)	.42 (1.94)	.49 (2.41)	.65
(2)	.88 (6.64)	.74 (5.20)	.87 (7.40)	.58 (2.92)	.50 (1.18)	.71
Oil (1)	.28 (1.08)	.27 (1.06)	.16 (.65)	.40 (1.74)	.51 (2.16)	.32
(2)	.87 (6.57)	.86 (6.76)	.72 (4.45)	.37 (1.51)	.08 (.32)	.48
Peas (1)	.57 (2.47)	.37 (1.45)	.60 (2.59)	.67 (3.05)	.63 (2.89)	.57
(2)	.25 (1.07)	1.02 (14.60)	.98 (12.17)	.40 (1.35)	.99 (10.25)	.72

TABLE 4
(Cont.)

STORE / GOOD		A	B	C	D	E	mean
Rice	(1)	.01 (.04)	.02 (.08)	.37 (1.45)	.34 (1.33)	.09 (.36)	.17
	(2)	.82 (5.62)	.80 (4.94)	.73 (3.93)	.25 (1.05)	.81 (5.16)	.68
Soap	(1)	.46 (.89)	.43 (1.94)	.49 (2.24)	.05 (.20)	.31 (1.36)	.35
	(2)	.95 (7.57)	.63 (2.86)	.34 (1.21)	.96 (11.23)	.60 (2.32)	.70
Tea	(1)	-.01 (-.03)	.08 (.28)	-.05 (-.20)	.26 (.99)	.25 (1.31)	.11
	(2)	.76 (9.49)	.83 (5.29)	.56 (3.64)	.57 (3.81)	.95 (7.14)	.73
Tomato Sauce	(1)	-.31 (-1.16)	.14 (.52)	-.33 (-1.31)	-.16 (-.60)	.06 (.23)	-.12
	(2)	.78 (4.37)	.94 (9.08)	.79 (4.76)	.83 (4.79)	.87 (4.76)	.84
Tuna	(1)	.36 (1.12)	.43 (1.47)	.71 (3.18)	.52 (1.93)	.51 (1.53)	.51
	(*)	.75 (3.71)	.89 (8.00)	.88 (6.93)	.61 (2.91)	.87 (6.02)	.80
Yerba	(1)	.80 (4.89)	.47 (1.90)	.37 (1.44)	.58 (2.55)	.38 (1.49)	.52
	(2)	.85 (6.95)	.82 (6.45)	1.01 (10.47)	.62 (4.09)	.81 (5.13)	.82

Note: t-statistics are in parentheses
(1) 15 weeks - January-May 1990
(2) 15 weeks - August-December 1990
(*) 15 weeks - May-August 1990

TABLE 6

Price Changes

WEEK	WEEKLY INFLA	NUMBER OF			AVERAGE INCREASE	ST.DEV. INCREASE
		Price Increases	No Change	Price Decreases		
1	-0.02	3	12	20	0.101	0.063
2	0.21	33	1	1	0.338	0.178
3	0.38	32	3	0	0.399	0.196
4	0.35	33	1	1	0.364	0.116
5	0.35	30	5	0	0.466	0.200
6	0.11	20	2	13	0.187	0.150
7	-0.04	3	19	13	0.125	0.043
8	-0.05	5	9	21	0.113	0.093
9	-0.05	4	15	16	0.203	0.106
10	0.01	8	10	17	0.102	0.061
11	0.00	16	5	14	0.099	0.065
12	-0.02	10	11	14	0.063	0.051
13	0.00	6	26	3	0.035	0.022
14	0.00	14	17	4	0.096	0.064
15	0.10	13	18	4	0.103	0.129
16	-0.06	12	20	3	0.054	0.032
17	0.00	6	23	6	0.055	0.027
18	0.01	15	10	10	0.072	0.044
19	0.00	0	35	0	-	-
20	0.02	12	19	4	0.099	0.087
21	-0.01	6	23	6	0.083	0.027
22	-0.02	5	17	13	0.068	0.020
23	0.02	13	18	4	0.077	0.047
24	0.02	6	20	9	0.088	0.067
25	0.00	8	22	5	0.068	0.039
26	-0.01	7	21	7	0.057	0.019

27	0.03	18	15	2	0.098	0.071
28	0.03	22	11	2	0.098	0.065
29	0.03	12	21	2	0.085	0.058
30	0.05	13	16	6	0.101	0.061
31	0.03	15	20	0	0.107	0.069
32	0.04	17	13	5	0.101	0.068
33	0.02	4	21	10	0.057	0.042
34	-0.01	5	25	5	0.053	0.015
35	0.00	5	21	9	0.079	0.030
36	0.03	13	17	5	0.104	0.060
37	0.01	11	21	3	0.090	0.076
38	0.00	8	24	3	0.059	0.040
39	0.02	18	9	8	0.049	0.052
40	-0.01	11	21	3	0.057	0.044
41	0.03	9	21	5	0.136	0.149
42	0.01	12	16	7	0.090	0.069
43	0.00	8	20	7	0.168	0.120
44	0.02	13	19	3	0.094	0.075
45	-0.01	4	27	4	0.099	0.069

NOTE: Total number of observations = 35 (5 stores x 7 products)

TABLE 7
Correlation of Price Changes
Across Goods (Per Store)

(+) Number of Price Increases
(-) Number of Price Decreases

WEEK	WEEKLY INFLA	STORE A		STORE B		STORE C		STORE D		STORE E	
		(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)
1	-0.02	0	3	0	4	1	4	0	6	2	3
2	0.21	6	0	6	0	7	0	7	0	6	1
3	0.38	4	0	7	0	7	0	7	0	6	0
4	0.35	6	0	7	0	7	0	5	1	7	0
5	0.35	6	0	7	0	6	0	7	0	3	0
6	0.11	2	3	3	4	4	2	4	3	7	0
7	-0.04	0	2	0	4	0	4	0	2	3	1
8	-0.05	0	4	0	4	2	4	1	4	2	4
9	-0.05	1	3	0	4	0	2	2	3	1	3
10	0.01	0	4	2	1	0	3	1	6	5	2
11	0.00	1	3	3	2	5	1	3	4	3	4
12	-0.02	3	0	1	4	2	0	2	4	1	6
13	0.00	2	0	1	2	1	1	1	0	1	0
14	0.00	4	1	4	0	2	1	2	0	2	2
15	0.10	2	1	2	0	3	2	3	1	3	0
16	-0.06	1	0	2	2	2	0	4	0	3	1
17	0.00	2	1	0	2	2	1	1	1	1	0
18	0.01	4	1	3	0	3	3	3	2	2	4
19	0.00	0	0	0	0	0	0	0	0	0	0
20	0.02	3	1	1	1	3	1	0	1	4	0
21	-0.01	0	1	1	2	1	1	3	2	1	0
22	-0.02	1	3	1	1	2	1	1	4	0	3
23	0.02	1	0	2	2	3	0	4	0	3	2
24	0.02	1	0	3	0	0	3	1	3	1	2

25	0.00	2	0	2	2	1	3	0	0	3	0
26	-0.01	1	1	1	0	1	0	2	4	1	2
27	0.03	3	0	2	0	4	0	3	1	5	1
28	0.03	5	0	2	1	3	1	7	0	4	0
29	0.03	2	0	3	0	2	1	3	0	2	1
30	0.05	2	0	2	2	3	1	3	3	2	0
31	0.03	2	0	3	0	3	0	2	0	4	0
32	0.04	3	2	2	0	4	1	5	1	2	1
33	0.02	1	2	1	1	1	2	0	2	1	3
34	-0.01	1	2	0	1	1	1	2	1	1	0
35	0.00	0	2	1	0	2	0	0	3	2	3
36	0.03	4	0	1	1	2	2	5	0	1	2
37	0.01	2	0	2	0	1	1	0	1	5	1
38	0.00	3	0	0	0	1	1	2	1	2	0
39	0.02	2	1	4	1	5	1	5	2	2	3
40	-0.01	1	0	2	0	3	1	1	0	3	2
41	0.03	3	1	1	1	1	1	3	2	1	0
42	0.01	1	1	2	3	3	1	0	1	5	1
43	0.00	1	1	2	0	2	2	0	2	3	1
44	0.02	0	1	3	0	2	0	4	1	3	1
45	-0.01	0	0	0	1	1	0	2	1	1	1

NOTE: Total number of goods per store = 7