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High Inflation and the Short-Run Variability of Relative Prices*

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A large body of recently developed evidence sustains the belief that the inflationary process is not neutral with respect to the structure of relative commodity prices. Due to the evolution of real variables like technology, productivity, preferences, etc., the distribution of relative prices also changes under conditions of price stability but the evidence indicates that monetary phenomena increase the variability of relative prices beyond the changes brought about by real forces. 1/ Four major relationships between inflation and relative prices have been theoretically and empirically considered. The general picture emerging indicates that (a) the variability of the aggregate rate of inflation over time and the cross-sectional variability of commodity prices tend to move in the same direction; (b) there is a positive correlation between the rate of inflation, particularly unexpected inflation, and the variability of relative prices; (c) changes in the rate of monetary expansion affect the distribution of relative prices; and (d) the variability of relative prices tends to increase with the degree of

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1/ The number of contributions to this literature has grown exponentially in recent years. A useful account of recent studies is given by Fischer (1981b) and comprehensive surveys of the literature are presented by Cukierman (1982) and by Marquez and Vining (1982).

dispersion of inflationary expectations among individuals. Although all these relationships are clearly connected, they have been analyzed in separate contexts, particularly at the empirical level. 1/

Most of the studies (except those for pre-war Germany) have dealt with low inflation countries, for which it is more difficult to isolate real from monetary effects on relative price changes. The purpose of this paper is to analyze in detail the characteristics of relative price behavior within the context of very rapid and variable inflation. Using disaggregated monthly data for Argentina covering the period 1977-81, a number of specific aspects of that country's experience are examined. 2/ In Section I the distributional characteristics of the short- and long-run dispersions of relative prices are studied. Quantitative indicators of aggregated relative price variability are calculated in Section II, and the sources of variability are analyzed by decomposing the commodity basket into several of its major components. Section III considers the validity, for the case of Argentina, of some of the relationships described above on the links between monetary variables and the fluctuation of relative prices. In addition, the effects that external sector developments may have on the degree of relative price fluctuations are discussed and measured. A summary of the main findings appears in Section IV.

I. The Distribution of Relative Prices in Argentina

This study is based on monthly observations of Argentina's consumer price index (CPI) for the period April 1977 to June 1981. A monthly index for each of the 61 components of the CPI is published by the

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1/ Relationship (a) has been studied, among others, by Vining and Elwertowski (1976) and Cukierman (1979); relationship (b) by Glejser (1965), Parks (1978), Clements and Nguyen (1980), Cornell (1981), Taylor (1981), Blejer (1981), and Ramirez-Rojas (1981); relationship (c) by Hercowitz (1981, 1982) and Bordo (1981); and relationship (d) by Cukierman and Wachtel (1982) and Fischer (1981a). Since the variability of inflation and of inflationary expectations are connected (Cukierman and Wachtel (1979)), propositions (a) and (d) are directly related. Equally given the evidence relating the variability to the level of inflation (Logue and Willett (1976), Foster (1978), and Blejer (1979)), propositions (a) and (b) are not independent.

2/ Many of the previous studies have relied on annual data. The use of monthly data reduces the incidence of real changes on the variability of relative prices and also assures that the coverage, as well as the quality content of the commodity disaggregation remains relatively unchanged. In these circumstances it is easier to isolate the impact of monetary factors on the determination of relative-price changes.

National Institute of Statistics. 1/ Although an official cost of living index was first made public in 1924, such indices were periodically revised and the coverage changed. 2/ A major revision was initiated in 1970, increasing the coverage of the index and the geographical area surveyed. Based on that revision, a new commodity breakdown of the CPI, not comparable with that previously used, was implemented starting in April 1977. The index covers the geographical area of metropolitan Buenos Aires for a sample of 2,850 retailers, which provides more than 100,000 monthly price observations. The expenditure weights for the aggregated index are based on a survey of 9,126 monthly budgets of 760 families. 3/

The average monthly rate of inflation for the period considered was 7.1 per cent, with a standard deviation of 1.98. It ranged from a high of 10.5 per cent in April 1978 to a low of 2.7 per cent in October 1979. The average inflation rate for individual commodities ranged from a high of 8.2 per cent for educational services to a low of 4.8 per cent for women's footwear. Standard deviations of individual prices were in the 10.12 - 1.73 range, indicating that almost all individual prices have fluctuated much more widely than the aggregate. 4/ No statistical relationship was found between the average and the standard deviations of inflation for single commodities (the correlation coefficient between both variables is -0.028), indicating that the abundant evidence on the positive correlation between the level and the variability of inflation at the aggregated level does not seem to hold at the individual commodity level.

A first indication of the large volatility of relative prices accompanying the inflationary process is the wide span over which individual prices have fluctuated. The lowest rate of price change registered over the period is a 20.6 per cent fall in the price of fresh and canned greens in March 1980, when the average rate of inflation was 5.79 per cent and the highest rate that month was 13.08 per cent for books and printed matter. 5/ The highest rate observed for an individual commodity was a 34.8 per cent rise in the price of household services in September

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1/ Instituto Nacional de Estadistica y Censos, Indice de Precios al Consumidor y Salarios Industriales, Buenos Aires, monthly. Data was seasonally adjusted, using the X-11 Variant of the Census Method II as modified by the Board of Governors of the U.S. Federal Reserve System. See Davis (1970).

2/ Major revisions were undertaken in 1933, 1943, and 1960.

3/ Self-employed persons are not included in the survey. The weights and the commodity definitions are reported in the methodological report of the National Institute of Statistics.

4/ All but two individual commodities have a standard deviation exceeding the standard deviation of the aggregate CPI.

5/ Extreme values like these are clearly affected by seasonality despite the corrections performed. Observe that March is the beginning of the school year in Argentina.

1979, when the average rate was 7.67 per cent and the lowest was -0.1 per cent.

Figure 1 plots the rate of change of the CPI, together with the highest and lowest rates observed the same month for individual commodities. The width of the band is a representation of the degree of relative price changes during the month. 1/ By comparing the width of the band with the average rate, we can obtain a simple measure of the degree of joint fluctuations in relative prices and inflation rates. In a regression of DIF (the difference between the highest and the lowest rates of price changes observed for individual commodities over a given month) on the rate of inflation for the same month, the following result is obtained: 2/

$$DIF_t = \underset{(3.62)}{14.81} + \underset{(2.43)}{1.35}\ DP_t \qquad R^2 = 0.110 \qquad D.W. = 1.64$$

When food products are excluded from the sample, the results are similar: 3/

$$DINF_t = \underset{(1.91)}{7.70} + \underset{(2.63)}{1.41}\ DPNF_t \qquad R^2 = 0.126 \qquad D.W. = 2.22$$

Although crude, these results indicate that the span over which individual prices fluctuate is directly related to the level of inflation.

One explanation for this result is that industries and sectors may differ in their speed of adjustment to nominal shocks. 4/ Fischer (1981b) distinguishes between two different approaches which explain the relationship between inflation and relative price variability in terms of intersectoral differences in speeds of adjustment. The first is based on what he calls "menu costs" theories which assume that due to fixed costs of changing prices, individual commodity prices change only at discrete intervals. 5/ As inflation increases, so does the frequency of price adjustments but still, when measured at a given point in time,

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1/ The difference between the maximum and the minimum is the larger pairwise relative price change taking place over the period. This form of presentation of the data is taken from Taylor (1981).

2/ Figures in parentheses are t-values.

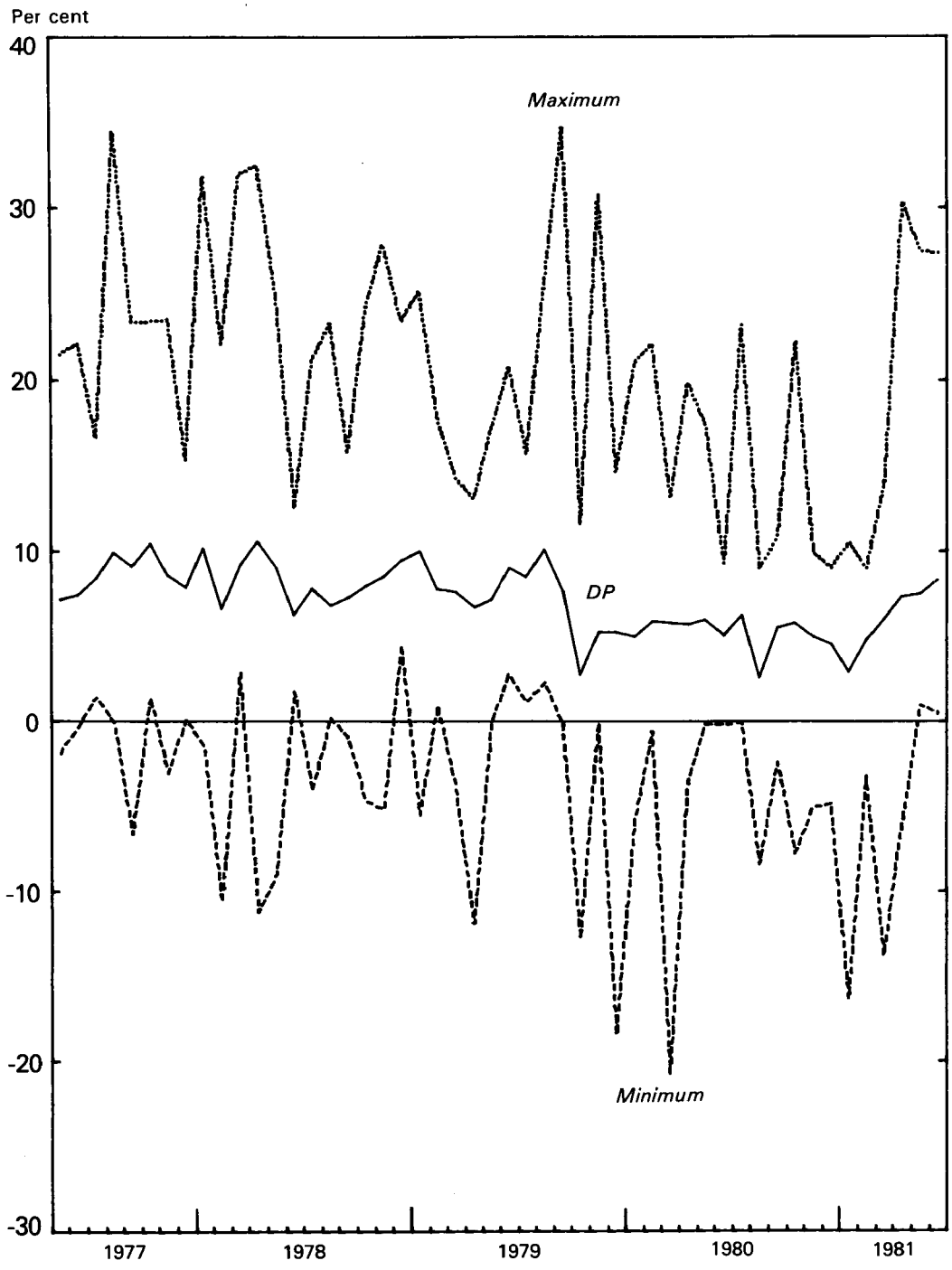
3/ DPNF is the rate of inflation, excluding food products. See the next section for a discussion on reclassification.

4/ As mentioned above, secular changes in real variables affect relative prices but they should not necessarily be correlated with short-term variations in the rate of inflation.

5/ See Mussa (1981), Rotemberg (1980), and Sheshinski and Weiss (1977).

FIGURE 1

MONTHLY INFLATION RATE (DP) - HIGHEST AND LOWEST INDIVIDUAL PRICE CHANGES



the differences between individual rates of inflation are larger. The second approach is based on the assumption of different short-run supply elasticities across industries. If the short run supply elasticity in one industry is smaller than in another but the long run elasticities are similar, a demand shift between the industries will result in a change in both aggregate and relative prices even if the shift is ultimately neutral in its relative price effect.

If different speeds of adjustment are indeed the main factor affecting the dispersion of relative prices, a lengthening of the time period of the observations should lead to more equilibration in relative prices and therefore should result in greater convergence in the degree of fluctuation of individual prices. In order to check this possibility, the monthly equivalent of the annual rate of inflation for each commodity may be calculated. 1/ On this basis, the disparities in the individual rates of price change are much smaller. Figure 2 plots the differences between maximum and minimum rates of inflation on monthly and annual bases. For comparison, the differences on a quarterly basis are also included in the figure. Both the magnitude and the degree of fluctuations of the differences over time are substantially reduced as the period of observation expands, lending support to the idea that differences in the velocity of adjustment are a central element in the determination of relative price dispersion.

An additional method for examining the changing pattern of relative price behavior over time is to analyze the nature and the evolution of the distribution of individual price changes around the mean rate. It can be assumed that the individual rates of inflation follow some probabalistic distribution but that the type of distribution is unknown. In order to identify the properties of the distribution in the Argentine case, tests for normality are performed by using the chi-square goodness-of-fit test and by calculating the first four sample moments of the distribution. All the calculations are performed for both the monthly and the annual rates of change. The chi-square values, as well as the values of the variance, skewness, and kurtosis are presented in Table 1 for the monthly observations and in Table 2 for the annual rates. 2/

The chi-square test indicates that, at the monthly level, the hypothesis that the rate of change of individual commodity prices distributed normally can be rejected for 27 out of the 50 months included in the sample. On the other hand, the normality hypothesis can be

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1/ For each commodity and each month, the annual inflation at monthly rate, DP^y_t, is equal to $DP^y_t = (1+DP^!_t)^{1/12} - 1$, where $DP^!_t$ is the percentage change in the commodity price over the previous 12 months.

2/ Notice the loss of 11 observations when moving from monthly to annual data. As explained above, there is no comparable data at the commodity level before April 1977.

rejected only once when annual rates are considered. 1/ Additional evidence on the change in the distribution as the length of the observation period increases is obtained from the values of the skewness and the kurtosis. As the skewness for the normal distribution equals zero, the value of the skewness of any particular distribution indicates how far this distribution departs from the perfect symmetry of a normal distribution. Considering the month-to-month changes in individual prices, it is observed that in 36 cases the value of the skewness is significantly different from zero while this is true in only three cases for the annual rates. 2/ The sign of the skewness indicates the directions in which more extreme values occur. For the monthly price changes, the distribution is significantly skewed to the right in 25 cases and to the left in the remaining 11 significant cases. This result appears to indicate that, in most of the months observed, the majority of price changes were below the mean but those above tended to be at a larger distance from it. 3/

The kurtosis, a measure of the peakedness of the distribution, has a value of 3 in mesokurtic (or mediumly peaked) distributions. Values significantly larger than 3 correspond to leptokurtic distributions, which indicate the presence of a heavy cluster of observations near the mean and relatively more observations at the tails than in normal distributions. Tables 1 and 2 indicate that in 43 cases the monthly distribution of relative prices is significantly more peaked and therefore could not have been drawn from a normal distribution, while only 14 such cases are present when yearly observations are considered. 4/

As a whole, the results appear to indicate a pattern of not normal but rather skewed and asymmetrical distribution of monthly commodity price changes. This pattern appears to arise from different speeds of adjustment to global shocks since over time the tendency is towards

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1/ The critical value at the 5 per cent level is $\chi_{(5)} = 11.1$. Similarly, using the Kolmogorov-Smirnov test, the hypothesis of normality can be rejected at the 90 per cent level in 24 cases for monthly observations and in only two cases for the annual changes. The values of the K-S statistic are presented in the Appendix, Table 2.

2/ Values larger (in absolute value) than 0.788 are significantly different from zero at the 1 per cent level.

3/ The results suggest a log normal distribution of relative price changes. Additional evidence in the same direction is obtained by calculating the differences between the highest rate of inflation for an individual commodity in a given month and the mean rate for the same month, and between the lowest rate and the mean. The average of the upward deviation over the complete sample is 13.51 per cent, while the average of the downward deviation is 10.9 per cent.

4/ The reported values of the kurtosis are the calculated statistics minus 3, and therefore the test performed is against zero. Values higher than 1.55 are not consistent with the hypothesis of normality at the 1 per cent level.

FIGURE 2

DIFFERENCES BETWEEN HIGHEST AND LOWEST RATES OF PRICE CHANGES FOR INDIVIDUAL COMMODITIES

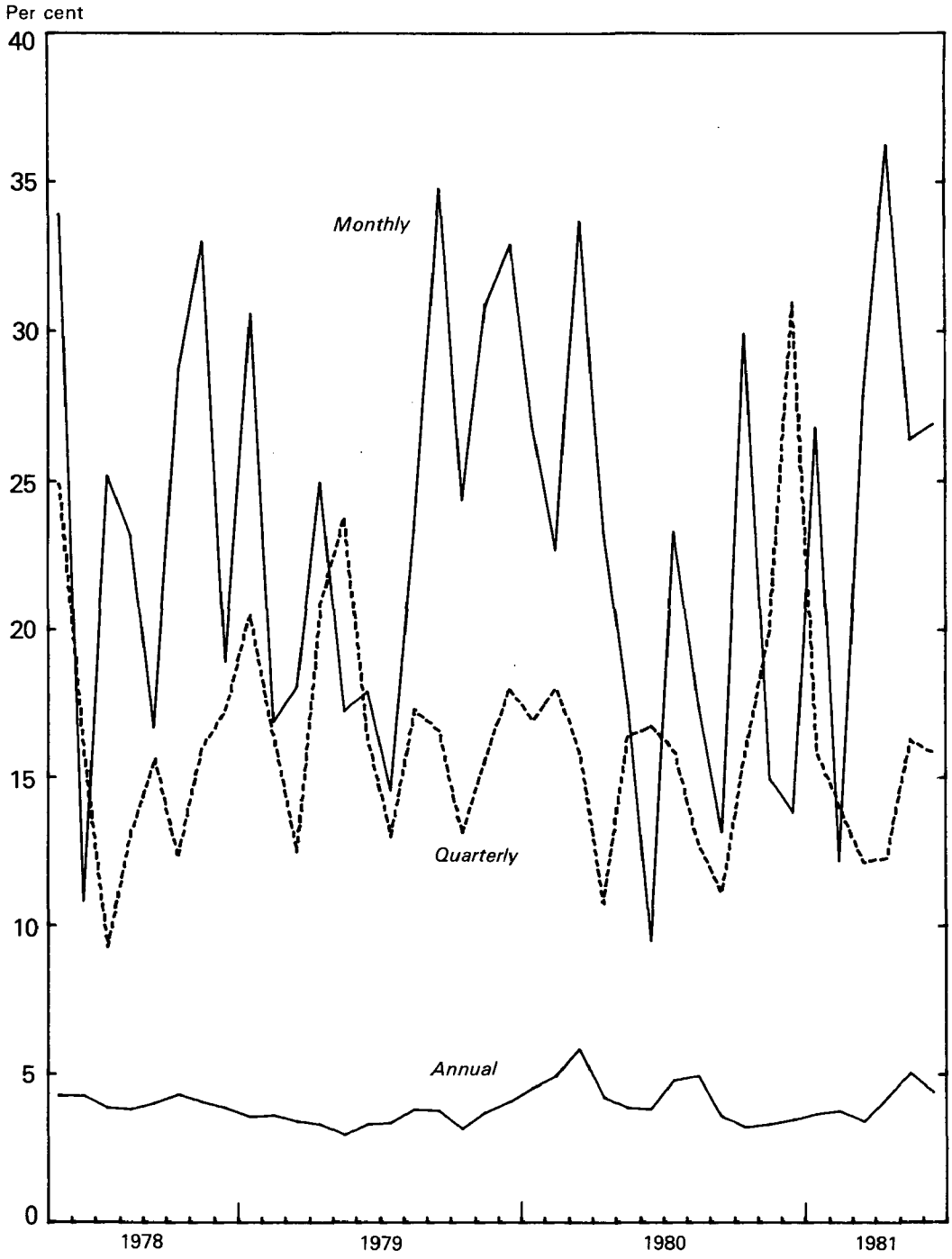

Table 1. Chi-Square Values and Descriptive Statistics of Price Change Distributions: Monthly Rates

	Chi-Square	Variance	Skewness	Kurtosis
1977 May	5.79	17.763	1.128 a/	1.538
Jun	2.44	16.132	1.042 a/	1.673 a/
Jul	6.38	8.871	0.469	0.386
Aug	9.72	24.241	1.945 a/	8.178 a/
Sep	13.66 b/	19.431	0.054	3.712 a/
Oct	5.79	17.398	0.945	0.876
Nov	4.41	24.802	-0.039	0.631
Dec	0.67	10.589	-0.421	-0.052
1978 Jan	14.44 b/	35.841	1.448 a/	3.754 a/
Feb	7.16	23.024	-0.625	3.395 a/
Mar	24.28 b/	32.888	3.949 a/	22.416 a/
Apr	23.30 b/	28.724	0.948	7.135 a/
May	21.52 b/	22.133	0.201	4.482 a/
Jun	4.21	4.926	-0.140	0.450
Jul	12.87 b/	11.391	0.741	4.848 a/
Aug	12.48 b/	11.429	1.955 a/	8.470 a/
Sep	7.75	7.292	0.400	1.987 a/
Oct	11.30 b/	16.610	1.021 a/	4.406 a/
Nov	23.69 b/	15.653	1.838 a/	9.628 a/
Dec	6.57	10.979	1.724 a/	3.668 a/
1979 Jan	10.11	17.370	0.540	4.524 a/
Feb	7.36	7.431	0.912 a/	3.116 a/
Mar	4.80	9.078	-0.811 a/	2.939 a/
Apr	19.16 b/	13.684	-2.414 a/	9.269 a/
May	11.30 b/	5.111	0.541	6.675 a/
Jun	14.44 b/	8.844	1.405 a/	2.568 a/
Jul	4.61	6.355	0.312	3.288 a/
Aug	12.48 b/	9.580	3.385 a/	11.993 a/
Sep	51.82 b/	18.443	4.081 a/	23.300 a/
Oct	29.00 b/	14.696	-3.027 a/	6.627 a/
Nov	34.90 b/	19.696	3.424 a/	18.097 a/
Dec	23.69 b/	14.977	-3.182 a/	20.581 a/
1980 Jan	19.56 b/	13.784	1.332 a/	5.873 a/
Feb	12.08 b/	13.311	1.952 a/	6.065 a/
Apr	7.36	13.479	1.148 a/	2.887 a/
May	6.18	6.279	1.529 a/	5.606 a/
Jun	1.66	3.964	-0.140	-0.110
Jul	23.89 b/	8.230	3.713 a/	17.846 a/
Aug	16.80 b/	8.232	-2.242 a/	4.830 a/
Sep	4.21	6.156	-0.316	1.812 a/
Oct	14.25 b/	23.740	0.974 a/	2.958 a/
Nov	6.38	8.397	-1.085 a/	2.617 a/
Dec	10.90	4.792	-1.125 a/	4.362 a/
1981 Jan	39.82 b/	17.523	-3.203 a/	11.000 a/
Feb	8.93	4.559	-1.027 a/	2.023 a/
Mar	17.98 b/	11.438	-2.688 a/	17.426 a/
Apr	26.25 b/	25.164	1.131 a/	6.399 a/
May	23.89 b/	15.016	2.403 a/	9.730 a/
Jun	7.95	15.891	1.803 a/	6.752 a/

a/ Significantly different from zero at the 1 per cent level.
b/ The hypothesis of normality can be rejected at the 5 per cent level.

Table 2. Chi-Square Values and Descriptive Statistics of Price Change Distributions: Monthly Equivalents of Annual Rates

	Chi-Square	Variance	Skewness	Kurtosis
1978 Apr	5.98	0.607	-0.854 a/	1.052
May	2.25	0.564	-0.676	1.597 a/
Jun	8.15	0.594	-0.619	1.234
Jul	3.82	0.653	-0.678	0.542
Aug	4.21	0.611	-0.708	0.658
Sep	1.46	0.565	-0.583	1.005
Oct	3.43	0.575	-0.562	0.977
Nov	7.75	0.535	-0.577	1.451
Dec	5.39	0.496	-0.327	1.601 a/
1979 Jan	6.57	0.579	-0.185	1.050
Feb	3.23	0.635	0.137	0.540
Mar	4.61	0.500	-0.282	1.225
Apr	2.84	0.464	-0.513	0.779
May	2.25	0.428	-0.601	0.746
Jun	3.03	0.437	-0.506	1.163
Jul	6.57	0.412	-0.320	1.637 a/
Aug	12.67 b/	0.426	0.192	3.369 a/
Sep	3.62	0.471	0.338	2.526 a/
Oct	2.84	0.449	-0.661	2.710 a/
Mar	26.25 b/	25.329	-2.686 a/	14.686 a/
Nov	8.34	0.394	-0.846 a/	3.802 a/
Dec	10.70	0.470	-0.589	3.131 a/
1980 Jan	6.97	0.518	-0.184	2.639
Feb	8.54	0.502	0.052	3.367 a/
Mar	7.16	0.611	-0.422	5.561 a/
Apr	6.77	0.499	0.604	2.246 a/
May	3.82	0.554	0.156	1.121
Jun	3.62	0.537	0.058	1.003
Jul	6.57	0.662	0.475	1.535
Aug	3.43	0.710	0.367	1.680 a/
Sep	3.62	0.615	-0.284	-0.488
Oct	2.84	0.657	-0.141	-0.582
Nov	1.46	0.725	-1.001	-0.395
Dec	3.82	0.721	0.112	-0.473
1981 Jan	0.67	0.720	0.012	-0.257
Feb	1.26	0.779	-0.287	0.014
Mar	1.85	0.567	-0.062	-0.423
Apr	3.62	0.599	-0.546	1.394
May	9.52	0.677	-0.225 a/	4.163 a/
Jun	3.23	0.650	-0.729	1.517

a/ Significantly different from zero at the 1 per cent level.
b/ The hypothesis of normality can be rejected at the 5 per cent level.

greater symmetry, as shown by the distribution of yearly price changes. The monthly distributions are highly leptokurtic, a characteristic that persisted in several of the yearly observations. This indicates that, although symmetrical, the distribution of price changes after one year's adjustment may be more peaked than the normal. 1/

As mentioned above, in most of the cases observed, the distributions of monthly price fluctuations appear to be skewed to the right, implying that a few commodities lead the inflationary process and pull up the mean, while most of the rest lag below the average. 2/ It is apparent, however, that the magnitude and direction of skewness is related to the magnitude of the inflationary process and also (as observed by Vining and Elwertowski (1976) for the United States), to the fluctuations and the direction of change of the general inflation rate.

In a regression of the skewness (SK_t) on both the level and the change in the rate of inflation, the following results were obtained:

$$SK_t = \underset{(2.46)}{-2.187} + \underset{(3.09)}{0.376}\ DP_t + \underset{(2.05)}{0.296}\ \Delta DP_t \qquad R^2 = 0.338 \qquad D.W. = 2.087$$

Clearly, accelerating inflation tends to increase the positive skew of the distribution, whereas moderation in the aggregated rate appears to be connected with a marked reduction in the rate of inflation of few commodities, but most of them still remain above the mean.

One implication of the nonnormality of the monthly price changes is that conventional measure of variability may yield misleading results. 3/ The next section considers, therefore, two alternative quantitative measures of relative price variability and, by reclassifying the consumer price index into different categories, the sources of relative price changes by group of commodities are analyzed.

1/ Vining and Elwertowski (1976) point out that this appears to be a common feature of the distribution of price changes, particularly speculative prices.

2/ This characteristic appears to be confirmed by simple observation. From the 3,050 observations of individual price changes available (50 monthly observations on 61 commodities), 1,991 were below their corresponding average and 1,059 above it.

3/ For example, Fama and Roll (1971) have shown that in nonnormal stable distributions the sample standard deviation is unstable and does not converge upon increases in sample size.

II. The Measurement and the Sources of Relative Price Variability

A number of alternative measures have been used to quantify the magnitude of variability in relative prices. The measures most commonly used are those based on the variance of individual prices around the mean. Vining and Elwertowski (1976) and Hercowitz (1981) used an unweighted variance, and Parks (1978) calculated a weighted variance as suggested by Theil (1967). The index below is calculated on the basis of the latter measure: 1/

$$VR_t = \sum_{i=1}^{n} w_i (Dp_{it} - DP_t)^2. \qquad (1)$$

where p_{it} is the logarithm of the price of commodity i, P_t is the logarithm of the average price index, and $DX_t = X_t - X_{t-1}$; therefore, $(Dp_{it} - DP_t)$ is the rate of change of the relative price of the ith commodity and w_i is the share of i in the CPI. VR measures the non-proportionality of price changes, and it increases the larger are the differences between individual price movements. Its lower bound is zero, for the case where all the prices change proportionally.

Given the potential problem with the second moment of some nonnormal distributions, an alternative measure, which is independent of the central values of the distribution, is also calculated. The index constructed is a weighted average of the absolute values of all the possible differences between pairs of observations: 2/

$$DR_t = [1/(n-1)] \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} (w_i + w_j) |(DP_i - DP_j)_t| \qquad (2)$$

When all prices change at the same rate, DR = 0 and increases in proportion to the size of pairwise disparities in the rate of individual inflation.

1/ The variance proposed by Theil (1967) is the Divisia second moment of the logarithmic price changes. It is Divisia because the weights are average budget shares. In the present case the weights are base period shares and therefore many of the desirable properties of the Divisia Indexes are not present. The author is indebted to K. Clements for clarifying the differences.

2/ This is a weighted variation of Gini's mean difference index.

The average rates of inflation for each period, together with the square root of VR_t and the values of DR_t, are reported in Table 3 for the monthly observations and in Table 4 for the annual ones. 1/ It is clear that relative prices have fluctuated much more on a monthly than on a yearly basis. On average, the value of VR_t is about one half of the rate of monthly inflation, while it is less than 20 per cent of the yearly rate. A similar tendency is observed in the comparison of the values for DR_t. 2/

A first test of the associations between money and inflation, on the one hand, and relative prices, on the other, is reported in Table 5. The simple regressions relating the measures of variability to the average rate of inflation indicate that there is a positive and significant link between both variables at the monthly level, but the relationship is not significant (and has the opposite sign) for annual rates. 3/ DR_t appears to perform better than VR_t by yielding more precise estimates. The relationship between the actual rate of growth of money 4/ and either measure of price variability is not significant. These results are only indicative, and a more careful evaluation of the nature of the relationships is elaborated in the next section.

The aggregated measures of variability may conceal very different relative price behavior within specific groups of commodities and may hide long-term trends in the relative prices between the groups. In order to analyze the main sources of relative price variability, the 61 components of the CPI are reclassified in three categories: food, other goods, and services. 5/ Individual price indices for each category and a VR index of relative price changes within each group were also computed. The rate of price change of each category, as well as an alternative price

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1/ The square root of VR_t is tabulated here so it can be interpreted as percentage per month, which is the same interpretation as the rate of inflation.

2/ Both measures of variability are highly correlated. The correlation coefficient between VR and DR is 0.936 (monthly) and 0.914 (annual).

3/ It is interesting to see that the relationship between inflation and relative prices was noted in Argentina well before many of the studies mentioned on page 2 (footnote 1) were published. Diaz-Alejandro (1970, p. 378) in his economic history of Argentina, says: "The thesis linking inflation with changes in the relative prices was first put forth in Argentina by Julio H.G. Olivera in 1959 in his "El Caso de la Argentina," an unpublished paper prepared for ECLA." The author thanks J.C. de Pablo for bringing this reference to his attention.

4/ Money is defined as M_2 (end of period), and data were obtained from the Central Bank of Argentina.

5/ The complete breakdown of the CPI, including the weight of each commodity, is presented in Appendix Table 1.

Table 3. Inflation and Relative Price Variability - Monthly Rates

	Inflation	SQRT(VR)	DR
1977 May	7.09	5.769	5.265
Jun	7.39	4.455	4.669
Jul	8.38	3.225	3.350
Aug	9.92	6.712	5.692
Sep	9.10	4.741	4.670
Aug	10.45	4.062	4.327
Nov	8.59	4.491	5.165
Dec	7.85	3.639	3.923
1978 Jan	10.17	6.928	6.721
Feb	6.59	4.470	4.765
Mar	9.16	5.321	4.874
Apr	10.49	5.582	4.912
May	8.99	5.771	5.492
Jun	6.19	2.572	2.786
Jul	7.77	3.066	3.378
Aug	6.74	3.442	3.167
Sep	7.25	2.529	2.774
Oct	7.89	3.890	4.173
Nov	8.47	4.432	4.241
Dec	9.46	3.234	3.593
1979 Jan	9.96	4.520	4.853
Feb	7.76	2.718	2.830
Mar	7.60	2.439	2.931
Apr	6.65	3.478	3.504
May	7.14	2.380	2.344
Jun	8.97	3.097	3.349
Jul	8.44	2.656	2.800
Aug	10.03	6.675	4.807
Sep	7.68	2.957	3.070
Oct	2.73	7.092	5.335
Nov	5.29	3.983	3.804
Dec	5.23	3.039	3.049
1980 Jan	5.00	2.952	3.263
Feb	5.90	3.496	3.499
Mar	5.78	4.617	4.468
Apr	5.74	3.943	3.937
May	5.93	2.715	2.662
Jun	5.06	1.883	2.134
Jul	6.24	2.127	2.188
Aug	2.54	5.165	4.064
Sep	5.49	2.605	2.788
Oct	5.78	4.894	4.907
Nov	4.97	3.157	3.175
Dec	4.52	2.071	2.243
1981 Jan	2.89	3.794	3.336
Feb	4.83	2.074	2.261
Mar	5.98	3.213	2.985
Apr	7.29	4.596	4.798
May	7.50	5.555	4.457
Jun	8.29	3.398	3.791
Mean	7.10	3.912	3.831
Standard Deviation	1.99	1.357	1.062

Table 4. Inflation and Relative Price Variability - Monthly Equivalents of Annual Rates

	Inflation	SQRT (VR)	DR
1978 Apr	6.17	0.849	0.902
May	6.26	0.742	0.818
Jun	6.21	0.782	0.856
Jul	6.18	0.823	0.917
Aug	6.04	0.744	0.854
Sep	5.96	0.717	0.823
Oct	5.85	0.716	0.820
Nov	5.84	0.688	0.749
Dec	5.91	0.639	0.721
1979 Jan	5.89	0.754	0.858
Feb	5.94	0.814	0.927
Mar	5.87	0.743	0.840
Apr	5.70	0.705	0.801
May	5.63	0.642	0.750
Jun	5.76	0.696	0.796
Jul	5.79	0.725	0.806
Aug	5.93	0.904	0.891
Sep	5.95	0.871	0.892
Oct	5.73	0.714	0.791
Nov	5.57	0.567	0.644
Dec	5.38	0.609	0.683
1980 Jan	5.14	0.625	0.690
Feb	5.04	0.586	0.684
Mar	4.95	0.661	0.755
Apr	4.91	0.571	0.722
May	4.86	0.642	0.793
Jun	4.68	0.613	0.770
Jul	4.55	0.679	0.831
Aug	4.16	0.926	1.001
Sep	4.05	0.948	1.004
Oct	4.21	0.810	0.942
Nov	4.19	0.753	0.931
Dec	4.15	0.755	0.926
1981 Jan	4.04	0.798	0.938
Feb	3.97	0.826	0.975
Mar	3.98	0.735	0.857
Apr	4.07	0.841	0.893
May	4.16	0.998	0.990
Jun	4.34	0.906	0.958
Mean	5.21	0.747	0.841
Standard Deviation	0.81	0.108	0.096

Table 5. Inflation, Money, and Relative Prices

Dependent Variable	Constant	Inflation Rate	Money Growth	R^2 D.W.
VR_t(M) 1/	5.49	1.636		0.073
	(0.88)	(1.95)		2.09
DR_t(M)	2.20	0.228		0.182
	(4.29)	(3.27)		1.80
VR_t(M)	13.91		40.45	0.014
	(3.32)		(0.83)	2.01
DR_t(M)	3.38		5.66	0.036
	(9.23)		(1.33)	1.612
VR_t(A) 2/	1.029	-0.089		0.051
	(3.09)	(1.39)		1.54
DR_t(A)	1.162	-0.063		0.072
	(5.89)	(1.67)		1.60

Note: Figures in parentheses are t-values.

1/ (M) monthly. The period is May 1977 to June 1981 for (M).

2/ (A) annual. The period is April 1978 to June 1980 for (A). The estimations for (A) are corrected by using the Cochrane-Orcutt technique.

index that excludes food products, is reported in Table 6, and the indices of relative price changes within each group appear in Table 7. 1/

One of the clear trends emerging from the data is the upward movement in the relative price of services, particularly after November 1979. 2/ This trend is observed more clearly when the percentage deviation of each individual index from the aggregate index is calculated and plotted in Figure 3 where the percentage deviation of each index from the CPI is calculated as $\ln C_k = \ln (P_k/CPI)$. The main explanation for the upward trend in the relative price of services is to be found in the exchange rate policy followed during most of the period, which caused a significant real appreciation of the peso, with the consequent increase in the relative price of nontraded commodities, many of which are included in the index of prices for services. A more detailed discussion of the role of the exchange rate in determining relative changes appears in the next section.

Figure 3 indicates that at least a portion of the observed price variability during the period can be traced to relative price changes among the three groups of commodities. Table 7 shows, however, that prices within each category have not changed homogeneously and that, in some cases, individual price fluctuations have displayed a large degree of disparity. In order to assess the specific contribution to overall price variability in the economy of relative price changes among groups and of relative price changes within each group, the weighted variance (VR_t) can be decomposed as follows: 3/

$$VR_t = \lambda_F VRF_t + \lambda_G VRG_t + \lambda_S VRS_t + VB_t;\ \lambda_F + \lambda_G + \lambda_S = 1 \qquad (3)$$

1/ The price index for category K is computed as follows:

$$PK = \sum_{i=1}^{m} w_i P_i/\lambda_k$$

where w_i is the share of commodity i in the CPI and λ_k is the combined share of the m commodities of class K in the CPI. The relative price variability for the K category equals

$$VRk_t = \sum_{i=1}^{m} (w_i/\lambda_k)(DP_i - DP_k)_t^2$$

2/ The average monthly rate of inflation for the period November 1979 - June 1981 was 5.51 per cent. The average inflation rate for each group in that period was: food, 5.31; goods, 5.40; and services, 6.27.

3/ See Theil (1967). A similar procedure is used by Blejer and Leiderman (1982) to distinguish between traded and nontraded goods and by Cukierman and Leiderman (1982) to distinguish between controlled and free commodities.

Table 6. Monthly Rates of Inflation by Sector

	Food	Goods	Services	Nonfood Index
1977 May	5.57	8.33	4.85	7.31
Jun	7.87	6.04	6.37	6.14
Jul	8.40	8.37	4.93	7.38
Aug	7.64	11.42	19.18	13.67
Sep	10.32	8.69	5.22	7.67
Oct	10.01	10.45	14.33	11.60
Nov	9.75	9.15	6.12	8.25
Dec	6.43	9.06	11.53	9.79
1978 Jan	6.98	13.45	16.90	14.49
Feb	7.22	7.21	6.67	7.04
Mar	9.25	7.56	10.91	8.59
Apr	10.97	7.39	8.49	7.73
May	9.08	8.22	8.22	8.22
Jun	4.99	7.27	7.33	7.29
Jul	6.49	7.86	8.72	8.13
Aug	7.52	6.78	7.66	7.06
Sep	7.56	6.98	5.82	6.61
Oct	9.25	6.66	8.74	7.32
Nov	9.45	8.25	7.04	7.86
Dec	10.78	8.30	8.72	8.43
1979 Jan	11.54	8.43	8.07	8.31
Feb	8.70	8.19	7.55	7.99
Mar	6.74	8.54	7.51	8.21
Apr	4.85	7.44	7.21	7.37
May	6.52	7.67	6.77	7.39
Jun	9.00	6.81	12.07	8.47
Jul	8.60	7.22	6.74	7.06
Aug	13.30	6.57	6.26	6.47
Sep	7.25	7.32	10.49	8.35
Oct	0.14	6.38	7.39	6.71
Nov	4.69	5.65	8.08	6.46
Dec	5.39	4.49	7.82	5.62
1980 Jan	5.35	4.42	6.17	5.03
Feb	6.75	5.22	7.14	5.89
Mar	5.07	5.11	6.36	5.55
Apr	6.51	4.01	5.54	4.55
May	5.74	5.40	6.23	5.70
Jun	3.79	5.50	5.27	5.42
Jul	6.03	5.04	6.49	5.56
Aug	0.65	5.46	5.30	5.40
Sep	4.80	5.13	7.39	5.95
Oct	5.75	8.09	5.95	7.31
Nov	4.73	4.63	6.66	5.37
Dec	4.79	4.14	5.40	4.61
1981 Jan	2.75	3.29	3.17	3.24
Feb	4.75	4.83	7.17	5.70
Mar	5.59	5.36	4.57	5.07
Apr	6.76	7.64	8.16	7.83
May	8.01	6.44	6.25	6.37
Jun	8.32	8.21	6.27	7.49
Mean	6.97	7.00	7.66	7.22
Standard Deviation	2.57	1.95	2.93	2.03

Table 7. Relative Price Variability within Sectors

	SQRT(VPF) Food	SQRT(VPG) Goods	SQRT(VPS) Services	SQRT(VPNF) Nonfood Index
1977 May	5.114	6.626	3.502	6.146
Jun	4.354	2.549	7.249	4.348
Jul	2.595	3.045	3.818	3.610
Aug	3.557	4.199	11.150	7.629
Sep	5.284	2.234	5.474	3.754
Oct	3.233	3.163	6.313	4.582
Nov	4.796	3.610	4.223	4.018
Dec	3.599	2.744	2.271	2.846
1978 Jan	4.414	6.230	7.962	6.913
Feb	5.680	2.660	3.022	2.772
Mar	4.856	1.975	10.072	5.689
Apr	6.083	4.541	2.864	4.185
May	7.610	2.868	3.477	3.043
Jun	2.682	1.720	2.217	1.867
Jul	2.893	2.013	4.566	2.952
Aug	4.388	1.631	2.753	2.033
Sep	2.925	1.175	3.130	1.977
Oct	4.116	3.026	3.690	3.350
Nov	4.328	4.928	2.166	4.393
Dec	3.576	2.278	2.483	2.343
1979 Jan	5.134	1.997	5.031	3.123
Feb	3.240	1.322	2.822	1.872
Mar	2.650	2.043	1.405	1.947
Apr	2.672	3.999	2.372	3.635
May	2.918	1.091	2.342	1.584
Jun	2.505	1.251	4.566	3.501
Jul	2.462	1.444	4.133	2.483
Aug	8.011	1.796	1.710	1.779
Sep	2.709	1.499	4.743	3.114
Oct	8.710	1.841	2.341	2.039
Nov	5.262	1.514	1.204	1.804
Dec	3.472	1.324	3.364	2.560
1980 Jan	2.492	3.535	2.136	3.313
Feb	4.038	2.858	1.842	2.763
Mar	5.659	3.064	3.530	3.246
Apr	4.106	3.910	1.130	3.464
May	3.484	1.761	1.041	1.644
Jun	1.696	1.535	1.667	1.575
Jul	2.113	1.260	2.927	1.975
Aug	6.195	1.756	2.433	1.963
Sep	2.973	1.718	2.076	2.091
Oct	4.089	5.532	4.114	5.279
Nov	3.203	3.333	1.560	3.103
Dec	2.409	1.132	2.388	1.673
1981 Jan	4.574	2.214	4.064	2.833
Feb	2.234	1.429	1.569	1.814
Mar	2.955	2.007	5.436	3.320
Apr	3.847	5.783	2.821	5.161
May	7.652	1.599	2.029	1.727
Jun	3.887	2.666	2.628	2.798
Mean	4.07	2.63	3.48	3.15
Standard Deviation	1.60	1.39	2.11	1.41

where VRF, VRG, and VRS are the measures of within group price variability, computed as in footnote 1, page 17, and presented in Table 7. VB is the measure of relative price variance among groups, which is equal to

$$VB_t = \lambda_F(DPF - DP)^2 + \lambda_G(DPG - DP)^2 + \lambda_S(DPS - DP)^2 \qquad (4)$$

where DPF, DPG, and DPS are the rates of inflation for each group of commodities (see Table 6).

In order to evaluate the effects of fluctuations of each of the partial indices on the determination of the total variability, it is now necessary to evaluate the shares of VR_t associated with each component: 1/

$$\beta_{1t} = \lambda_F VRF_t / VR_t$$

$$\beta_{2t} = \lambda_G VRG_t / VR_t$$

$$\beta_{3t} = \lambda_S VRS_t / VR_t$$

$$\beta_{4t} = VB_t / VR_t$$

$$\sum_{i=1}^{4} \beta_{it} = 1$$

β_1 to β_3 represent the portions of VR arising from relative price variability within each group, while β_4 is the share associated with changes among groups. These shares are reported in Table 8. It is clear from the table that the importance of the different indices in determining the overall level of price variability fluctuated widely from month to month. However, the pattern emerging from the period averages appears to be the dominant one: most of the price variability in the economy (about 90 per cent) arises from intragroup relative price changes, with price variability within the group of food products accounting for about

1/ The individual indices reported in Table 7 are not directly comparable since the degree of aggregation in each group is different, affecting the absolute level of each computed index. See Theil (1967, p. 162).

FIGURE 3

CHANGES IN THE RELATIVE PRICE OF FOOD, GOODS, AND SERVICES

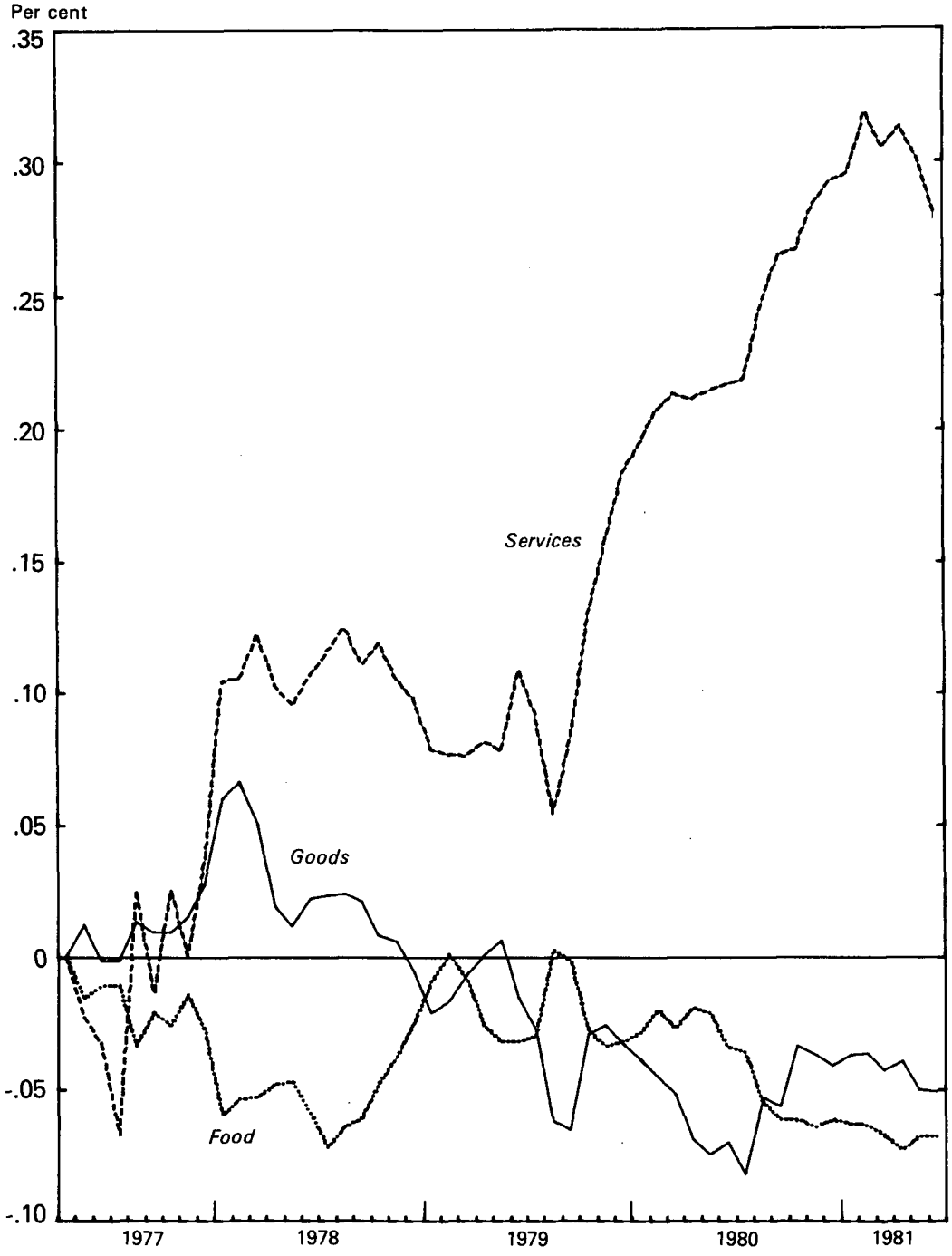

Table 8. Proportion of Total Relative Price Variability Accounted for by Each Component

	Within Food	Within Goods	Within Services	Among Sectors
1977 May	38.33	49.41	5.07	7.18
Jun	46.60	12.26	36.44	4.70
Jul	31.58	33.37	19.29	15.76
Aug	13.70	14.66	37.99	33.65
Sep	60.61	8.31	18.35	12.72
Oct	30.90	22.70	33.25	13.15
Nov	55.62	24.20	12.17	8.01
Dec	47.73	21.30	5.36	25.61
1978 Jan	19.80	30.28	18.18	31.73
Feb	78.78	13.26	6.29	1.66
Mar	40.63	5.16	49.33	4.88
Apr	57.94	24.78	3.62	13.65
May	84.82	9.25	5.00	0.93
Jun	53.06	16.76	10.23	19.95
Jul	43.43	16.13	30.53	9.90
Aug	79.29	8.41	8.81	3.49
Sep	65.27	8.08	21.09	5.56
Oct	54.61	22.67	12.38	10.34
Nov	46.52	46.29	3.29	3.89
Dec	59.65	18.59	8.12	13.65
1979 Jan	62.94	7.31	17.06	12.69
Feb	69.33	8.86	14.84	6.96
Mar	57.58	26.26	4.57	11.59
Apr	28.81	49.52	6.41	15.27
May	73.35	7.87	13.33	5.45
Jun	31.92	6.11	29.92	32.05
Jul	41.91	11.07	33.34	13.69
Aug	70.26	2.71	0.90	26.13
Sep	40.95	9.63	35.41	14.01
Oct	73.57	2.52	1.50	22.40
Nov	85.13	5.41	1.26	8.21
Dec	63.67	7.11	16.87	12.35
1980 Jan	34.77	53.72	7.21	4.30
Feb	65.08	25.03	3.82	6.07
Mar	73.31	16.50	8.05	2.15
Apr	52.90	36.84	1.13	9.13
May	80.33	15.75	2.02	1.89
Jun	39.61	24.90	10.80	24.69
Jul	48.14	13.14	26.08	12.63
Aug	70.19	4.33	3.06	22.43
Sep	63.51	16.28	8.74	11.46
Oct	34.06	47.86	9.73	8.36
Nov	50.22	41.77	3.36	4.66
Dec	65.96	11.19	18.30	4.55
1981 Jan	70.91	12.75	15.79	0.55
Feb	56.64	17.78	7.88	17.70
Mar	41.27	14.62	39.41	4.70
Apr	34.17	59.28	5.19	1.36
May	92.57	3.10	1.84	2.49
Jun	63.84	23.05	8.24	4.87
Mean	54.92	19.76	14.02	11.30

half of the total. Price variability within the group of goods was also relatively important, accounting for about 25 to 50 per cent of total variability in one third of the cases. 1/

The fact that relative prices between food products have fluctuated more than other prices is not surprising, given the higher incidence of seasonal factors within the group. 2/ It is, however, interesting that relative price changes within the groups of goods and services, as well as between groups, have accounted for an important share of the total (only slightly less than 50 per cent). In addition, it is apparent that the relative importance of food price variations declines as the inflationary process accelerates. In order to test this possibility, maximum likelihood parameters of a four-equation system relating the shares β_1 to β_4 to the rate of inflation are estimated. 3/

Food	β_{1t}	$= 74.79 - 2.80\ DP_t$ $(8.32)\ (2.29)$
Goods	β_{2t}	$= 20.61 - 0.12\ DP_t$ $(2.67)\ (0.11)$
Services	β_{3t}	$= -0.02 + 1.98\ DP_t$ $(0.01)\ (2.40)$
Across sectors	β_{4t}	$= 4.62 + 0.94\ DP_t$ $(1.05)\ (1.75)$

These results confirm that the share of food price variations in total relative price variability falls as the inflationary process accelerates. The portion of overall variability due to fluctuations in the relative price of goods does not seem to change with the magnitude of the inflationary process, but the parts contributed by relative price changes within the service sector and by relative price changes among sectors increase. A possible inference from this result is that the

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1/ Additional information on this issue is obtained by calculating the share of relative price changes between food and nonfood commodities (i.e., VNF/VR), where

$$VNF = \lambda_F(DPF - DP)^2 + (1 - \lambda_F)(DPNF - DP)^2$$

and DPNF is the rate of change in the price of nonfood products. VNF has fluctuated between 0.4 per cent and 29.8 per cent, with an average of 7.9 per cent.

2/ Cornell (1981) also reported a similar conclusion regarding the price of food products in the United States.

3/ Figures in parentheses are asymptotic t-values. The constants were constrained to add up to 100 and the coefficients to zero.

differences in the speed of adjustment to inflationary shocks across service industries are greater than those within the other sectors. 1/ Considering the commodity composition of the various groups, it is also feasible to assert that the observed link between inflation and relative price variability appears to be intensified by the price relationships within industries producing nontraded commodities.

III. The Determinants of Relative Price Variability

The results reported in Table 5 reveal the presence of a positive link between the level of inflation and the degree of relative price variability. No such relationship was found between monetary growth and relative prices. However, recent studies carried out within the framework of market-clearing models with rational expectations and imperfect information have stressed that the structure of relative prices is likely to be affected only by "surprises"--that is, by the unexpected components of nominal shocks--while anticipated shifts in nominal variables are basically neutral with respect to the relationship between individual prices. Parks (1978) and Hercowitz (1981) applied two variants of the partial information models of Lucas (1973) and Barro (1976) to the explanation of relative price fluctuations, deriving estimable forms that were subject to empirical implementation. Both formulations obtained price equations for each individual commodity from supply and demand functions that are dependent on the extent of confusion between actual and perceived prices. Parks incorporated a measure of nominal income into the demand function, while Hercowitz included in it the stock of money, deflated by the expected price level, to account for real balance effects.

By aggregating across markets and substituting into the weighted variance, Parks obtained an estimable equation that includes quadratic and linear terms for unanticipated inflation and real income. Hercowitz solved the system in terms of the exogenous variables (money growth and real shifts) and estimated a reduced form, relating price variability to innovation in the rate of unexpected monetary growth.

1/ Another possible explanation is the effect of administrative and regulated prices. Although only few price controls remained in effect in the goods sector, tariffs and rates of public services and utilities were continuously controlled. If higher rates of inflation induced discrete adjustments of the various public sector rates which, in order to minimize their inflationary impact, were performed at different time periods, a result like the one observed could emerge.

Both studies abstract from open economy considerations when formulating their specification. However, in the case of a country with an important external sector, it is highly possible that at least a portion of local price variability is determined by the behavior of foreign prices and by other variables related to the external sector. 1/

Given the significance of the foreign sector in Argentina and the prominent role assigned to external sector considerations in the implementation of economic policy, it seems important to consider, when explaining the behavior of relative prices, a variable reflecting developments in the foreign sector. During most of the period considered here, and particularly after 1978, there has been a trend in Argentina toward a greater integration of the domestic goods and financial markets with the corresponding world markets. Increasing numbers of commodities entered the category of internationally traded goods, especially from the import side, following the liberalization of commercial policies and the implementation of exchange rate policies that increased foreign competitiveness and reduced the cost and risk of engaging in foreign trade operations.

In a small open economy, price variability of internationally traded goods tends to be determined mainly by external factors, while domestic variables affect only the price structure of nontraded goods. 2/ Therefore, the larger the share of traded commodities, the higher the importance of foreign factors compared with domestic factors in the determination of relative price fluctuations. If foreign relative prices display larger stability than domestic variables--a sensible assumption in a highly inflationary setting--it follows that relative price variability should decline as additional commodities become exposed to international rather than domestic pricing. In order to capture such an effect, a measure of the real value of the exchange rate is included in the specifications estimated below. This is based on the rationale that, as the real value of the exchange rate falls, not only the volume of existing imports increases but also imports of additional commodities, not previously traded, begin to take place because the protective effect of prohibitive and redundant tariffs is eroded or eliminated. A positive relationship should therefore be observed between an aggregate measure of relative price variability and the level of the real exchange rate. 3/

1/ Blejer and Leiderman (1982) extend the Parks framework to the case of a small open economy operating under fixed exchange rates. Frenkel (1982) pointed out the desirability of including variables representing the external sector in the set of variables explaining domestic relative price variability.

2/ This result is shown to hold for the case of Mexico by Blejer and Leiderman (1982).

3/ It is clear that real appreciation of the domestic currency reduces the competitiveness of domestic goods in export markets, reducing the number of exportable goods actually traded. As it is well established, however, that exports tend to be much more commodity concentrated than

Two specifications, following the models discussed above, are implemented here to explain the fluctuations in relative prices. First, relative price variability is estimated as a function of unexpected inflation and changes in real money balances. Then, the indices of price variability are related to measures of unexpected monetary shocks. In both cases, the real exchange rate is included to account for the effects of increased openness of the import side of the economy.

By adapting the partial information model to consider a sector of internationally traded goods and a domestic sector, a specification of the following form can be obtained (see Appendix II for the derivations):

$$V_t = a_0 + a_1(DP^*_t)^2 + a_2(DM_t - DP_t)^2 + a_3(RE_t)^2 \qquad (5)$$

where V_t stands for VR_t or DR_t, DP^*_t is the unexpected rate of inflation, $(DM - DP)$ is the rate of change of real money balances, and RE is the real exchange rate. A number of different measures of unexpected inflation were used. In the results reported here unexpected inflation is represented by the difference between realized inflation and the 30-day nominal interest rate set at the end of the previous month. 1/

The results obtained in the estimation of equation (5) for the period May 1977 to June 1981 are reported in Table 9. They clearly support the hypothesis that inflation and relative price variability are linked only to the extent that inflationary developments are unexpected. While the coefficient of DP^*_t is significant in all the equations, the expected component of price changes does not yield a significant coefficient. 2/ The hypothesis advanced here about the positive link between price variability and the real exchange rate also received strong support. The rate of change in real money balances, however, is significant (at a low level) only in the equation for DR_t.

Equation (5) is not, however, a reduced form, and this fact may account for the poor performance of the monetary variable. An alternative procedure, closer to the Hercowitz formulation, is to solve for the aggregate rate of inflation in terms of the rate of monetary growth and to obtain a specification relating relative price variability to a measure of unexpected monetary changes. In order to implement a test

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3/ (Cont'd from page 25) imports (see Michaely (1962)), the effects should be, in the main, in the direction described here.

1/ The assumption is that interest rates are set by the market as efficient predictors of future inflation rates. On the relevance of this assumption for Argentina, see Leiderman (1979). Interest rates on 30-day instruments were obtained from the Central Bank of Argentina, and nominal exchange rates are from International Financial Statistics.

2/ A similar result for a shorter period, and with seasonally unadjusted data, is reported in Blejer (1981).

Table 9. Inflation and Relative Price Variability in Argentina, May 1977 to June 1981

Dependent Variable	Constant	$(DP^*_t)^2$	$(DM_t-DP_t)^2$	$(RE_t)^2$	$(DP^E_t)^2$	R^2/D.W.
VR_t	2.510	1.521	1.046	1.20		0.370
	(0.57)	(4.16)	(1.40)	(2.06)		2.11
DR_t	2.051	0.089	0.084	0.195		0.385
	(5.31)	(2.80)	(1.72)	(3.83)		1.90
VR_t	2.323	1.498	-0.152	1.085	0.055	0.351
	(0.500)	(3.99)	(0.22)	(1.57)	(0.70)	2.13
DR_t	1.993	0.086	-0.012	0.171	0.008	0.381
	(4.97)	(2.66)	(0.21)	(2.85)	(1.14)	2.00

along these lines, it is necessary to distinguish between the expected and the unexpected components of the monthly rate of money supply growth. The hypothesis postulated here is that the money supply follows a second order autoregressive process, with seasonality factors at the sixth and twelfth lags. Such a process was estimated for the period February 1976 to June 1981 with the following results:

$$DM_t = \underset{(0.26)}{0.003} + \underset{(2.32)}{0.281}\ DM_{t-1} + \underset{(1.22)}{0.127}\ DM_{t-2} + \underset{(3.11)}{0.373}\ DM_{t-6} + \underset{(1.26)}{0.127}\ DM_{t-12}$$

$$R^2 = 0.440; \quad D.W. = 1.80.$$

The autocorrelation function of the residual term, calculated with up to 13 lags, shows no pattern of serial correlation, and the Box-Pierce Q-statistic is consistent with the hypothesis that the residuals are white noise. 1/ We interpret the fitted values of equation (6) as the predicted or expected value of money supply growth ($\hat{DM}_t$) and the difference between actual money growth and its predicted value ($DM_t - \hat{DM}_t$) as the unexpected rate of monetary growth (DM^*_t).

A number of estimations that include linear and quadratic terms of DM* and of the real exchange rate were performed for the two aggregated measures of variability, as well as for the VR measure which excludes food products. The results are reported in Table 10. The hypothesis about the effects of the real exchange rate is again confirmed, as it continues to be significant in all the equations, in both linear and quadratic form. The effects of the monetary shock are not significant in quadratic form, but the linear specification does support the hypothesis derived from the partial information models about the monetary effects on relative prices. Although actual monetary growth appears to have no effect on relative price variability (Table 5), unexpected changes in the supply of money do increase the degree of price dispersion. Expected changes in the rate of monetary expansion appear, in fact, to diminish relative price variations, although the negative coefficients do not reach the conventional level of significance. Unlike in low inflation countries where, as reported by Fischer (1981b), the association between inflation and relative price variability follows mostly from the behavior of food and energy prices, in Argentina the nonfood as well as the aggregated variability index appear to be very similarly affected by monetary and exchange rate variables. 2/

1/ The value of Q is 7.77, which has a significance level of 0.86, based on the X^2 distribution with 13 degrees of freedom.

2/ The limitations of using equation (6) to decompose the monthly rate of monetary growth should be acknowledged. In the first place less than one half of actual monetary growth is explained by (6). In addition, the estimation uses data of the complete sample which could not have been available to economic agents during the complete period.

Table 10. Unexpected Monetary Growth and Relative Price Variability

Dependent Variable	Constant	DM^*_t	RE_t	$(DM^*_t)^2$	$(RE_t)^2$	DM^E_t	R^2/D.W.
VR_t	0.906	157.84	6.24				0.227
	(0.09)	(2.76)	(1.81)				2.07
DR_t	1.167	10.98	1.02				0.328
	(1.52)	(2.33)	(3.57)				1.82
$VRNF_t$	-14.439	117.15	10.04				0.280
	(1.66)	(2.18)	(3.10)				1.91
VR_t	-1.584	139.78	10.60			-113.62	0.252
	(0.16)	(2.38)	(2.17)			(1.25)	2.08
DR_t	0.905	9.08	1.47			-11.94	0.363
	(1.17)	(1.90)	(3.69)			(1.61)	1.91
$VRNF_t$	-17.47	95.13	15.36			-138.50	0.319
	(2.00)	(1.75)	(3.38)			(1.64)	1.89
VR_t	5.379			810.25	1.54		0.117
	(1.05)			(0.79)	(2.29)		2.16
DR_t	2.229			51.07	0.21		0.265
	(5.40)			(0.61)	(3.99)		1.99
$VRNF_t$	-5.026			1,634.72	2.18		0.279
	(1.12)			(1.31)	(3.68)		0.28

The nonzero coefficients of the monetary shocks, together with the lack of significance of the quadratic monetary term, suggests that positive and negative shocks do not have the same effect on price dispersion and therefore variability responds asymmetrically to monetary surprises. This could indicate a certain degree of downward rigidity in the rate of change of individual prices. Although individual prices accelerate at different rates following a positive monetary surprise, the unexpected slowdown of monetary growth triggers a more unified price response due, probably, to similar tendencies across sectors to resist the reversion of upward price trends.

IV. Summary

The rapid inflation experienced by Argentina in recent years, together with the stabilization and liberalization policies implemented in that country over the period, provide an appropriate framework to study the response of relative commodity prices to steady inflationary pressures in the context of an economy that is becoming increasingly open.

Through an analysis of the monthly price behavior of the 61 components of the consumer price index (CPI) between 1977 and 1981, a number of conclusions are reached, which can be summarized as follows:

1. Individual commodity prices have fluctuated over a much wider range than the aggregated CPI. The span over which individual prices fluctuate is positively related to the magnitude of the inflationary process. The disparities in the rate of change of individual prices are much smaller on yearly than on monthly bases, suggesting that differences in the speed of adjustment to nominal shocks is a central factor determining relative price variability in the short run.

2. Individual price changes appear to be distributed normally around the mean on a yearly basis but are distributed asymmetrically on a monthly basis. For the majority of the observations of monthly price changes, the distribution is significantly skewed to the right, implying that most of the individual price changes were below the mean but those above tended to be at a large distance from it. The magnitude of the skewness increases with the level and the acceleration of the rate of inflation.

3. There is a clear upward trend in the relative price of services, with the consequent reduction in the relative price of goods and food products.

4. Relative price variability within the group of food products accounts, on average, for about one half of total price variability in the economy. Variability within the group of goods accounts for about 20 per cent and within services for about 15 per cent. The rest comes from relative price changes among the three large groups. The shares, however, have varied widely over the period and are not independent of

the rate of inflation; as inflation accelerates, the importance of intragroup fluctuations within the food sector falls while the importance of variability within the services sector and across sectors increases.

5. Relative price variability appears to be related to the magnitude of nominal shocks; only the unexpected components of inflation and monetary growth have explanatory power in variability equations, while the expected parts of these variables do not yield significant coefficients. The extent of import competition, as reflected by the real value of the exchange rate, has a significant effect on the variability measures, indicating that a larger integration into the world markets, at least on the import side, would tend not only to stabilize the overall rate of inflation but also to reduce the degree of variability of domestic prices.

The exercise performed here may have relevance in the context of stabilization efforts, particularly to the extent that relative price variability imposes real and welfare costs on the economy. 1/ More certainty about the future path of nominal variables, and the increase of openness with the consequent integration of goods markets may yield benefits higher than those reflected by the behavior of aggregated price measures.

1/ On the real and welfare costs of relative price variability, see Fischer (1981a) and Jafee and Kleiman (1976).

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Appendix I - Commodity Classification

The basic level of disaggregation used in the subgroup. When groups are not divided into subgroups, the group level is considered. The following table details the breakdown of the consumer price index by chapters, groups, and subgroups. The base period weights correspond to the 61 groups and subgroups used in the study.

Table 1. Consumer Price Index by Chapter, Group, and Subgroup

Chapter, Group, and Subgroup	Weight (per cent)
Chapter 1: FOOD AND BEVERAGES	
Cereals and products derived therefrom	
Bakery products	3.600
Flour and rice	0.453
Noodles and other pasta	0.898
Meats, sausages, and cold cuts	
Fresh meats	13.407
Sausages and cold cuts, dried and canned meats	1.746
Fish and shellfish: fresh and canned	0.578
Oils and fats	1.019
Dairy Products and eggs	5.722
Fruits, greens, and pulses	
Fresh, dried, and canned fruits	2.486
Fresh, dried, and canned greens	2.983
Fresh, dried, and canned pulses	0.239
Sugar, sweets, cocoa and products derived therefrom	1.335
Coffee, tea, mate, and other infusions	0.851
Vinegar, spices, sauces, condiments, and the like	0.288

Table 1 (continued). Consumer Price Index by Chapter, Group, and Subgroup

Chapter, Group, and Subgroup	Weight (per cent)
Prepared and partially prepared foods not included among the above	0.686
Food away from home	
Meals	4.141
Snacks	0.946
Beverages	
Nonalcoholic	1.722
Alcoholic	3.197
Chapter 2: CLOTHING	
Men's clothing and footwear	
Underwear	0.237
Outerwear and accessories	2.826
Footwear	0.883
Women's clothing and footwear	
Underwear	0.587
Outerwear and accessories	1.984
Footwear	1.251
Clothing and footwear for children under age 13	
Underwear	0.091
Outerwear	1.152
Footwear	0.639
Fabrics, accessories, and miscellaneous services	1.279
Chapter 3: HOUSING, FUEL, AND ELECTRICITY	
Expenses for housing	7.156
Fuel and electricity	
Electricity	2.500
Fuel	1.612

Table 1 (continued). Consumer Price Index by Chapter, Group, and Subgroup

Chapter, Group, and Subgroup	Weight (per cent)
Chapter 4: HOUSEHOLD FURNISHINGS AND OPERATION	
Furniture and accessories	1.050
Appliances and fixtures	0.892
Textile house furnishings	0.520
Tableware	0.310
Household utensils and accessories	
Utensils	0.203
Tools and other	0.055
Miscellaneous goods and services	
Goods	1.590
Services	0.257
Household services	0.382
Chapter 5: MEDICAL CARE AND HEALTH EXPENSES	
Medicinal and pharmaceutical products and therapeutic accessories	
Medicinal and pharmaceutical products	1.828
First-aid items	0.090
Therapeutic apparatus and accessories	0.223
Services rendered by medical professionals and auxiliary services	2.350
Chapter 6: TRANSPORT AND COMMUNICATIONS	
Vehicles for personal transport	1.075
Operation of vehicles for personal transport	
Miscellaneous parts, accessories and repairs	0.951
Gasoline, oil, and grease	1.335
Other expenses	0.387

Table 1 (concluded). Consumer Price Index by Chapter, Group, and Subgroup

Chapter, Group, and Subgroup	Weight (per cent)
Transportation expenses	4.488
Communications	0.423
Chapter 7: RECREATION AND EDUCATION	
Equipment, accessories, and repair thereof	1.368
Cultural and recreational services	1.043
Vacations and tourism	1.375
Books, newspapers, magazines, and school supplies	1.579
Educational services	1.075
Chapter 8: MISCELLANEOUS GOODS AND SERVICES	
Tobacco	2.494
Articles and services for personal care	
Goods	1.200
Services	0.572
Miscellaneous goods not included in the above	0.599
Other services not included in the above	1.801

Table 2. The Kolmogorov-Smirnov Test of Normality

		Monthly Rates	Annual Rates
1977	May	0.690	
	Jun	0.639	
	Jul	0.601	
	Aug	0.976	
	Sep	1.092	
	Oct	0.932	
	Nov	0.853	
	Dec	0.530	
1978	Jan	1.156	
	Feb	0.785	
	Mar	1.443	
	Apr	1.340	0.886
	May	1.333	0.707
	Jun	0.517	0.735
	Jul	0.986	0.784
	Aug	1.078	0.776
	Sep	0.872	0.512
	Oct	1.126	0.706
	Nov	1.328	1.210
	Dec	0.999	0.994
1979	Jan	0.811	0.964
	Feb	0.925	0.697
	Mar	0.929	0.875
	Apr	1.430	0.789
	May	0.952	0.615
	Jun	1.123	0.671
	Jul	0.574	0.517
	Aug	0.988	0.955
	Sep	1.905	0.679
	Oct	1.564	0.915
	Nov	1.883	0.884
	Dec	1.559	0.911
1980	Jan	1.471	1.095
	Feb	1.177	0.783
	Mar	1.349	0.885
	Apr	0.914	0.692
	May	0.782	0.558
	Jun	0.606	0.544
	Jul	1.359	0.559
	Aug	1.223	0.856
	Sep	0.662	0.713
	Oct	1.125	0.577
	Nov	1.039	0.393
	Dec	0.874	0.421
1981	Jan	1.962	0.628
	Feb	1.080	0.534
	Mar	1.447	0.509
	Apr	1.226	0.569
	May	1.317	0.906
	Jun	0.845	0.628

Appendix II - Derivation of Equation (5)

A formulation similar to equation (5) can be obtained by modifying the partial information model used by Parks (1978) to account for the presence of a foreign sector.

For the k individual commodities not subject to international trade, the logarithmic supply and demand functions can be written as follows:

$$y_i^s = \varepsilon_i^s(DP_i - DP^E) - \delta_i^s(DE - DP^E) + \gamma_i^s \qquad i = 1...k \qquad (1a)$$

$$y_i^d = -\varepsilon_i^d(DP_i - DP^E) + \theta_i(DM - DP^E) + \delta_i^D(DE - DP^E) + \gamma_i^d$$

$$i = 1...k \qquad (2a)$$

where DP^E is the expected rate of inflation, DE is the nominal rate of devaluation and γ_i represents the real shift in supply and demand. The changes in the expected real value of the exchange rate enter the supply and demand function for nontraded commodities because of the substitution effects in production and consumption.

From equations (1a) and (2a) the equilibrium price change for each commodity is

$$DP_i = DP^E + \theta_i/\varepsilon_i(DM - DP^E) + \delta_i/\varepsilon_i(DE - DP^E) + \gamma_i/\varepsilon_i \qquad (3a)$$

$$\gamma_i = \gamma_i^d - \gamma_i^s$$

$$\varepsilon_i = \varepsilon_i^s + \varepsilon_i^d$$

$$\delta_i = \delta_i^s + \delta_i^d$$

$$i = 1...k$$

and the relative price change is, using the identity $DP = DP^E + DP^*$

$$DP_i - DP = ([\delta_i + \theta_i - \varepsilon_i]/\varepsilon_i)(DP^*) + (\delta_i/\varepsilon_i)(DM - DP)$$

$$+ (\delta_i/\varepsilon_i)(DE - DP) + \gamma_i/\varepsilon_i \qquad i = 1...k \qquad (4a)$$

Aggregating the weighted square of equation (4a) across the set k of non-traded commodities yields

$$\sum_{i=1}^{k} w_i(DP_i-DP)^2 = \sum_{i=1}^{k} w_i Z_{1i}(DP^*)^2 + \sum_{i=1}^{k} w_i Z_{2i}(DM-DP)^2$$

$$+ \sum_{i=1}^{k} w_i Z_{3i}(DE-DP)^2 + F \qquad (5a)$$

where F includes the linear and interaction terms, and

$$Z_{1i} = ([\delta_i+\theta_i-\epsilon_i]/\epsilon_i)^2$$

$$Z_{2i} = \theta_i^2/\epsilon_i^2$$

$$Z_{3i} = \delta_i^2/\epsilon_i^2$$

Regarding the n-k commodities subject to international trade, the assumption of a small open economy implies that prices of such commodities are determined in international markets and their domestic price changes would be affected only by exchange rate fluctuations:

$$DP_i = \delta_i(DE + DP_i) \qquad (6a)$$

$$\delta_i = 1$$

$$i = k+1...n$$

where DP_i is the rate of change of the foreign price of commodity i. Assuming given foreign prices, the weighted sum of the n-k squared relative prices is

$$\sum_{i=k+1}^{n} w_i(DP_i-DP)^2 = \sum_{i=k+1}^{n} w_i\delta_i^2(DE-DP)^2 + F' \qquad (7a)$$

Since $DP = \sum_{i=1}^{n} w_i DP_i$, aggregation across the economy implies that

$$VR = \sum_{i=1}^{n} w_i(DP_i-DP)^2 = \sum_{i=1}^{k} w_i Z_{1i}(DP^*)^2 + \sum_{i=1}^{k} w_i Z_{2i}(DM-DP)^2$$

$$+ \left(\sum_{i=1}^{k} w_i Z_{3i} + \sum_{i=k+1}^{n} w_i\right)(DE-DP)^2 + F + F' \qquad (8a)$$

Clearly, the coefficients of $(DP^*)^2$ and $(DM-DP)^2$ will tend to fall and those of $(DE-DP)^2$ will tend to increase as the number k of commodities which are not exposed to international trade (and therefore to international pricing) is reduced. The hypothesis advanced here is that the level of the real exchange rate is a determinant of the proportion of commodities subject to international trade, and, therefore, an increase in its value tends to increase the effects of unexpected inflation and of real money balances on relative price variability across the economy.

The inclusion of the real exchange rate in such form, i.e., affecting the estimated coefficients, would introduce additional nonlinearities in the variability equation. Nonlinear least squares estimations, however, did not yield satisfactory results. The real value of the exchange rate was therefore included in an additive form in equation (5), which also treats the components of F and F' as part of the residual term. Although belonging to the derived equation, the rate of real devaluation does not seem to have significant effects on the degree of relative price variability since its coefficient is never significant. For completeness, the corresponding estimations for VR and DR, including $(DE-DP)^2$ in the right-hand side, are reported below: 1/

$$VR_t = \underset{(0.58)}{2.611} + \underset{(4.13)}{1.517}(DP^*_t)^2 + \underset{(1.46)}{1.115}(DM-DP)^2_t + \underset{(2.04)}{1.200}(RE_t)^2 + \underset{(0.63)}{17.358}(DE-DP)^2_t$$

$R^2 = 0.375$; D.W. = 1.057

$$DR_t = \underset{(5.26)}{2.052} + \underset{(2.76)}{0.089}(DP^*)^2 + \underset{(1.26)}{0.084}(DM-DP)^2_t + \underset{(3.78)}{0.195}(RE_t)^2 + \underset{(0.05)}{0.122}(DE-DP)^2_t$$

$R^2 = 0.385$; D.W. = 1.897.

1/ Figures in parentheses are t-values.