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INFLATION AND RELATIVE PRICE VARIABILITY IN THE OPEN ECONOMY

by

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I. Introduction

The idea that the inflationary process is not neutral with respect to the structure of relative prices has been recently supported by a growing number of studies. Glejser (1965) and Jaffee and Kleiman (1977) have found a positive correlation between differential inflation across sectors and the aggregate rate of inflation. Similarly, Vining and Elwertowski (1976) and Cukierman (1979) relate the variability of relative prices to that of the rate of inflation. Yet, in a recent important contribution Parks (1978) has shown that it is mainly the amount of unanticipated inflation which affects relative price variability.[1/] Parks develops a model which results in an equation relating changes in relative price variability to fluctuations in unanticipated inflation and in real income. He tests the model using data for the United States, obtaining favorable results.[2/]

The analysis by Parks, and in most of the existing literature, abstracts from open-economy considerations. In the case of an economy having close links with the rest of the world through its international trade, part of the domestic variability in relative prices will, presumably, be due to foreign variability in relative prices. The existence of such a mechanism of international transmission of relative price variability may lead to policy implications which differ from those of previous studies. A prerequisite for the derivation of these implications is, clearly, the extension of the previous formulations to the case of the open economy.

The main objective of this study is to develop and test a framework for the analysis of the determination of relative price variability in the context of a fixed-exchange-rate open economy, Mexico (1951-76). It should be recognized that at any point in time relative prices change in response to changes in the real side of the economy. Yet our main focus here is on isolating the effects of inflation and of other macroeconomic variables on the variability of relative prices. There are at least two important reasons for studying the determination of relative price variability. First, relative prices are relevant signals in the process of allocation of resources. Therefore, an increase in their variability can be expected to have significant welfare as well as real effects.[3/] Second, the empirical study of relative price variability in the open economy can serve as a scenario for testing some of the implications of currently controversial theories in the macro and trade literature. For example, most of the existing rational-expectations macroeconomic models, especially those of the Lucas-Barro-Sargent class, embody the natural rate hypothesis. This hypothesis asserts that inflation affects real economic variables <u>and</u> (perceived) relative prices only when it is unanticipated by economic agents.[4/] Other theories, on the other hand, emphasize the existence of real costs associated with price and contract adjustment. To the extent that these costs vary across sectors, these theories imply that even fully anticipated changes in the rate of inflation will lead to changes in relative price variability.[5/] Similarly, the price behavior implied by different theories of the open economy is one of the main subjects of controversy in the trade literature (see Frenkel (1978) and Kravis and Lipsey (1978)). On the one hand, monetary theories emphasize the law of one price (or a version of purchasing-power-parity), according to which prices of traded goods will tend to be equalized across countries.[6/] On this view, then, the variability of relative prices within traded goods is unaffected by the domestic variables of a fixed-exchange-rate small open economy. Standard theories[7/] of the open economy, on the other hand, assert the possibility that prices of traded goods need not be identical in different countries. As a consequence, domestic economic variables may affect relative price variability of traded goods. In the course of the analysis, we will empirically examine the effects of anticipated versus unanticipated inflation and of domestic versus foreign variables on relative price variability. Thus, we will present evidence bearing directly or indirectly on the controversial issues mentioned above.

In Section II we discuss the construction of measures of relative price variability that are appropriate for the case of a two sector (traded and non-traded) open economy. We then use those measures in order to assess the relative importance of relative-price variability <u>within</u> the sets of traded and non-traded goods and <u>between</u> these two sets of goods. Section III of the paper begins with a simple examination of the relationship between inflation (anticipated, unanticipated, and actual) in traded and non-traded goods and relative-price variability of each of these goods. Then, a simple model of the open economy is developed and its implications for relative price variability are derived. The basic framework is an extension of that of Parks to the case of a fixed-exchange-rate open economy.

Apart from the inclusion of new variables relevant in the case of the open economy, the model presented differs from Parks' in terms of the market clearing mechanisms. While in the case of non-traded goods equilibrium requires zero domestic excess-demand for these goods, in the case of traded goods domestic excess demand need not be zero especially if the economy under study faces given international prices of traded goods. The model is then tested with annual Mexican data. Section IV summarizes the implications of this study.

II. Measurement of Relative Price Variability in a Two-Sector Model

In order to analyze the determinants of relative price variability, a measure of such variability is required. Here we have adopted a measure proposed by Theil (1967, Ch. 5), and used by Parks, which has the form,

$$VP_t = \sum_i w_{it} \, (DP_i - DP)_t^2 \qquad (1)$$

where w_{it} is the average expenditure share on the ith good in periods t-1 and t; DP_i is the rate of change in the price of the ith good between t-1 and t; DP is the average rate of inflation; and VP_t is our measure of relative price variability. Since $(DP_i - DP)$ is the rate of change in the ith relative price, VP_t measures the nonproportionality of price movements. In case that all prices change by the same rate, VP_t will be equal to zero. Also, the greater the dispersion of inflation rates across commodities, the greater will be the value of VP_t.

Given a sample of n commodities, VP_t can be computed by direct application of (1). However, to the extent that subsets of the commodities considered differ in their economic characteristics, as in the case of traded and non-traded goods, the use of partial indexes of dispersion would be more appropriate.[8/] To derive such partial indexes for traded and non-traded goods, we express the aggregate rate of inflation as a weighted average of the inflation rates in each of these two sectors:[9/]

$$DP = \beta DP_T + (1-\beta)\ DP_{NT} \qquad (2)$$

where DP_T is the average rate of change of prices of traded goods, and DP_{NT} is the corresponding rate for the non-traded sector. β is the share of expenditures on traded goods in total expenditures.

With this specification, it is possible[10/] to decompose VP_t into three different components:

$$VP_t = VPR_t + \beta_t VP_{Tt} + (1-\beta)_t\ VP_{NTt} \qquad (3)$$

where VPR_t measures the between-set price variance, and VP_{Tt} and VP_{NTt} are the measures of price variance within each set. According to equation (3), relative price variability derives from variability in relative-price changes <u>between</u> traded and non-traded goods as well as from variability in relative price changes <u>within</u> each set of commodities. The between-set and within-set measures, in turn, are defined as follows:

$$VPR_t = \beta_t (DP_T - DP)_t^2 + (1-\beta\ )_t (DP_{NT} - DP)_t^2 \qquad (4)$$

$$VP_{Tt} = \sum_{i=1}^{k} \alpha_{it} (DP_{iT} - DP_T)_t^2 \qquad \text{and} \qquad (5)$$

$$VP_{NTt} = \sum_{i=k+1}^{n} \alpha_{it} (DP_{iNT} - DP_{NT})_t^2 \qquad (6)$$

The notation is as follows: DP_{iT} is the rate of change of the price of the ith traded commodity. There are k traded commodities and n-k which are non-traded. Thus in equation (5) α_{it} is the average share of the ith traded commodity in total expenditures on traded goods. DP_{iNT} and α_{it} which appear in equation (6) are the equivalent measures for the sector of non-traded goods.

The data base on which we perform the computations consists of annual time-series for Mexico covering the 1951-1976 period.[11] Using data for prices and outputs of 47 sectors we first constructed the VP_t index described in equation (1) above. Subsequently, the partial variability indexes, which appear in the right-hand-side of equation (3), were calculated. All these indexes are reported in Table 1. It is clear, from Table 1, that the indexes exhibit a non-negligible degree of fluctuation: the values of VP_t range from a low of 0.56 (in 1968) to a high of 6.10 (in 1974); VPR_t obtains values in the (.0005,1.079) range; and the values of VP_{Tt} and VP_{NTt} are in the (0.42,8.65) and (0.22,8.55) intervals.

Are fluctuations in VP mainly associated with fluctuations in a specific partial index? Although Table 1 is informative in this respect, its interpretation faces a difficulty: since the degree of aggregation of the data affects the different measures of variability,[12] the indexes are not directly comparable. However, it is possible to use equation (3) in order to assess the partial contribution of each index to the overall variability in relative prices. Specifically, we calculate (from (3)) the share of VP that is associated with between-sets variability (VPR/VP), and the shares associated with within-set relative-price variability (i.e., $\beta VP_T/VP$ and $(1-\beta)VP_{NT}/VP$). These shares are reported in Table 2.

From Column (1) of Table 2 we observe that the relative price between non-traded and traded goods does not display large changes in the present sample. Further, except for a few cases, the share of total variability that can be attributed to VPR is negligible. Most of VP, then, can be attributed to the dispersion of relative price changes within each set. For this reason we will focus our analysis below on the determination of relative price variability within the sets of traded and non-traded goods.

To assess the relative importance of within-set variability for the determination of overall relative price variability, we can now concentrate on columns (2) and (3) of Table 2. It can be observed that in almost all cases the variability of relative prices within the set of traded goods accounts for a much larger fraction of total variability than relative-price variability within non-traded goods. An important implication of this finding is the following: To the extent that domestic economic variables affect mostly relative-price variability within the set of non-traded goods, while foreign (exogenous) factors affect primarily relative price variability within traded goods, it is apparent that a large fraction of relative price variability in the open economy is attributable to variables that are beyond the direct control of the domestic authorities. We will examine below, in Section III, the extent to which domestic and foreign variables (including inflation) differ in their impact on the measures of within-set relative price variability.

Table 1: Relative Price Variability and its Components - Mexico (1951-1976)

Year	Total Variability (VP_t)	Price Variance Between Sets (VPR_t)	Price Variance Within Tradables (VP_{Tt})	Price Variance Within Nontradables (VP_{NTt})
1951	3.89	0.117	6.08	1.44
1952	3.09	1.079	2.15	1.88
1953	8.33	0.067	7.98	8.55
1954	3.17	0.140	4.29	1.71
1955	2.11	0.009	3.72	0.41
1956	1.89	0.006	2.07	1.69
1957	3.98	0.091	6.42	1.27
1958	3.12	0.678	3.94	0.89
1959	1.22	0.100	1.58	0.63
1960	1.68	0.356	1.46	1.18
1961	0.93	0.001	1.13	0.71
1962	0.90	0.0008	0.42	1.41
1963	0.93	0.038	0.93	0.86
1964	1.11	0.092	1.02	1.02
1965	0.74	0.001	0.76	0.72
1966	0.88	0.245	0.94	0.31
1967	0.75	0.0005	0.98	0.51
1968	0.56	0.033	0.68	0.37
1969	0.57	0.026	0.82	0.25
1970	0.73	0.013	1.17	0.22
1971	2.12	0.074	3.53	0.44
1972	0.86	0.022	1.34	0.32
1973	3.21	0.015	5.10	1.21
1974	6.10	0.160	8.65	3.12
1975	1.67	0.021	2.71	0.55
1976	2.42	0.037	3.86	0.88

Note: For explanation and definitions see text. All the original indexes have been multiplied by 1000.

Table 2; Percentage of VP Accounted for by Each of its Components

Year	Between Sets (VPR_t/VP_t) (1)	Within Tradables ($\beta VP_{Tt}/VP_t$) (2)	Within Nontradables ($(1-\beta)\ VP_{NTt}/VP_t$) (3)
1951	0.03	0.78	0.19
1952	0.34	0.34	0.30
1953	-	0.48	0.52
1954	0.04	0.69	0.27
1955	-	0.90	0.10
1956	-	0.55	0.45
1957	0.03	0.82	0.15
1958	0.22	0.64	0.14
1959	0.08	0.67	0.25
1960	0.21	0.45	0.34
1961	-	0.62	0.38
1962	-	0.24	0.76
1963	0.04	0.51	0.45
1964	0.08	0.47	0.45
1965	-	0.53	0.47
1966	0.28	0.55	0.17
1967	-	0.67	0.33
1968	0.06	0.62	0.32
1969	0.05	0.74	0.21
1970	0.02	0.83	0.15
1971	0.03	0.87	0.10
1972	0.03	0.79	0.18
1973	-	0.81	0.19
1974	0.03	0.72	0.25
1975	0.01	0.82	0.17
1976	0.02	0.80	0.18

Note: A dash (-) indicates less than one percent

III. Determinants of Relative-Price Variability in the Open Economy

A. The Effects of Inflation on Relative-Price Variability: Simple Tests

Before we consider the determination of relative-price variability in the context of a complete macroeconomic model, we investigate the existence of direct effects of inflation on the variability of relative prices within each group of commodities. To do so, we estimated equations of the form

$$VP_{jt} = a_j + b_j(DP_{jt})^2 \quad , (j = T,NT) \qquad (7)$$

where VP_{jt} is the variability measure within each group of commodities and DP_{jt} is the rate of inflation corresponding to each group. Table 3 reports the results of estimating equation (7). While relative price variability in the traded-goods sector appears to be positively and significantly affected by actual inflation in that sector, an insignificant relationship emerges for the non-traded sector.

As mentioned in the Introduction, however, recent theories have suggested that inflation affects relative price variability only when it is unanticipated by economic agents. This hypothesis can be tested by estimating equations of the form

$$VP_{jt} = a_j' + b_j'(EDP_{jt})^2 + c_j'(DP_{jt} - EDP_{jt})^2, \ (j = T,NT) \qquad (8)$$

where the actual rate of inflation has been decomposed into an anticipated part, denoted by EDP, and an unanticipated part, denoted by DP-EDP. In order to estimate equation (8) measures of expected inflation in each sector are required. Here we have fitted simple first-order autoregressive processes of the form $DP_{jt} = h_{oj} + h_{1j}\ DP_{jt-1}$ + residual; (j = T, NT). With this simple specification, the best predictor for DP_{jt} is $h_{oj} + h_{1j}\ DP_{jt-1}$; we have used this predictor to approximate the expected inflation variable, EDP_{jt}.[13/]

The results of estimating (8) are presented in Table 3. We find that for both sets of goods (traded and non-traded) only unexpected inflation has a significant and positive effect on the pertinent measures of relative-price variability; the effects of expected inflation are not significant.

We turn now to a more complete analysis of the determinants of relative price variability in the context of a simple formal model of the open economy.

Table 3: Inflation and Relative Price Variability: Sectoral Equations - Mexico 1951-1976

A. Traded Goods - Dependent Variable: VP_{Tt}

Equation	Constant	Actual Inflation $(DP_{Tt})^2$	Expected Inflation $(EDP)^2$	Unexpected Inflation $(DP_{Tt}-EDP_{Tt})^2$	R^2/DW
(7)	.002 (.0004)	.111 (.031)			.362 1.427
(8)	.002 (.0005)		.026 (.057)	.325 (.097)	.365 1.883

B. Non-Traded Goods - Dependent Variable: VP_{NTt}

Equation	Constant	Actual Inflation $(DP_{NTt})^2$	Expected Inflation $(EDP_{NTt})^2$	Unexpected Inflation $(DP_{NTt}-EDP_{NTt})^2$	R^2/DW
(7)	.001 (.0004)	.017 (.032)			.013 1.691
(8)	.0005 (.0004)		.037 (.049)	.291 (.071)	.441 2.055

Note: Figures in parentheses are standard errors of regression coefficients

B. Formulation and Testing of a Multimarket Model of the Open Economy

The results presented above shed light on the relationship between inflation and relative price variability for both traded and non-traded goods. However, these results are derived from simple specifications that abstract from other macroeconomic determinants of relative price variability than inflation. Our purpose here is to develop and test a multimarket model of the open economy that will enable us to analyze the role of inflation in conjunction with that of other macroeconomic variables in the generation of relative price changes.

The basic model is an extension of Parks' framework to the case of a fixed-exchange-rate economy. An important modification to Parks' model is the incorporation of an explicit distinction between traded and non-traded goods. This distinction is based on the notion that the market clearing mechanism may operate differently for these two subsets of goods. On the one hand, equilibrium in the market for a given non-traded good implies zero domestic excess demand for the good. This equilibrium condition is very similar to that used by Parks in his closed-economy framework. Indeed, our model for non-traded goods resembles Parks' except for the inclusion of additional variables that are relevant in the open economy. The model yields an equation relating the amount of relative price variability of non-traded goods to domestic and foreign variables. On the other hand, equilibrium in the domestic market for traded goods does not necessarily imply zero domestic excess demand. Moreover, to the extent that the law of one price applies, and to the extent that the economy faces exogenously given international prices of traded goods,[14/] then the variability of domestic prices of traded goods will be determined by foreign, exogenous, variables.[15/]

B.1. Non-traded goods

Here, the basic model consists of the following supply and demand equations for each one of the non-traded goods which are expressed in rates of change:

$$Dq^s_{it} = \gamma^s_i + \varepsilon^s_i \, (DP_{it} - DP^*_t) \qquad (9)$$

$$Dq^d_{it} = \gamma^d_i - \varepsilon^d_i (DP_{it} - DP^*_t) + \lambda_i (DM_t - DP_{it}) \qquad (10)$$

where D is the first-difference operator, q^s denotes the log of commodity supply, q^d is the log of commodity demand, DP_i is the rate of change in the price of commodity i, DP^* is the expected rate of inflation, DM represents money growth, and i = k+1, ..., n (i.e., i is an index that runs over all non-traded goods). Equation (9) posits that supply of each commodity has a trend-growth component (γ^s_i), which presumably captures the supply effects of secular changes in technology, resource availability, and in other underlying determinants of supply. In addition, it is postulated that supply of the ith commodity is an increasing function of its perceived relative price; i.e., ε^s_i is greater than zero.[16/] Equation (10) posits that the quantity demanded of commodity i depends on three variables: (i) γ^d_i, which is a trend-growth component that represents the demand effects of secular changes in permanent real income, family composition, and other underlying determinants of demand; (ii) the perceived relative price of commodity i. Whenever agents perceive an increase in the price of i relative to the prices of other commodities, they decrease their demand for i, i.e., ε_i^d is positive; (iii) $(DM-DP_i)$, which stands for a real balance effect on demand. When the government increases its transfers of money to the public, part of these additional transfers is translated into an increase in the demand for commodities as reflected by the λ_i coefficient $(\lambda_i>0)$.[17/]

Assuming that the market for each non-traded good clears, the equilibrium rate of change of the price of each such good is given by

$$DP_{it} = \left(\frac{1}{\varepsilon_i + \lambda_i}\right)[\varepsilon_i DP_t^* + \lambda_i DM_t + \gamma_i] \qquad (11)$$

where $\varepsilon_i \equiv \varepsilon_i^d + \varepsilon_i^s$ and $\gamma_i = \gamma_i^d - \gamma_i^s$

The model results in standard predictions: increases in money growth and in expected inflation result in increases in prices. Similarly, an increase in underlying excess-demand growth increases prices.

The hypothesis of rational expectations in conjunction with the definition of the price level (see equation (2) above) implies that

$$DP_t^* = EDP_t = \beta EDP_{Tt} + (1-\beta)\ EDP_{NTt} \qquad (12)$$

where E is the mathematical expectation conditional on a given information set that will be specified below. According to (12), the expected rate of inflation is a weighted average of expected inflations in traded and non-traded goods.

Substituting equation (12) into (11), subtracting from both sides DP_{NTt}, and using the condition $DP_{NT} \equiv EDP_{NT} + (DP_{NT} - EDP_{NT})$, yields

$$DP_{it} - DP_{NTt} = \left(\frac{1}{\varepsilon_i + \lambda_i}\right)[\varepsilon_i \beta (EDP_{Tt} - EDP_{NTt}) - \varepsilon_i (DP_{NTt} - EDP_{NTt}) +$$

$$\lambda_i (DM_t - DP_{NTt}) + \gamma_i] \qquad (13)$$

Equation (13) expresses the actual change in the relative price of the ith non-traded commodity as a function of the expected change in the traded/non-traded price ratio, unanticipated inflation in non-traded goods, and growth in real money balances. As previously defined, relative price variability within non-traded goods is measured by

$$VP_{NTt} = \sum_{i=k+1}^{n} \alpha_i (DP_{it} - DP_{NTt})^2 \qquad (14)$$

Combining expressions (13) and (14), the following equation is obtained:

$$VP_{NTt} = f_o + f_1 (EDP_{Tt} - EDP_{NTt})^2 + f_2 (DP_{NTt} - EDP_{NTt})^2 + f_3 (DM_t - DP_{NTt})^2$$

$$+ f_4 (EDP_{Tt} - EDP_{NTt}) + f_5 (DP_{NTt} - EDP_{NTt}) + f_6 (DM_t - DP_{NTt}) + Z_t \qquad (15)$$

where the f coefficients are defined as follows (recall that for non-traded goods, $i = k+1, \ldots, n$):

$$f_o = \sum_i \frac{\alpha_{it}\,\gamma_i^2}{(\varepsilon_i+\lambda_i)^2}$$

$$f_1 = \sum_i \frac{\alpha_{it}\,(\varepsilon_i\beta)^2}{(\varepsilon_i+\lambda_i)^2}$$

$$f_2 = \sum_i \frac{\alpha_{it}\,\varepsilon_i^2}{(\varepsilon_i+\lambda_i)^2}$$

$$f_3 = \sum_i \frac{\alpha_{it}\,\lambda_i^2}{(\varepsilon_i+\lambda_i)^2}$$

$$f_4 = 2\sum_i \frac{\alpha_{it}\,\varepsilon_i\beta_i\gamma_i}{(\varepsilon_i+\lambda_i)^2}$$

$$f_5 = -2\sum_i \frac{\alpha_{it}\,\varepsilon_i\gamma_i}{(\varepsilon_i+\lambda_i)^2}$$

$$f_6 = 2\sum_i \frac{\alpha_{it}\,\lambda_i\gamma_i}{(\varepsilon_i+\lambda_i)^2}$$

and Z_t includes further interaction terms,

$$Z_t = f_7(EDP_{Tt} - EDP_{NTt})(DP_{NTt} - EDP_{NTt}) + f_8(EDP_{Tt} - EDP_{NTt})(DM_t - DP_{NTt})$$

$$+ f_9(DP_{NTt} - EDP_{NTt})(DM_t - DP_{NTt})$$

and

$$f_7 = -2 \sum_i \frac{\alpha_{it}\varepsilon_i^2\beta_i}{(\varepsilon_i+\lambda_i)^2}$$

$$f_8 = 2 \sum_i \frac{\alpha_{it}\beta\varepsilon_i\lambda_i}{(\varepsilon_i + \lambda_i)^2}$$

$$f_9 = -2 \sum \frac{\alpha_{it}\varepsilon_i\lambda_i}{(\varepsilon_i + \lambda_i)^2}$$

According to Equation (15), the variability of relative prices within the subset of non-traded goods responds to changes in the expected price ratio between traded and non-traded goods, unanticipated inflation in non-traded goods, changes in real money growth, and excess-demand shifts. Notice that the f coefficients are functions of the underlying non-traded supply-and-demand parameters. Our previous assumptions imply that (f_o, f_1, f_2, f_3, f_7, f_8, f_9) should be positive. Regarding the sign of (f_4, f_5, f_6) there is an ambiguity. Their sign depends on whether it is assumed that the trend-growth of excess demand for non-traded goods is positive (i.e., a positive γ_i), or whether the opposite assumption is made (i.e., a negative γ_i). To the extent that γ_i is positive, then f_4 and f_6 should be positive and f_5 should be negative.

In order to test the model on the basis of Equation (15), three additional assumptions were made. First, we assumed that the coefficients are stable, so that the equation can be estimated on the basis of standard regression methods. Second, an assumption about the mechanism of formation of the expectations EDP_T and EDP_{NT} is required. Here we have made the same assumption previously presented in Section III.A: the expectational variables were constructed from the fitted values of estimated first-order autoregressions of inflation in traded and non-traded goods.[18/] Third, we have assumed that the contribution of Z_t to VP_{NTt} is of a negligible order of magnitude, so that the estimated equations abstract from this variable.[19/]

With these specifications, Equation (15) was estimated on Mexican annual data for 1951-1976.[20/] We used the Cochrane-Orcutt technique of estimation, and the estimated equation is:

$$\begin{aligned} VP_{NTt} = \underset{(.0003)}{.001} &+ \underset{(.472)}{.899}(EDP_{Tt} - EDP_{NTt})^2 + \underset{(.063)}{.270}(DP_{NTt} - EDP_{NTt})^2 \\ &+ \underset{(.077)}{.312}(DM_t - DP_{NTt})^2 + \underset{(.015)}{.021}(EDP_{Tt} - EDP_{NTt}) \\ &- \underset{(.005)}{.017}(DP_{NTt} - EDP_{NTt}) - \underset{(.009)}{.037}(DM_t - DP_{NTt}) \end{aligned} \tag{16}$$

$R^2 = .864$ $\qquad DW = 2.08 \qquad$ $RHO = \underset{(.163)}{-.601}$

where figures in parentheses are standard errors of regression coefficients and RHO is the estimated first order autocorrelation coefficient of the residuals. The regression equation based on the model appears to explain movements in VP_{NTt} quite satisfactorily. The variables measuring the traded/non-traded price ratio, unanticipated non-traded goods inflation, and real money growth enter very significantly in squared form. Regarding their linear form, only the price-ratio variable is not significant. To the extent that a positive trend-growth of excess demand is assumed ($\gamma_1 > 0$), one sign reversal occurs, that corresponding to the coefficient of the real money growth variable.[21/]

Overall, this pattern of empirical results indicates that the model is quite consistent with the sample information. In particular, there are significant effects of unanticipated inflation in non-traded goods on the amount of relative-price variability within these goods. Notice that expected inflation in non-traded goods is not included in the estimated equation. This is so because the model embodies the hypothesis that such inflation, other things being equal, will not affect relative price variability. To test this implication of the model, we re-estimated equation (16) with the inclusion of expected inflation in non-traded goods in both squared and linear forms. The estimated equation is:

$$VP_{NTt} = \underset{(.0015)}{-.002} + \underset{(.994)}{.560}(EDP_{Tt} - EDP_{NTt})^2 + \underset{(.069)}{.340}(DP_{NTt} - EDP_{NTt})^2$$

$$+ \underset{(.096)}{.252}(DM_t - DP_{NTt})^2 + \underset{(.048)}{.019}(EDP_{Tt} - EDP_{NTt}) \qquad (17)$$

$$- \underset{(.005)}{.020}(DP_{NTt} - EDP_{NTt}) - \underset{(.013)}{.025}(DM_t - DP_{NTt}) - \underset{(.273)}{.262}(EDP_{NTt})^2$$

$$+ \underset{(.042)}{.054}(EDP_{NTt}) .$$

$R^2 = .896$ $\qquad$ $DW = 2.30$ $\qquad$ $RHO = \underset{(.168)}{-.571}$

The expected-inflation variables are not individually significant. Moreover, with only one exception the estimated coefficients on the other variables included in the equation are not strongly affected by the inclusion of the expected-inflation variables; however, the precision in their estimation is decreased. All in all, then, the findings reported in both the previous section and this section indicate that inflation in non-traded goods affects the degree relative-price variability in these goods only when it is unanticipated by economic agents.

B.2. Traded Goods

In modeling the determination of relative-price variability within the subset of traded goods, we considered two alternative possibilities. First, it can be hypothesized that the same underlying factors that determine relative-price variability within non-traded goods are also of relevance in the case of traded goods. Alternatively, to the extent that the law of one price applies and the economy faces exogenously-given international prices of traded goods, then relative-price variability of traded goods would be exogenous to the economy under consideration. In what follows we consider these two alternative approaches.

In principle, it is possible to postulate the previous multi-market model for the case of traded goods. Indeed, all what is needed now is to allow for the index i to cover the k traded commodities. If this is done, and if we substitute (12) into (11), substract from both sides DP_{Tt}, and use the condition $DP_{Tt} \equiv EDP_{Tt} + (DP_{Tt} - EDP_{Tt})$, we obtain the following equation:

$$DP_{it} - DP_{Tt} = \left(\frac{1}{\varepsilon_i + \lambda_i}\right)[\varepsilon_i(1-\beta)(EDP_{NTt} - EDP_{Tt}) - \varepsilon_i(DP_{Tt} - EDP_{Tt}) + \lambda_i(DM_t - EDP_{Tt}) + \gamma_i] \qquad (13)'$$

where $i = 1,\ldots, k$. Recall that relative-price variability within traded-goods is defined by

$$VP_{Tt} = \sum_{i=1}^{k} \alpha_i(DP_{it} - DP_{Tt})^2 \qquad (14)'$$

As before, we can now combine (13)' and (14)' to obtain an equation for VP_{Tt} of the form

$$VP_{Tt} = f_o + f_1^{'}(EDP_{NTt} - EDP_{Tt})^2 + f_2(DP_{Tt} - EDP_{Tt})^2 + f_3(DM_t - DP_{Tt})^2$$
$$+ f_4^{'}(EDP_{NTt} - EDP_{Tt}) + f_5(DP_{Tt} - EDP_{Tt}) + f_6(DM_t - DP_{Tt}) + Z_t^{'} ,$$

(15)'

where the f coefficients are defined as before, except that now $i = 1,\ldots,k$, and that[22/]

$$f_1^{'} = \sum_i \frac{\alpha_{it}\varepsilon_i^2 (1-\beta)^2}{(\varepsilon_i + \lambda_i)^2} ,$$

and
$$f_4^{'} = 2\sum_i \frac{\alpha_{it}\varepsilon_i(1-\beta)\gamma_i}{(\varepsilon_i + \lambda_i)^2}$$

Equation (15)' is the expression for relative-price variability of traded goods implied by application of the same model that was previously postulated for the case of non-traded goods. Estimation of this equation, using the same assumptions and technique than for equation (15), yields the following result:

$$VP_{FT} = \underset{(.001)}{.003} + \underset{(1.180)}{1.689}(EDP_{NTt} - EDP_{Tt})^2 + \underset{(.244)}{.310}(DP_{Tt} - EDP_{Tt})^2 \qquad (16)'$$
$$- \underset{(.255)}{.069}(DM_t - DP_{Tt})^2 - \underset{(.044)}{.023}(EDP_{NTt} - EDP_{Tt}) + \underset{(.016)}{.004}(DP_{NTt} - EDP_{NTt})$$
$$- \underset{(.038)}{.008}(DM_t - DP_{Tt}) \qquad (16)$$

$R^2 = .559$ $\quad$ DW = 1.37 $\quad$ RHO = $\underset{(.200)}{-.181}$

The sample information yields no support for the specification embodied in Equation (15)'. Only the constant term in the equation significantly differs from zero. Moreover, the F-statistic pertinent for testing the significance of the explanatory power of the regression as a whole is $F(6,17) = 3.59$, which is smaller than the 1% critical level. This should be compared with the results for the non-traded sector: the F-statistic for equation (16) is $F(6,17) = 18.03$, which is much larger than the 4.10 critical (1%) value. Thus, the multimarket model of the previous section appears to be applicable only to the non-traded sector of the small-open-economy under study.

With this finding in mind, we now turn to a second approach in modeling the price behavior in the traded good sector. This approach is based on the idea that in a small-open-economy, operating under fixed-exchange-rates and well-integrated with the rest of the world, the behavior of domestic prices of traded goods will follow closely that of international prices of these goods. At the extreme, to the extent that no changes in domestic tariffs or transportation costs occur, then the following condition is implied

$$DP_{iT} = DP^{W}_{iT} \tag{17}$$

that is, the domestic rate of change of the price of the ith traded commodity will be equal to its rate of change in international markets (DP^{W}_{iT}). In this case, relative-price-variability in traded goods can be expressed as

$$VP_{Tt} = \sum_{i=1}^{k} \alpha_i (DP^w_{it} - DP^w_{Tt})^2 \qquad (18)$$

that is to say, VP_{Tt} is externally given to the small-open-economy.

Clearly, a direct test of this approach would have to be based on testing the validity of the hypothesis embodied in equation (17). This could be done by looking at disaggregated data, using a similar methodology than Isard's (1977). However, moving in such a direction would put us far beyond the scope of this paper. Therefore, at this point we present some other indicative evidence on this issue. First, it should be recalled that our findings of Section III.A suggested that relative price variability within traded goods in Mexico was mainly a function of unanticipated inflation in these goods. An important implication of this finding and of the approach that postulates the law of one price, as expressed in (17), would be that domestic unanticipated inflation in traded goods follows closely its foreign unanticipated inflation counterpart. If the latter is proxied by unanticipated inflation in the United states, 23/ which is Mexico's main trading partner, it turns out that the correlation coefficient between unanticipated inflation in Mexican traded goods and unanticipated inflation in the U.S. is 0.9. (The correlation between this same U.S. variable and unanticipated inflation in Mexican non-traded goods is 0.7). Thus, the view that relative price variability in traded goods depends on unanticipated foreign inflation, through the latter's effects on domestic unanticipated inflation in traded goods, receives some support from the data.

Second, it is possible to test in a more direct way the hypothesis that domestic relative price variability follows closely foreign relative price variability. This can be done by using the VP variable constructed by Parks for the U.S. as a proxy for foreign variability, and by relating this variable to the domestic measures of variability that we constructed. The following were the regression results obtained:

Traded Goods:

$$VP_{Tt} = \underset{(.0004)}{.002} + \underset{(.456)}{2.091}\ VPUS \qquad (19)$$

$R^2 = .489$ DW = 1.44 F(1,22) = 21.06

Non-Traded Goods:

$$VP_{NTt} = \underset{(.0004)}{.001} + \underset{(.426)}{.795}\ VPUS \qquad (20)$$

$R^2 = .137$ DW = 1.62 F(1,22) = 3.48

where VPUS is Parks' index of relative price variability for the United States.[24/]

The estimates suggest that U.S. relative price variability significantly and positively affects the Mexican relative price variability of both traded and non-traded goods. However, these effects are much more important in the case of Mexican traded goods: while the F-statistic for the traded-goods regression is highly significant, the F-statistic for non-traded is statistically insignificant (the 5% critical value is 4.30). These findings constitute a further indication that the relative-price variability of Mexican traded goods is mainly determined by economic factors which are external to the Mexican economy.

IV. Summary and Concluding Remarks

This paper has explored the determination of relative-price variability in a fixed-exchange-rate open economy, Mexico (1951-76). A distinguishing feature of the analysis presented is the explicit adoption of the distinction between traded and non-traded goods. Once this distinction is made, it is appropriate to decompose overall relative price variability into three components: relative price variability within the sets of traded and non traded goods and between these two sets. The results presented in Section II suggest that in the Mexican economy an important part of overall relative price variability is explained by variability within the set of traded goods. It was also found that relative price variability between the two sectors accounted for a negligible share of overall variability. Thus, it was concluded that the study of overall variability can be confined to studying variability within traded and non-traded goods. Accordingly, the determination of these two variables was analyzed in Section III. Our findings suggest that when the actual rate of inflation is decomposed into expected and unexpected components, only the unexpected components appear to have strong and significant effects on the variability of relative prices within traded and non-traded goods. These findings emerged from the simple examination of the relationship between variability within traded and non-traded goods and their respective rates of inflation as well as from the results of testing the multi-market model that was presented in Section III.

This model results in an equation relating relative price variability within a given set of goods to unanticipated inflation in these goods, the expected rate of change of the traded/non-traded price ratio, and real money growth. While the model explained well the relative-price variability within non-traded goods, evidence was presented in support of treating the variability within traded goods as exogenously given to the Mexican economy.

Overall, our results imply that total relative price variability in Mexico is significantly affected by expected changes in the traded/non-traded price ratio, real money growth, unanticipated inflation, and the external variability within traded goods. These findings are in line with Parks'. However, by explicitly considering open economy specifications we have identified additional variability effects that operate through the international-trade sector of the economy. Part of these effects may be externally given to the small open economy.

An important implication of these findings is that there appears to be a mechanism of international transmission of relative-price variability, at least under fixed exchange rates. Thus, a significant positive correlation between the amount of relative-price variability across countries can be expected to emerge from the data. If this is so, then small-open-economies would have to bear the welfare implications of "imported" relative-price variability. Another implication of the findings is from the point of view of controversies in the current macro and trade literature (see the Introduction). Standard models embodying the natural rate hypothesis yield the hypothesis that the variability of relative prices is independent of expected inflation, but varies in response to unexpected inflation. Also, monetary theories of the balance of payments have put emphasis on the close dependence of domestic prices on foreign prices. Both views receive some empirical support from the information contained in our sample.

Finally, there are at least two promising directions for future research. First, since domestic relative price variability may closely depend on foreign variability, it would seem appropriate to study the feasibility and desirability of implementing domestic policies aimed at insulating the economy from such external variability. Second, it would be interesting to extend our analytical framework to the case of a flexible-exchange-rate regime. This would increase the number of countries, other than Mexico, for which this type of analysis can be performed.

FOOTNOTES

1/ Interestingly, a relationship like this found by Parks was also observed by Graham (1930, p.p. 175-6) in his study of the German hyperinflation.

2/ Another relevant study in this context is the one by Hercowitz (1978). Hercowitz investigates the relationship between unanticipated money growth and relative price variability for the case of the German hyperinflation. His findings show a statistically significant correlation between unanticipated money growth and the degree of price dispersion.

3/ On the welfare implications of relative price variability, see Jaffee and Kleiman (1977). On the effects of such variability on real economic variables, see Keynes (1924, p.p. 35-6), Friedman (1977), and Blejer and Leiderman (forthcoming).

4/ For a survey of recent work along these lines and its policy implications, see Lucas and Sargent (1978).

5/ See, e.g., Sheshinski and Weiss (1979).

6/ For a detailed discussion of this view, see Frenkel (1978).

7/ This is the term used by Kravis and Lipsey to refer to the elasticity, Keynesian, and absorption approaches to the balance of payments.

8/ See Theil (1967), Chapter 7, Section 6.

9/ This is derived from a standard Divisia price-index formulation.

10/ Again, see Theil (1967, Ch. 7).

11/ The basic data that we used are published by the Bank of Mexico (1969, 1977). Ten sectors are classified as producing non-traded goods, including construction and housing, transportation and communications, commerce, government, and other services.

12/ See Theil (1967, p.p. 162-3).

13/ The estimated equations are:

$$DP_{Tt} = \underset{(.013)}{.022} + \underset{(.169)}{.667}\, DP_{Tt-1}$$

R^2 = .394 DW = 1.889 h = .50

$$DP_{NTt} = \underset{(.016)}{.032} + \underset{(.186)}{.597}\, DP_{NTt-1}$$

R^2 = .301 DW = 2.034 h = -.26

standard errors of regression coefficients appear in parentheses, and h is Durbin's statistic for testing serial correlation in autoregressive models.

14/ This is certainly one version of the often-invoked "small-open-economy" assumption.

15/ Recall that we are assuming a fixed-exchange-rate regime.

16/ This supply function can be rationalized in terms of a specification that assumes that the production function for the ith good uses as inputs all N goods. See Parks, footnote 6, p.88. Alternatively, it can be assumed that while labor demand by the ith sector depends on the nominal wage deflated by P_i, labor supply is a function of the nominal wage deflated by P^*. Assuming that production varies mainly as a function of labor employment, and that the labor market clears, a supply function of this form can be obtained.

17/ Hercowitz (1978) includes a similar real-balance effect in his aggregate-demand specification.

18/ See again footnote 13/ above.

19/ This assumption was mainly made in order to avoid problems of multicollinearity. Notice, also, that Z_t does not have a straightforward interpretation.

20/ The data used here are described in footnote 11/. In addition, data on money growth was constructed from the M1 series of International Financial Statistics.

21/ However, if one assumes that γ_1 is negative, then two sign-reversals occur.

22/ Z_t' is the counterpart of Z_t for the case of traded goods. As before, the analysis will proceed by abstracting from this term.

23/ This variable was constructed from the residuals of a second-order autoregression of the U.S. (C.P.I.) rate of inflation.

24/ See Parks, Table 3, p. 85.

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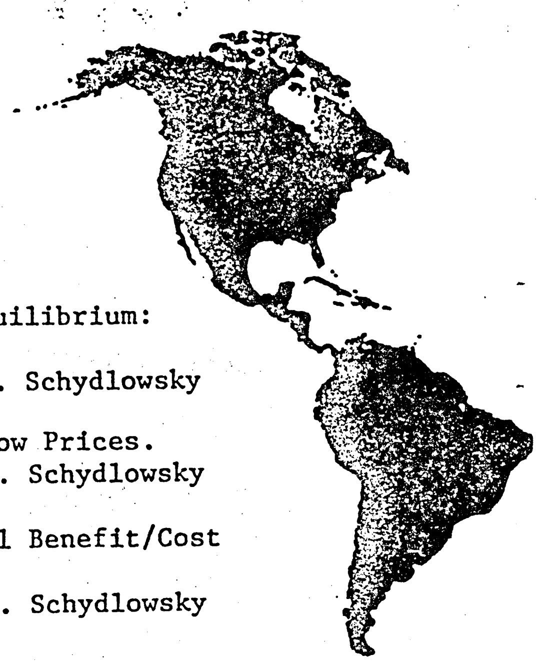

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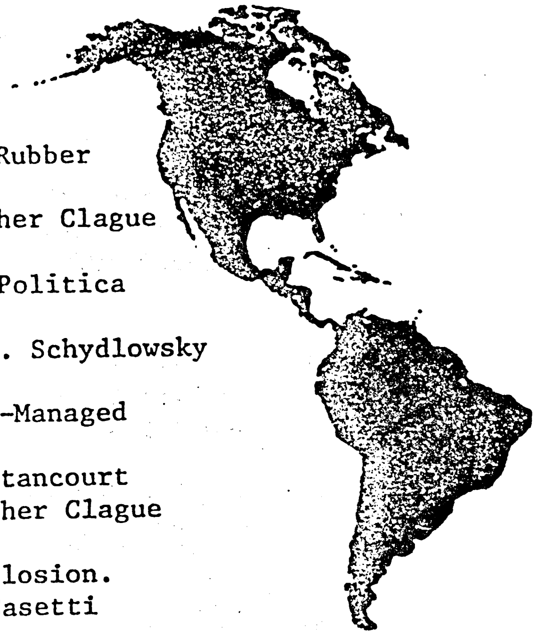

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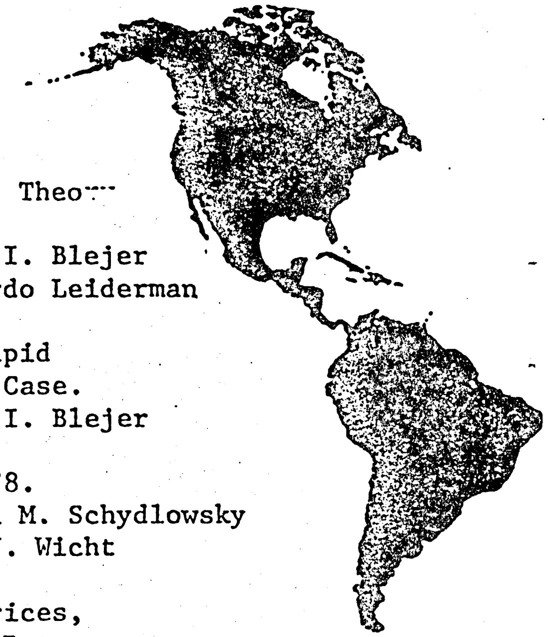

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