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## I. INTRODUCTION

The study of the effects of inflation and relative price variability on the real side of the economy is a clear prerequisite for an overall assessment of the welfare and efficiency implications of the inflationary process. In an earlier empirical study (Blejer and Leiderman, forthcoming), we investigated the effects of inflation and relative price variability on real output and the rate of unemployment for the United States. Our framework embodied two main hypotheses: (a) a version of the Natural Rate Hypothesis, which postulates that only the unanticipated portion of the inflation rate affects real economic variables; and (b) the hypothesis that an increase in the amount of relative price variability has negative effects on real output and positive effects on the unemployment rate. These hypotheses received support from the econometric tests we performed on annual data for the postwar United States.

Although these findings are informative, it should be recognized that in order to reach a final judgement on their general empirical validity, we need to examine the robustness of these results. One relevant test would be the extent to which similar results emerge from data for other countries. Accordingly, the first major aim of the present paper is to assess the empirical accuracy of hypotheses (a) and (b) in a different setting than of the U.S. economy: The Mexican Economy Between 1953 and 1976. An important difference between the economies of the U.S. and Mexico is in their degree of openness. In this context, it turns out that open economy

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Note to the reader: footnotes appear at the end of the paper.

considerations (which are highly relevant for analysis of the Mexican economy) may have crucial implications for the econometric specifications used in testing the above hypotheses. Therefore, the second main purpose of the paper is to extend our previous analysis in the (traded/nontraded goods) open economy direction, so as to explicitly take into account these implications.

The paper is structured as follows: the next section discusses the effects of inflation and relative price variability on Mexican aggregate real output. Section III deals with the formulation and testing of these effects separately for sectors producing traded and nontraded goods. Our conclusions are presented briefly in the final section.

## II. EFFECTS OF INFLATION AND RELATIVE PRICE VARIABILITY ON AGGREGATE REAL OUTPUT

The basic equations analyzed in this section are:

$$Y_t = a_o + a_1 Y_{t-1} + a_2(DP_t - EDP_t) + e_t, \qquad (1)$$

$$Y_t = b_o + b_1 Y_{t-1} + b_2(DP_t - EDP_t) + b_3 V_t + u_t, \qquad (2)$$

where Y is the log of aggregate real output, DP is the actual rate of inflation, EDP is the expected rate of inflation, V is a measure of relative price variability, and e and u are regression residuals.

Equation (1) represents an equilibrium rational expectations version of the output-inflation tradeoff (or reverse Phillips curve).[1/] The equation asserts that inflation influences real output only when it is unanticipated. As such, it embodies a common variant of the Natural Rate Hypothesis. In addition, it is postulated that current real output also depends on last period output, thereby capturing the persistence effects that are likely to emerge in the presence of adjustment costs.

Equation (2) extends the above representation by allowing independent output effects of relative price variability. It has been recently recognized that accelerating inflation is generally accompanied by an increase in the amount of relative price variability, which in turn may have definite effects on the economy's real sector. Like Keynes (1924), Friedman (1977) argues that an increase in relative price variability is likely to cause a decline in measured real output. This conjecture has also emerged in other studies. Overall it appears that three major channels of output effects of relative price variability have been identified in the literature. First, an increase in relative price variability may reduce the value of market prices as allocative signals, and thus lead to an increase in the amounts of time and other resources devoted to search activities (Hayek 1945, Alchian 1970). Second, increased variability is likely to lead to a shortening of optimal contract length, thus implying higher per-period costs of contracting and the possible misallocation of resources among industries (Gray 1978). Third, increased volatility of relative price changes may represent additional output price uncertainty at the firm level. Under some assumptions, this marginal increase in uncertainty leads to a reduction in factor demand and output of the firm (Sandmo 1971, Batra and

Ullah 1974). Each of these channels suggest that increases in relative price variability may depress measured real output.

The estimation of (1) and (2) requires measures of expected inflation and relative price variability. To approximate expected inflation we have fitted a third order autoregressive process of the form

$$DP_t = f_o + f_1 DP_{t-1} + f_2 DP_{t-2} + f_3 DP_{t-3} + \text{residual}.$$

With this specification, the least squares predictor for $DP_t$ is $f_o + f_1 DP_{t-1} + f_2 DP_{t-2} + f_3 DP_{t-3}$ and we have used this predictor to approximate the $EDP_t$ variable.[2/]

The measure of relative price variability adopted in this study is based on that proposed by Theil (1967, Chap. 5), and used by Parks (1978):

$$VP_t = \Sigma_i w_{it} (DP_i - DP)_t^2 \qquad (3)$$

where $w_{it}$ is the share of expenditure on good i averaged over periods t-1 and t; $DP_i$ is the rate of change in the price of good i between t-1 and t; DP is the average rate of inflation; and VP is an index of relative price variability. As $(DP_i - DP)$ is the rate of change in the relative price i, $VP_t$ measures the nonproportionality of price movements. If all prices change at the same rate, $VP_t$ will be equal to zero, and it increases with the dispersion of inflation rates across commodities. (For further discussion of the properties of VP, see Theil (1967)).

Our VP index for Mexico (Table 1) is based on annual time series for prices and outputs in 47 sectors between 1951 and 1976.[3/] It exhibits considerable fluctuations, ranging from a low of 0.56 (in 1968) to a high of 8.33 (in 1953). Although in principle $VP_t$ can be used for $V_t$ in the empirical implementation of (3), here we have constructed $V_t$ from current and lagged values of $VP_t$; specifically, we have defined $V_t = VP_t + VP_{t-1} + VP_{t-2}$. The reason for including lagged values of VP in $V_t$ is that the real effects of relative price volatility are likely to be delayed rather than immediate, especially if it takes time to accomplish desired changes in the scale and composition of production. Moreover, production efficiency and the informational usefulness of market price signals may be reduced not just by current changes in price dispersion but by cumulative relative price volatility, which is captured by a $V_t$ variable that takes into account VP values over current and past periods.[4/]

Table 2 reports the results obtained in estimating equations (1) and (2) as well as variants of these equations. The results for equation (1), a rational expectations version of the inflation/aggregate-output tradeoff indicate that unanticipated inflation has positive but statistically insignificant effects on aggregate real output. Also, there are strong and significant persistence effects of output movements, as reflected in the parameter estimate on the $Y_{t-1}$ variable. Equation (1a) represents a version of the output/inflation tradeoff which incorporates the actual inflation rate rather than its unanticipated component. As such, this equation embodies a more conventional formulation of the (reverse) Phillips curve than the Natural-Rate specification embodied in (1). It can be seen that actual inflation has negative but insignificant effects on aggregate output.

Next, we turn to the results for equations (2) and (2a) which extend the previous equations to allow for the independent output effects of relative price variability. We find that an increase in the amount of relative price variability leads to a significant decline in aggregate output. As before, the findings show significant output own persistence effects, and the coefficients on the different inflation variables considered are statistically insignificant. (Note, however, that the coefficient on unanticipated inflation shows a clear increase in magnitude and significance). In summary, these results support the notion that relative price variability has negative effects on real output. As such this finding conforms with the available empirical evidence for the U.S. (see Blejer and Leiderman, forthcoming). In addition, and at variance with our findings for the U.S., no output/inflation tradeoff appears to emerge from the aggregate output equations so far considered.

## III. TEST WITHIN AN OPEN ECONOMY FRAMEWORK

Although the previous results for aggregate real output are useful, we must point out that they are derived from closed-economy type specifications. In the case of an open economy such as Mexico that maintains close economic links with the rest of the world, it may be more appropriate to focus the analysis on separate output-inflation tradeoffs for the traded and nontraded sectors.

Several considerations suggest the importance of this traded/nontraded goods disaggregation. In particular, to the extent that the economy under study is a price taker in international goods markets (satisfying the small open economy assumption), changes in the prices of its traded goods will be determined independently of domestic monetary and fiscal policy aggregates, and only the prices of nontraded goods will be affected by these domestic policy variables. 5/ Thus, there is a strong presumption that the shocks that account for most of the output fluctuations in the traded and nontraded sectors will differ both in nature and origin. Furthermore, changes in the amount of relative price variability, which are a focal issue in this study, may have differential output effects across these two sectors. The proposed disaggregation is also important for the task of assessing the effects of different shocks on the economy's balance of payments. Since the trade balance deficit is equal to the excess of domestic demand for traded goods over their domestic supply, changes in variables that primarily affect output supply of traded goods through the output-inflation tradeoff (such as changes in relative price variability) will have different implications for the balance of payments than those emerging from effects on domestic output supply in the nontraded goods sector. Although we are not concerned here with the direct output effects of domestic monetary and fiscal policies, or with the balance of payments effects of output fluctuations, the above discussion suggests that the traded/nontraded output disaggregation is a prerequisite for investigation of these issues, as well as for a meaningful study of the output-inflation tradeoff in the open economy. This section reports empirical results based on this disaggregation.

The basic output equations analyzed here are direct open economy counterparts of equations (1) and (2) above:

$$Y_t^i = c_o^i + c_1^i Y_{t-1}^i + c_2^i (DP_t^i - EDP_t) + e_t^i, \qquad (4)$$

$$Y_t^i = d_o^i + d_1^i Y_{t-1}^i + d_2^i (DP_t^i - EDP_t) + d_3^i V_t + u_t^i, \qquad (5)$$

$$i = T, NT$$

where T denotes the traded goods sector and NT the nontraded goods sector.

In principle, the relative price (or inflation) terms appearing in (4) and (5) are very similar to those of (1) and (2). However, their interpretation in the open economy context differs from the one associated with the closed economy specifications. To see this, note that the aggregate rate of inflation is defined as a weighted average of the inflation rates for both types of goods:

$$DP_t = hDP_t^T + (1-h)DP_t^{NT},$$

where h is the share of traded goods in total expenditures. Under the assumption of rational expectations, the expected rate of inflation is given by

$$EDP_t = hEDP_t^T + (1-h)EDP_t^{NT}, \qquad (6)$$

and the expected sectorial inflation rates obey

$$DP_t^i = EDP_t^i + z_t^i, \quad i = T, NT, \qquad (7)$$

where $z_t^i$ is the forecast error. With these specifications, the relative inflation terms appearing in output equations (4) and (5) can be expressed from (6) and (7) as follows:

$$DP_t^T - EDP_t = z_t^T + (1-h)(EDP_t^T - EDP_t^{NT})$$

(Traded Goods)

and (8)

$$DP_t^{NT} - EDP_t = z_t^{NT} + h(EDP_t^{NT} - EDP_t^T)$$

(Nontraded Goods).

From (4) and (8) we see that the relative inflation term relevant for determining output in each sector has two components: unexpected sectoral inflation [$z_t^i$, which is defined in (7)], and the expected change in the terms of trade. Thus, our specifications embody the notion that whenever a given sector experiences unexpected (sectoral) inflation or an expected improvement in its terms of trade there will be an increase in the amount of resources employed in such sector which, in turn, will result in an expansion of output.6/

To further clarify the importance of the (traded/nontraded) open economy considerations that underly equations (4) and (5), we now discuss the implications of these specifications for the Natural Rate Hypothesis. According to this hypothesis, only the unexpected portion of the inflation rate affects real economic variables such as aggregate real output. The traded/nontraded output equations postulated above turn out to embody this version of the Natural Rate Hypothesis for inflation shocks that have equal and uniform price effects across all sectors. Indeed, it can be seen that an expected uniform (across all sectors) increase in the inflation rate will have no influence on real output; uniform movements in inflation can affect real output only if they are unexpected (that is, through the $z_t^i$'s). However, to the extent that fluctuations in the aggregate inflation rate are accompanied by changes in the traded/nontraded terms of trade, output will expand in some sectors and decline in others. In this case, even expected changes in the aggregate inflation rate may alter measured aggregate real output. Although this feature of (4) and (5) is at variance with the version of the Natural Rate Hypothesis outlined above, it is consistent with agents' optimizing behavior in the (traded/nontraded) open economy discussed here.[7/]

Table 3 reports the results of econometric implementation of variants of equations (4) and (5). Consider, first, the results for output in the nontraded goods sector (Panel A). The parameter estimates of (4) and (4a), equations that abstract from relative price variability, show that the relative inflation variable ($DP_t^i - EDP_t$) has positive output effects, and actual inflation has negative effects on output; yet neither inflation variable is statistically significant. However, once the measure of relative price variability is included in the output equations,[8/] as in (5) and (5a), this pattern of results is somewhat altered. In the case of (5), we see that the relative inflation variable is now positive and significant, and that relative price variability has significant negative effects on the output of nontraded goods.[9/] This latter finding also holds for (5a), in which the actual inflation rate is not significantly different from zero. In all cases, the findings indicate the existence of strong output own persistence effects, and the reported h-statistics are consistent with an absence of serial correlation.

Similar results show up for the traded goods' output equations, reported in Panel B. In particular, (5) and (5a) support the hypothesis that both $(DP_t^T - EDP_t)$ and $V_t$ have important effects on output. The actual inflation rate, however, appears with a statistically insignificant coefficient.

Comparison of the estimated equations (5), our (open economy and relative price variability) extended version of the output/inflation tradeoff, between the traded and nontraded goods sectors suggests quantitatively similar negative output effects of relative price variability, as well as similar output persistence effects. The output responses to the relative inflation variables considered, $(DP_t^i - EDP_t)$, are positive for both sectors, with traded goods output responding more than nontraded good's output.

## IV. CONCLUSIONS

Empirical investigation of the relationship between relative price variability and output/inflation tradeoffs for Mexico between 1953 and 1976 has indicated that changes in the amount of relative price variability have negative effects on the level of aggregate output. However, no significant output/inflation tradeoffs emerged from these aggregative equations. With this last result in mind, and given the relatively high degree of openness of the Mexican economy, we then incorporated open economy considerations into the estimated specifications. Extending the empirical analysis to allow disaggregation of output into traded and nontraded goods indicated that both are decreasing functions of relative price variability. Yet in this case we we found positive and significant responses of these outputs to changes in the relative inflation variables considered ($DP_t^i - EDP_t$). All in all, then, our findings for Mexico support the specification of an extended (Natural Rate) version of the output/inflation tradeoff, one that explicitly takes into account the disruptive real effects associated with increases in relative price variability as well as relevant open economy considerations.

TABLE 1 - INDEX OF RELATIVE PRICE VARIABILITY, MEXICO: 1951-76

| YEAR | $VP_t$ | YEAR | $VP_t$ |
|---|---|---|---|
| 1951 | 3.89 | 1964 | 1.11 |
| 1952 | 3.09 | 1965 | 0.74 |
| 1953 | 8.33 | 1966 | 0.88 |
| 1954 | 3.17 | 1967 | 0.75 |
| 1955 | 2.11 | 1968 | 0.56 |
| 1956 | 1.89 | 1969 | 0.57 |
| 1957 | 3.98 | 1970 | 0.73 |
| 1958 | 3.12 | 1971 | 2.12 |
| 1959 | 1.22 | 1972 | 0.86 |
| 1960 | 1.68 | 1973 | 3.21 |
| 1961 | 0.93 | 1974 | 6.10 |
| 1962 | 0.90 | 1975 | 1.67 |
| 1963 | 0.93 | 1976 | 2.42 |

NOTE: $VP_t$ is calculated according to equation (3), on the basis of the prices and output (national accounts) data for 47 sectors published by the Bank of Mexico (1969, 1977). The index computed is here multiplied by 1000.

TABLE 2 - AGGREGATE OUTPUT EQUATIONS - MEXICO, 1953-76

(DEPENDENT VARIABLE: $Y_t$)

| EQUATION | CONSTANT | $Y_{t-1}$ | $(DP_t-EDP_t)$ | $DP_t$ | $V_t$ | $R^2$/SER | h |
|---|---|---|---|---|---|---|---|
| (1) | 0.163<br>(1.28) | 0.991<br>(94.6) | 0.082<br>(0.81) | | | 0.998<br>0.019 | 1.26 |
| (1a) | 0.052<br>(0.44) | 1.000<br>(101.4) | | -0.0903<br>(1.13) | | 0.998<br>0.019 | 0.65 |
| (2) | 0.334<br>(2.63) | 0.978<br>(95.72) | 0.152<br>(1.67) | | -0.251<br>(2.76) | 0.998<br>0.017 | 0.01 |
| (2a) | 0.282<br>(1.77) | 0.982<br>(75.95) | | 0.065<br>(0.60) | -0.268<br>(2.00) | 0.998<br>0.018 | 0.29 |

NOTE: (i) For notation and explanation see text. SER is the standard error of estimate, and h is Durbin's statistic for testing serial correlation in autoregressive models (See Johnson, p.313). Numbers in parentheses are absolute values of t-statistics.

(ii) The unanticipated inflation variable $(DP_t - EDP_t)$ corresponds to the residuals of the estimated inflation equation:

$$DP_t = \underset{(0.637)}{0.0129} + \underset{(2.44)}{0.495}DP_{t-1} - \underset{(0.41)}{0.091}DP_{t-2} + \underset{(1.87)}{0.467}\, DP_{t-3}$$

$$R^2 = 0.325 \qquad DW = 1.87$$

(iii) Data Source: Prices and Output data published by the Bank of Mexico (1969, 1977). The calculation of $V_t$ is explained in the text.

TABLE 3 - OUTPUT EQUATIONS FOR NONTRADED AND TRADED GOODS - MEXICO 1953-75

(Dependent Variable : $Y_t^i$; i = NT,T).

| Equation | Constant | $Y_{t-1}^i$ | $(DP_t^i - EDP_t)$ | $DP_t$ | $V_t$ | $R^2$/SER | h |
|---|---|---|---|---|---|---|---|
| | | | A. NONTRADED GOODS (i = NT) | | | | |
| (4) | 0.022 | 1.007 | 0.157 | | | 0.997 | -0.01 |
| | (0.36) | (88.97) | (1.66) | | | 0.021 | |
| (4a) | -0.046 | 1.021 | | -0.144 | | 0.997 | 0.01 |
| | (0.78) | (89.72) | | (1.56) | | 0.021 | |
| (5) | 0.108 | 0.994 | 0.167 | | -0.280 | 0.998 | -0.75 |
| | (1.77) | (91.50) | (2.04) | | (2.76) | 0.018 | |
| (5a) | 0.065 | 1.002 | | 0.004 | -0.274 | 0.498 | -0.38 |
| | (0.77) | (65.19) | | (0.03) | (1.77) | 0.020 | |
| | | | B. TRADED GOODS (i = T) | | | | |
| (4) | 0.166 | 0.981 | 0.256 | | | 0.998 | 1.75 |
| | (3.27) | (105.6) | (2.76) | | | 0.016 | |
| (4a) | 0.088 | 0.995 | | -0.103 | | 0.998 | 1.17 |
| | (1.42) | (83.0) | | (1.07) | | 0.019 | |
| (5) | 0.240 | 0.970 | 0.234 | | -0.257 | 0.999 | 0.03 |
| | (5.03) | (116.0) | (3.74) | | (3.15) | 0.013 | |
| (5a) | 0.272 | 0.963 | | 0.123 | -0.385 | 0.988 | 0.03 |
| | (3.21) | (62.42) | | (1.07) | (2.78) | 0.016 | |

NOTE: See note to Table 2. (i) The Data source is indicated in that Table. Nontraded goods comprise construction and housing, transportation and communications, commerce, public services and other services, and are subdivided into ten sectors. (ii) To account for additional traded goods output effects of the devaluation of the peso in October, 1954, the output equations of Panel B were estimated with the inclusion of dummies for 1955 and 1956. Both dummies turned out to be approximately the same magnitude (.08) and of opposite sign. (iii) As before, $EDP_t$ was constructed from the fitted values of the equation reported in the note to Table 2.

## FOOTNOTES

1/ This form of the output-inflation tradeoff is similar to that utilized by Lucas (1973) and Sargent (1973), except that they relate output to a $(P_t - EP_t)$ variable. Equation (1) is derived by assuming that $P_{t-1}$ is known at the time that agents form their $EP_t$ expectations, and adding and substracting $P_{t-1}$ inside the above parenthesis. [See Sargent (1973, Footnote 34)]. There are at least two theoretical setups that would yield an equation such as (1): First, it can be assumed that while labor demand in the i-th sector of the economy depends on the nominal wage divided by $P_i$, labor supply is a function of the nominal wage deflated by EP, as implied by Friedman (1968). Aggregating over sectors yields an equation such as (1) for aggregate output. Lucas (1973) presents a similar setup except that he directly focuses on output suppliers' behavior. Second, it can be assumed that the production function for good i uses all the goods in the economy as inputs; again, aggregating over all sectors one obtains the relevant aggregate equation.

2/ We originally considered other autoregressive processes, but the AR3 process produced the most satisfactory white noise residuals. The main results reported below are quite insensitive to the inflation predictor used.

3/ For a study of the relationship between VP and inflation, and for a decomposition of Mexico's VP index into indexes of traded and nontraded goods, see Blejer and Leiderman (1979).

4/ This amounts to a restricted distributed lag specification that assigns equal weights to all lags, as in our previous study for the U.S. (Blejer and Leiderman, forthcoming). Results obtained using alternative restricted specifications were similar but less satisfactory. Unrestricted distributed lags were not used because they generated multicollinearity.

5/ We assume a fixed-exchange-rate regime, and no important changes in tariffs or transportations costs.

6/ The basic presumption here is that unexpected sectoral inflation and expected improvements in the terms of trade cause an outward shift in the sector's demand for labor, and other variable factors, thus increasing employment and output. On the effects of the terms of trade and unanticipated price movements on aggregate output in an open economy, see Leiderman (1979). The derivation and estimation of output reduced-forms from labor market considerations is discussed in Blejer and Fernandez (1980).

7/ See Leiderman (1979) for further discussion of this issue at a different open economy level of aggregation.

8/ Note that the equations of Table 3 include relative price variability in the $V_t$ form, and not in a sector specific form since we assume that suppliers in each sector i care about the relative inflation variable ($DP^i$ - EDP).

9/ The fact that the relative inflation variable is statistically insignificant in (4), but significant in (5) can be interpreted in terms of an omitted variable problem. To the extent that $V_t$ and ($DP^i$ - EDP) are positively correlated, as suggested in recent studies by Parks (1978) and Blejer and

Leiderman (1979), and to the extent that $V_t$ has negative effects on output, then an output equation that abstracts from $V_t$, like equation (4), will yield a downward biased parameter estimate on the $(DP^i - EDP)$ variable.

## REFERENCES


Alchian, Armen, A., "Information Costs, Pricing, and Resource Unemployment," in Edmund S. Phels et al., Microeconomic Foundations of Employment and Inflation Theory, (New York: Norton, 1970).

Banco de Mexico, Cuentas Nacionales y Acervos de Capital Consolidadas y por Tipo de Actividad Economica, 1950-67, Mexico City, 1969.

_______________, Estadisticas de la Oficina de Cuentas de Produccion, 1960-76, Mexico City, 1976.

Batra, Raveendra, N., and Aman Ullah, "Competitive Firm and the Theory of Input Demand under Price Uncertainty," Journal of Political Economy, Vol.82, May/June 1974, 537-48.

Blejer, Mario, I., and Roque B. Fernandez, "The Effects of Unanticipated Money Growth on Prices and on Output and its Composition in a Fixed Exchange Rate Open Economy," Canadian Journal of Economics, Vol.13, February 1980, 92-95.

_______________, and Leonardo Leiderman, "On the Real Effects of Inflation and Relative Price Variability: Some Empirical Evidence," Review of Economics and Statistics, forthcoming, November 1980.

_______________, and _______________, "Inflation and Relative Price Variability in the Open Economy," Discussion Paper No. 35, Center For Latin American Development Studies, 1979.

Friedman, Milton, "The Role of Monetary Policy," American Economic Review. Vol.58, March 1969, 1-17.

_______________, "Nobel Lecture: Inflation and Unemployment," Journal of Political Economy, Vol.58, June 1977, 451-72.

Gray, Jo Anna, "On Indexation and Contract Length," Journal of Political Economy, Vol.86, February 1978, 1-18.

Hayek, F.A., "The Use of Knowledge in Society," American Economic Review, Vol.35, September 1945, 519-30.

Johnston, J., Econometric Methods, (New York: McGraw-Hill 1972, 2nd edition).

Keynes, John M., Tract on Monetary Reform, (New York: Harcourt, Brace & Co., 1924).

Leiderman, Leonardo, "Expectations and Output-Inflation Tradeoffs in a Fixed-Exchange-Rate Economy," Journal of Political Economy, Vol.87, December 1979. 1285-1306.

Lucas, Robert E., Jr., "Some International Evidence on Output-Inflation Tradeoffs," American Economic Review, Vol.63, June 1973, 326-34.

Parks, Richard W., "Inflation and Relative Price Variability," Journal of Political Economy, Vol.86, February 1978, 79-96.

Sandmo, A., "Competitive Firm under Price Uncertainty," American Economic Review, Vol.61, March 1971, 65-73.

Sargent, Thomas, J., "Rational Expectations, the Real Rate of Interest and the Natural Rate of Unemployment," Brookings Papers on Economic Activity, 1973, 429-79.

Theil, Henri, Economics and Information Theory, (Chicago: Rand McNally, 1967).