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EXCHANGE RATE CHANGES AND INFLATION IN DEVELOPING COUNTRIES

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August 7, 1980
I. Introduction

A major reason for the widespread reluctance of policymakers in less developed countries (LDCs) to undertake exchange rate adjustments, despite the recognition of domestic currency overvaluation, is the anxiety about induced general price increases which may "rapidly undercut the improved competitiveness that the devaluation is designed to achieve" (Cooper, 1971; p. 21). There is a pervasive belief that devaluation is inflationary, not only in the sense of a once-and-for-all price increase but that some cost-push mechanism (e.g., a wage-price spiral) will make a higher rate of inflation inevitable. While the nature and empirical significance of such mechanisms have been debated in the literature for some time, the evidence from cross-country studies based on LDC experience under the Bretton Woods system seems to indicate that the worst fears concerning the inflationary effect of devaluation are unfounded.

In a study of 24 devaluation episodes involving 19 (mostly developing) countries during the period 1959-1966, Cooper (1971) finds that increases in wholesale and consumer prices have been far less than the devaluation -- on average, by 32 and 42 per cent, respectively, of the devaluation. Connolly and Taylor (1976) have likewise observed that 8 devaluations in 5 LDCs during 1962-1970 resulted in faster increases in wholesale and consumer prices in the year following devaluation but at much lower rates than export and import prices; over two years "the devaluation would have
added 13 and 14 1/2 per cent to the export and import price indices" (p. 857). Finally, in a regression analysis of the inflationary impact of devaluation in ten developing countries (included in the recently completed NBER project on foreign exchange regimes and economic development) using data through 1972, Krueger (1978) concludes that, after taking account of monetary behavior, the net effect of other influences on the rate of price increase in each of the four quarters following devaluation has not been statistically significant.

The devaluations examined in the aforementioned studies occurred under the Bretton Woods system of adjustable par values, involving large once-and-for-all exchange rate changes. The purpose of the present study is to re-examine the issue of the inflationary effect of exchange rate changes in the recent period of generalized currency floating. For several reasons the impact of exchange rate changes on domestic prices may be quantitatively different under the present exchange rate system. One possibility is that producers, in their pricing decisions, may react less significantly to smaller changes in the exchange rate (over a given period) in view of the transactions cost of changing prices in imperfectly competitive markets. Moreover, the publicity attending policy decisions involving large, discrete exchange rate changes may lead to greater domestic price repercussions. Some producers may even take the opportunity to raise prices of certain products which were difficult to do before the exchange rate adjustment "for reasons of law, custom, fear of public approbrium or simply inertia" (Cooper, 1971; p. 27); the large, 

\[1/\] Prime examples are public utility companies and other firms whose products are subject to government price control.
once-and-for-all devaluation serves as an excuse for producers to correct prices upwards even for unrelated reasons. On the other hand, continuous exchange rate adjustments, whether large or small, may generate expectations of sustained movements in the same direction, which add to the inflationary pressure. Moreover, to the extent that there is increased variability in an LDC's effective exchange rate under generalized floating, downward rigidity of domestic prices could result through the so-called "ratchet effect" in a cumulative rise in the general price level.

This paper analyzes the contribution of exchange rate and foreign price changes to domestic inflation in a sample of 12 developing countries, using the multiple regression technique on pooled time series and cross-section data for the period 1975 to 1978. In Section II we set out variants of the standard cost-push model of inflation. Section III reports the results of estimation, and Section IV discusses briefly the implications of the findings.

II. Basic Model of Inflation

The standard procedure of measuring the domestic price level (P) is as a weighted average of the prices of foreign- and home-produced goods. Thus, expressing all variables as proportionate changes (denoted by a dot above the variable), we can write

\[ \dot{P} = \theta(\dot{R} + \dot{P}_f) + (1-\theta) \dot{P}_h, \quad 0 \leq \theta \leq 1 \]

where

\[ R = \text{exchange rate, in units of domestic per unit of foreign currency} \]
\[ P_f = \text{foreign currency price of imported final goods} \]
\[ P_h = \text{price of home-produced final goods} \]

and \( \theta \) is the share of imports in final consumption. If we treat \( \dot{R} \) and \( \dot{P}_f \) as exogenous variables, specification of the price equation will depend on our theory of price determination of domestically produced goods. \( P_f \) is clearly exogenous to small countries. \( R \) can be treated as exogenous under an adjustable par value regime, but even under current arrangements the exchange rate is largely a policy determined variable.\(^1\) The bulk of recent empirical work on inflation has applied the standard mark-up pricing model which, on the basis of the firm's cost function, hypothesizes that

\[ (2) \quad \dot{P}_h = k[\alpha_1 \dot{W} + \alpha_2 \dot{P}_i] \]

where

\[ k = \text{constant mark-up factor} \]
\[ \dot{W} = \text{rate of change in nominal wages} \]
\[ \dot{P}_i = \text{rate of change in material input prices} \]

and \( \alpha_1 \) and \( \alpha_2 \) are reduced-form coefficients of the production function, the sum of which is equal to one if the production function is linear homogeneous.\(^2\) Since our interest is in the aggregate price equation, we can simplify matters by assuming that \( \dot{W} \) represents the change in variable cost not only of labor at the final stage of production but of domestically produced intermediates as well. This allows us to rewrite (2) as

\[ (2') \quad \dot{P}_h = k[\alpha_1 \dot{W} + \alpha_2 (\dot{R} + \dot{P}_f)] \]

\(^1\) See Branson and Katseli-Papaefstratiou, (1980). This would be less valid for crawling-peg countries for which reason none of these countries is included in our sample.

\(^2\) Because our analysis is short-run we ignore the role of capital accumulation and technological change in price determination.
where \((R + Pf)\) now measures the change in the cost of imported intermediates.  

Substituting \((2')\) into \((1)\) yields

\[
\dot{P} = a_1(R + Pf) + a_2 \dot{W}
\]

where

\[
a_1 = \theta + (1-\theta)ka_1' \\
\]

\[
a_2 = (1-\theta)ka_1'.
\]

In \((3)\) foreign price changes affect domestic inflation both directly by changing the prices of final goods and indirectly by affecting the cost of imported intermediates.

Equation \((3)\) in its many forms has appeared in numerous empirical studies of price adjustment (cf. Eckstein, 1972; Coutts, Godley and Nordhaus, 1978). The cost-plus pricing hypothesis can be rationalized on many grounds. On whatever ground, as a theory of inflation it requires the assumption that money is passive. Moreover, in the form of \((3)\) it assumes that wages are determined exogenously and ignores the role of expectations in determining inflation. A common solution to these shortcomings is to introduce a wage-price adjustment equation (cf. Bruno, 1978) such as

\[
\dot{W} = b \text{E}(\dot{P}) \quad b \leq 1
\]

where \(\text{E}(\dot{P})\) is the expected rate of inflation. If expectations are formed rationally, then

---

1/ In order to keep our analysis simple and empirically operational we are ignoring relative price changes in world markets. In effect, \(P_f\) represents the rate of change both of foreign final and intermediate goods.
where \((\hat{R} + \hat{P}_f)\) now measures the change in the cost of imported intermediates.\(^1\)

Substituting \((2')\) into \((1)\) yields

\[
\dot{p} = a_1(\hat{R} + \hat{P}_f) + a_2 \dot{w}
\]

where

\[
a_1 = \theta + (1-\theta)k_2'
\]

\[
a_2 = (1-\theta)k_1'.
\]

In \((3)\) foreign price changes affect domestic inflation both directly by changing the prices of final goods and indirectly by affecting the cost of imported intermediates.

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\[
\dot{w} = b E(\dot{p}) \quad b \leq 1
\]

where \(E(\dot{p})\) is the expected rate of inflation. If expectations are formed rationally, then

\(^1\) In order to keep our analysis simple and empirically operational we are ignoring relative price changes in world markets. In effect, \(\hat{P}_f\) represents the rate of change both of foreign final and intermediate goods.
(5) \( \dot{\pi} = b\dot{p} = bc (\dot{R}+\dot{P}_f) \), \( c \leq 1 \)

in which cost-push is instantaneous and, assuming homogeneity in price and wage adjustment (i.e., \( b = c = 1 \)), complete pass-through of foreign price changes to the domestic price level (cf. Bruno, 1978; p. 385).

Given existing institutional arrangements and costs of recontracting, it seems unreasonable to assume instantaneous adjustment of prices to changes in costs even when they are foreseen. Moreover, informational constraints suggest that it is unrealistic to assume perfect foresight. Instead, we might hypothesize that expectations are formed by extrapolating from the past, such that

(6) \( E(\dot{p}) = \dot{p}_{-1} \).

Substituting (6) into (4) and then back into (3) yields

(7) \( \dot{p} = d_1(\dot{R}+\dot{P}_f) + d_2 \dot{p}_{-1} \).

In this case adjustment to a change in foreign prices is gradual, the mean lag of adjustment being \( (1-d_2)^{-1} \). Homogeneity in the price adjustment in this case implies \( d_1(1-d_2)^{-1} = 1 \).

Thus far, we have ignored the potential role of excess demand. Although empirical studies have failed to find a significant effect of demand on prices, completeness requires that we include a demand variable in the price equation. Following the quantity theory, we propose to use as a proxy for excess demand the difference between the rates of growth of the nominal money supply and real income \( (\dot{M} - \dot{Y}) \). This variable, used as an additional explanatory variable in a regression equation based on (3),...
would show a significant effect on \( P \) if money supply were expanded at a rate greater than that dictated by real growth or required to accommodate cost increases.

In addition to adjusting for excess demand, since the model is to be applied to cross-section data, it might be necessary to adjust for inter-country differences in the degree of openness (\( m \), defined as the import-GNP ratio). The degree of openness could affect the relationship between a given foreign price change and domestic inflation if what is important is the share of imports (which varies considerably from country to country) rather than the share of importables (which is relatively uniform across countries) in GNP. In addition to potentially affecting the coefficient of the foreign price variable in the price equation, the degree of openness may influence key institutions in an economy, thus contributing an independent explanation of inter-country inflation rate differences. In this regard, our hypothesis would be that the more open an economy is the more able policymakers are to impose discipline on competing interest groups attempting to force redistribution of income in their favor. For these reasons, it is useful to test for shifts in both the intercept and slope of the price equation due to differing degrees of openness among the sample developing countries.

III. Empirical Results

The results of estimation of the model in its various forms are presented in Table 1.\(^1\) The results confirm the central proposition of

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\(^1\) See Appendix below for a description of the measures of the variables used in the regressions and sources of data. The developing countries in our sample were chosen largely on the basis of data availability and to specifically exclude crawling peg countries and those that experienced extraordinary political disturbances during the observation period; see Appendix Table for the list of sample developing countries.
Table 1: Regression Results, 1975-78  
(Independent Variable: \( \hat{P} \))

<table>
<thead>
<tr>
<th>Equation No.</th>
<th>Const.</th>
<th>( \hat{R} + \hat{P}_F )</th>
<th>( \hat{W} )</th>
<th>( \hat{P}_{-1} )</th>
<th>( \hat{M} - \hat{Y} )</th>
<th>( m )</th>
<th>( R^2 )</th>
<th>s.e.e.</th>
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Note: Numbers in parentheses are t-statistics.
the model, namely, that foreign price and exchange rate changes are the principal determinants of inflation in developing countries, the premise being of course that their inflationary effects are validated by monetary expansion.

Regression equations (1) and (2) in Table 1 treat wages as exogenously determined. The shortcoming of this specification is that if wages are determined under rational expectations or if costs of recontracting in the labor market are low, \( \dot{W} \) is itself a function of \( \dot{R} + \dot{P}_f \). Regression equations (3) and (4), on the other hand, implicitly treat wages as endogenously determined and allow for lags greater than a year in the adjustment of wages to changes in the price level. The finding that the regression coefficient of \( \dot{R} + \dot{P}_f \) is higher and its standard error is lower in regression equations (3) – (5) than in (1) or (2), together with the fact that the explanatory power of the model in (3) – (5) is not appreciably lower than (1) or (2) suggests that wages should not be treated as exogenously determined. The specification of the model (3) – (5) is therefore judged to be the more appropriate.

The finding that the coefficient of \( \dot{P}_{-1} \) is not significantly different from zero suggests that the adjustment of nominal wages to change in the price level is instantaneous, or more accurately in the present context, occurs within a year. The (\( \dot{R} + \dot{P}_f \)) coefficient estimate of .642 in regression equation (5) suggests less than full homogeneity of price adjustment. It is further observed that the constant term is significantly different from zero, implying that some rate of inflation (1.7 per cent in regression equation (5)) is unexplained by the model. It might be noted that even if the function is forced through the origin, less than full homogeneity is obtained, the coefficient of (\( \dot{R} + \dot{P}_f \)) increasing to .85.
Finally, we observe that the excess demand variable $\dot{M}-\dot{Y}$ contributed no additional explanatory power to the model, a result that is consistent with the majority of empirical studies of inflation in the industrialized countries (cf. Bruno, 1978; Eckstein 1972; and Gordon, 1975). However, openness clearly is a significant independent variable in explaining intercountry differences in inflation rates among developing countries. The negative coefficient of $m$ confirms our hypothesis that public and private institutions impart a smaller inflationary bias in more open economies. The degree of openness did not prove significant in defining the relationship between $\dot{P}$ and $(\dot{R}+\dot{P}_f)$, a result confirming that it is the share of importables rather than imports per se that determines the impact of foreign prices on domestic inflation.

The model estimated in this paper for a sample of developing countries is similar to that estimated by Bruno (1978) which pooled time series data for OECD countries for 1972-76. Estimating an equation similar to regression equation (3) in Table 1, but using consumer price rather than wholesale price inflation as the dependent variable, Bruno (1978) obtained the result (using our notation):

$$\dot{P} = .031 + 0.177 (\dot{R}+\dot{P}_f) + 0.517 P_{-1}$$

$$R^2 = .658$$

This result provides an interesting and somewhat paradoxical comparison of price adjustment in developed versus developing countries. As in the case of our developing countries, Bruno finds that "in the particular empirical context analyzed, the system may exhibit less than full homegeneity" (p. 389). However, what is remarkable in comparing the results is the
difference between the two groups in the speed of domestic price adjustment to foreign price changes. The mean lag adjustment found for OECD countries is two years, whereas all adjustment was found to occur within one year in the developing countries. Moreover, the results suggest that pass-through in developing countries (.64) is almost double that in the OECD countries \([(1-.517)^{-1} \times .177 = .366]\). This result would suggest that either expectations are more rationally formed in developing than in developed countries, or what is more probable, institutional arrangements and recontracting costs are less of an obstacle to price adjustment in developing countries.

IV. Conclusion

The findings of this paper concerning the inflationary effect of exchange rate changes are clearly at variance with those of earlier studies based on the experience under the Bretton Woods system. It is recognized that differences in methodology and approach may limit comparability with the present study. Nevertheless, it is worth noting that in a recent investigation of the influence of exchange rate changes on prices in 18 developed countries, "the main conclusion ... is that parity changes have a larger and quicker effect on the rate of inflation than they need to have" (Robinson, et al. 1979; p. 48). Apparently, this is true in developing countries as well.
APPENDIX: Definition of Variables and Data Sources

\[ \dot{P} = \text{annual rate of change in wholesale price index} \]

\[ \dot{M} = \text{annual rate of change in money supply} \]

\[ \dot{Y} = \text{annual rate of change in gross domestic product (at 1975 prices)} \]

\[ m = \text{ratio of imports to gross national product in 1976} \]

\[ \dot{W} = \text{annual rate of change in non-agricultural (industrial, manufacturing) wage rate} \]

\[ \dot{R} = \text{annual rate of change in import-weighted effective exchange rate index} \]

\[ \dot{P}_f = \text{annual rate of change in import-weighted index of foreign export unit values}. \]

Data for \( \dot{P}, \dot{M}, \dot{Y} \) and \( m \) were drawn entirely from the IFS computer file of the IMF. The ILO Yearbook of Labor Statistics provided most of the wage data, which were supplemented by published materials from individual countries. Calculation of the import weights \( w_{mi} \) is based on the proportions of developing country (i) imports for which prices are set in the currencies of 12 developed countries (United States, Canada, Japan, United Kingdom, France, West Germany, Netherlands, Belgium, Italy, Switzerland, Sweden and Australia) on the assumption that world prices of primary agricultural products and fuels are set in U.S. dollars, metals and minerals in British pounds, and other traded goods in the currencies of developed country origin of imports (cf. Bautista and Riedel, 1980). \( R \) and \( P_f \) were computed as

\[ R = \prod_{i=1}^{12} (R_i)^{w_{mi}} \quad \text{and} \quad P_f = \prod_{i=1}^{12} (P_{xi})^{w_{mi}} \]

where \( R_i \) is the bilateral exchange rate index and \( P_{xi} \) is export unit value index of developed country \( i \), both obtained from the IFS computer file of the IMF.

The observed values of \( \dot{P}, \dot{R} \) and \( \dot{P}_f \) are shown in the appendix table below.
APPENDIX TABLE: Values of $\dot{P}$, $\dot{R}$ and $\dot{P}_f$

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