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Empirical Analysis of High-Inflation
Episodes in Argentina, Brazil, and Israel

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Abstract

Although accommodative policies and widespread indexation may account for the persistence of high inflation, they cannot explain changes in the inflation rate. This paper examines the causes of such changes for the high-inflation episodes immediately preceding the recent "heterodox" attempts at stabilization in Argentina, Brazil, and Israel. An attempt is made to distinguish between the "fiscal" and "balance of payments" views of the causes of high inflation by computing historical decompositions of these episodes based on vector autoregressions. In all three cases, the results indicate that nominal exchange rate shocks played the dominant role in triggering an acceleration of inflation.

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I. Introduction

Argentina, Brazil, and Israel have recently undertaken comprehensive stabilization programs to combat chronic high inflation. These "heterodox" programs, so called because, in contrast to more orthodox stabilization efforts, a wage and price freeze was an important component of each, represented a novel attempt to halt--quickly and without substantial costs in terms of foregone output--levels of inflation which, while persistently high, had not yet reached hyperinflationary dimensions. Although all three programs succeeded in virtually eliminating inflation on impact at minimal output costs, this success proved to be only temporary in Argentina and Brazil, which have recently experienced a strong resurgence of inflation. While the Israeli program at present remains on track, its eventual success cannot yet be confidently predicted.

High inflation has apparently proven to be as resistant to "heterodox" stabilizations as it had previously proven to be to those of the "orthodox" variety. ^{1/} The seeming absence of a low-cost means for achieving a permanent reduction in high inflation makes it imperative to understand the nature of the shocks that have triggered an acceleration of inflation in countries that have suffered from the high-inflation malady. Considerable interest therefore attaches to understanding the causes of recent high inflation in Argentina, Brazil, and Israel. This paper approaches this problem by analyzing historical decompositions of the high-inflation episodes that immediately preceded the recent stabilization programs in these three countries. This technique essentially uses estimated vector autoregressions to decompose innovations in a given macroeconomic variable (e.g., the rate of inflation) into portions that can be attributed to innovations in other macroeconomic variables (such as the exchange rate and the money supply) that are correlated with the variable of interest. The objective is to assess the extent to which innovations in the inflation rate in these high-inflation countries can be associated with innovations in alternative variables that have been viewed in the literature as triggering these high-inflation episodes.

The organization of the rest of the paper is as follows. The next section describes the dominant views on the causes of high inflation. Section III presents the empirical methodology and analyzes the results. A concluding section summarizes the paper's findings and points to directions for further research.

^{1/} For a recent survey of "orthodox" stabilization experiences, see Kiguel and Liviatan (1987)

II. Causes of High Inflation

Recent analyses of the causes of high inflation have tended to coalesce around two views, which can be termed the "fiscal" view and the "balance of payments" view.

Proponents of the fiscal view essentially take Milton Friedman's adage that "inflation is always and everywhere a monetary phenomenon" one step back by focusing explicitly on the sources of monetary growth. Working primarily in a closed-economy context, authors such as Sargent and Wallace (1981) argue that continuous expansion of base money essentially arises from a fiscal disequilibrium. ^{1/} Given an exogenous real fiscal deficit (in proportion to real GDP), a Cagan semi-log money demand function, and rational expectations, it can be shown (see, for example, Bruno and Fischer (1985)) that the economy will be characterized by two inflationary equilibria. The high-inflation equilibrium will be stable, while the low-inflation equilibrium will be unstable. Ultimately, the position of the stable high-inflation equilibrium and thus the value of the equilibrium inflation rate, depends on the value of the only exogenous variable in the model--the ratio of the fiscal deficit to GDP. Hence the term "fiscal view."

In many developing countries, inflation erodes the real value of tax revenue while leaving the real value of public sector expenditures relatively unaffected, thus increasing the real value of the fiscal deficit. ^{2/} The simple fiscal view described above can readily be modified to allow for feedback from the inflation rate to the real deficit via this Olivera-Tanzi effect (see, for example, Dornbusch and Fischer (1986)). While the dynamics of inflation become more complicated in this case, adherents of the fiscal view can still point to movements in the exogenous component of the fiscal deficit as the fundamental source of monetary emission that moves the economy to a high-inflation equilibrium.

Those who advocate the "balance of payments" view tend to emphasize instead the role of the exchange rate. A strong form of this balance of payments view is taken by Liviatan (1986), who sees inflation as tightly linked to exchange rate changes prompted by balance of payments crises. According to Liviatan, an exchange rate depreciation increases the underlying rate of inflation either by increasing inflationary expectations, which are then accommodated by monetary authorities, or via the wage

^{1/} See also Buiter (1984) and van Wijnbergen and Anand (1987).

^{2/} This phenomenon is known in the literature as the Olivera-Tanzi effect--see Olivera (1967) and Tanzi (1977). See also Dutton (1971), and Aghevli and Khan (1978).

indexation mechanism. The latter channel is said to work as follows: suppose that the "base" real wage over the life of the contract is given by w_0 and that the nominal wage is adjusted every n periods for the change in the price level since the last adjustment. Letting π represent the inflation rate, the average real wage over the life of the contract, denoted w_a , is given by:

$$w_a = w \begin{matrix} (w_0, & n, & \pi) \\ + & + & - \end{matrix}$$

where the symbols beneath the arguments of w denote the signs of its partial derivatives. The average real wage will obviously increase, other things equal, with the value of the "base" real wage. Since the initial real wage will continuously be eroded by inflation during the period between adjustments, the average real wage will be lower the longer the period of erosion lasts (i.e., the smaller is n) and the greater the degree of erosion, which depends on the inflation rate π . This explains the signs of the second and third partial derivatives. According to Liviatan, an exchange rate depreciation will increase n , and for a given value of w_0 , will therefore imply a higher rate of inflation to generate the equilibrium value of the average real wage. ^{1/} In Liviatan's view, a persistently large fiscal deficit is associated with inflation primarily because by depleting the central bank's foreign exchange assets it will prompt a balance of payments crisis, which will then generate inflation through one of the mechanisms described above.

Other authors have adopted a somewhat weaker form of the balance of payments view. As summarized by Dornbusch (1985):

"The alternative theory is the balance of payments approach. This theory claims that adverse balance of payments developments force exchange depreciation which then deteriorates inflation and with that, budgetary performance. In a setting of passive money, exchange rate disturbances then cause inflation." (p. 15.)

In other words, when the authorities are not pursuing money supply targets (passive monetary policy), either because of an explicit policy of monetary accommodation or because of monetary financing of a real budget deficit which is endogenous with respect to the price level, nominal exchange-rate shocks prompted by adverse external developments can give rise to inflationary episodes.

^{1/} See also Bacha and Lopes (1983).

It is difficult to draw analytical distinctions between the fiscal and balance of payments views. For a small open economy, the steady-state inflation rate can be determined either by the fiscal deficit or by nominal exchange-rate policy, depending on the policy regime in force. If the authorities pursue a fiscal deficit target, the location of the steady-state equilibria for the inflation rate will be determined by the implied rate of growth of the money supply, á la Sargent-Wallace. Given the world inflation rate, constancy of the steady-state real exchange rate will then determine a unique path for the nominal exchange rate. Conversely, if the authorities instead fix a path for the nominal exchange rate, constancy of the steady-state real exchange rate determines the domestic rate of inflation and thus the size of the fiscal deficit that can be financed with revenue from the inflation tax. If otherwise temporary shocks to the inflation rate modify either the target value of the fiscal deficit in the first regime, or of the nominal exchange-rate path in the second, then some portion of such shocks will prove to be sustained. In the limit, if inflationary shocks are completely accommodated by both steady-state fiscal and exchange-rate policies, then these shocks will become permanent. In the absence of a nominal anchor for the system, the inflation rate will behave like a random walk. ^{1/} Notice, however, that the sources of such shocks can be a temporary fiscal expansion, a step devaluation of the nominal exchange rate or, for that matter, any other disturbance which is associated with an increase in the average price level.

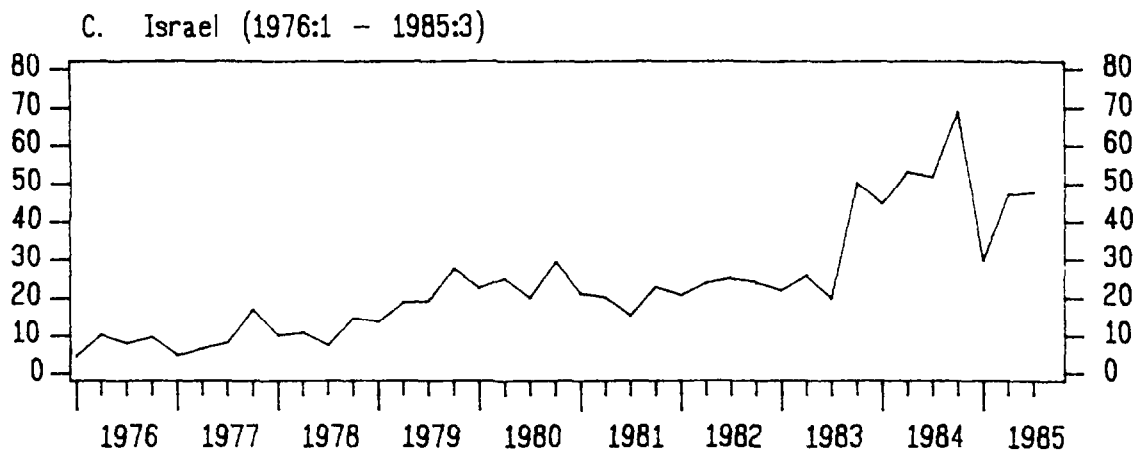
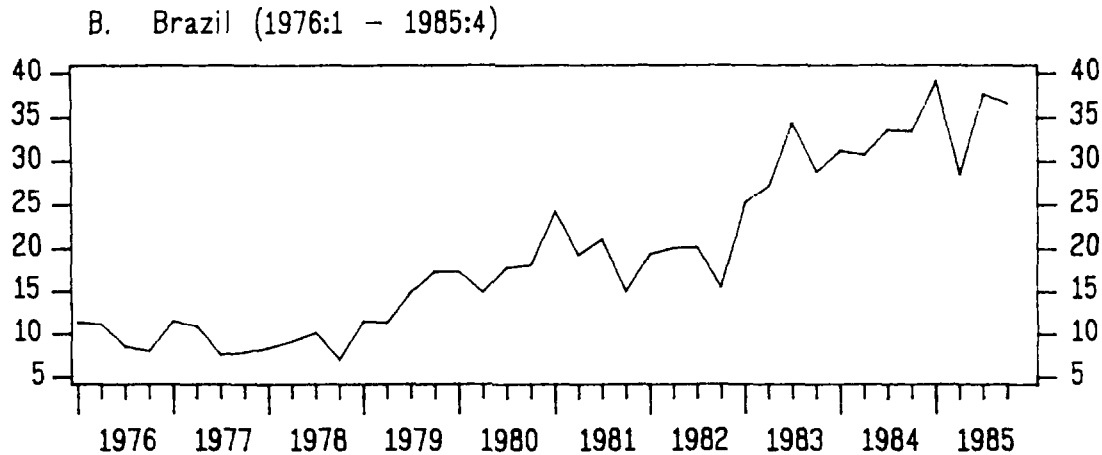
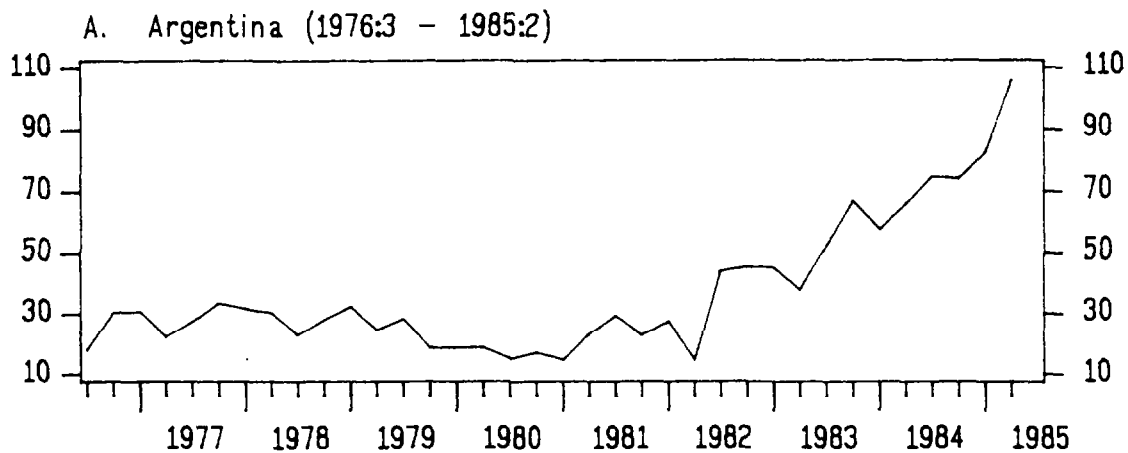
It follows that the fundamental difference between the fiscal and balance of payments views must be an empirical one. That is, given the presence of a substantial degree of feedback from changes in the aggregate price level to both the fiscal deficit and the rate of depreciation of the nominal exchange rate (which accounts for the sustainability of inflation), these views differ with respect to the nature of the shocks that have empirically been observed to trigger episodes of sustained high inflation. This empirical issue is addressed in the next section for the inflationary episodes that immediately preceded heterodox stabilization in Argentina, Brazil, and Israel.

III. Empirical Methodology and Results

Figure 1 depicts quarterly inflation rates measured by the Consumer Price Index for Argentina, Brazil, and Israel. With the exception of the Martinez de Hoz period (1979:1 - 1980:4), the inflation rate in Argentina

^{1/} An analysis of a sequence of models with this property is provided in Adams and Gros (1986).

Chart 1
Quarterly Rate of Inflation
in Argentina, Brazil and Israel



was fairly stable at quarterly rates averaging slightly under 25 percent from 1976:3 to 1982:1. In the second quarter of 1982, however, the Argentine rate of inflation accelerated markedly, and continued to rise until the Austral plan was launched in 1985:2 (Panel A). In the case of Brazil, the quarterly inflation rate was reasonably steady at about 10 percent during 1976-78, but accelerated in mid-1979, averaging a little over 20 percent from 1979:3 to 1982:3. From the fourth quarter of 1982 to the end of 1984 the quarterly inflation rate more than doubled, and it averaged about 35 percent during 1985 (Panel B). The Cruzado Plan was adopted in February of 1986. Finally, quarterly inflation averaged about 11 percent in Israel during 1976:1 - 1978:2, then accelerated to almost 30 percent over the next five quarters, before leveling off to an average quarterly rate of about 23 percent from the third quarter of 1979 to the second quarter of 1983. As shown in Panel C, the inflation rate accelerated sharply--to over 50 percent--in the third quarter of 1983 and averaged about 48 percent per quarter over the next two years. All three countries, therefore, witnessed extremely sharp accelerations of inflation which then tended to persist for prolonged periods. The shortest of these (the most recent inflationary episode in Israel) lasted a little over two years before the Economic Stabilization Program was implemented in the third quarter of 1985.

Although several observers have noted this "plateau" character of inflation in these countries, descriptive analyses of the recent history of inflation in Argentina, Brazil, and Israel have taken a fairly eclectic view of the causes of the acceleration in the rate of inflation in the period leading up to the "heterodox shocks". For example, Williamson (1985) summarized the findings of a conference on inflation in Argentina, Brazil and Israel held in December 1984 (i.e., in the midst of the high-inflation episodes being considered here) as follows:

. . . the conference suggested that the causes of the present inflation are very different in the three countries. In Argentina the overwhelming problem was perceived to be one of distributive inconsistency--of a set of claims to real income that cannot all be satisfied simultaneously out of the economy's real output. In Brazil the problem was diagnosed as the persistence of inflationary inertia despite the removal of active inflationary pressures, and indeed despite the adoption of contractionary policies that should tend to reduce inflation according to "orthodox" theories. In Israel the problem is predominantly one of a fiscal deficit out of control. . . (p.2)

The purpose of this section is to account for the inflationary accelerations experienced by Argentina beginning in 1982:3, by Brazil in 1982:4, and by Israel in 1983:3, in a systematic empirical fashion, with

a view to assessing the roles of the "fiscal" and "balance of payments" hypotheses described in the previous section and contrasting their explanatory powers.

1. Methodology

To assess the relative contributions of exogenous changes in base money and the nominal exchange rate in triggering the inflationary episodes identified above, one would ideally hope to work with a reduced-form price equation for each country which links current price changes to current and lagged changes in the exogenous components of growth in base money and in nominal exchange-rate depreciation, together with any other relevant variables. It would then be possible to simulate the path of the domestic inflation rate during the period in question in the absence of shocks to base money on the one hand and to the nominal exchange rate on the other, thereby separately identifying the contributions of the two types of shocks. Since in systems with monetary and exchange-rate accommodation neither the observed values of changes in base money nor in the nominal exchange rate can be regarded as exogenous movements in the time series processes generating these variables, the reduced-form price equation would need to be supplemented by reduced-form equations for base money and the nominal exchange rate that could be used to extract estimates of the exogenous components of base money growth and exchange rate depreciation from the data.

Although a substantial amount of econometric work exists on price determination in developing countries--including Argentina, Brazil, and Israel--and some work exists on the money supply process, there is still a lack of consensus on the appropriate specification of the types of equations described above for the three countries that concern us here. In the absence of much reliable prior information, therefore, this section relies on unrestricted vector autoregressions (VARs) to empirically estimate the dynamic relationships among prices, base money, and the nominal exchange rate for Argentina, Brazil, and Israel. ^{1/} To minimize the probability of serious misspecification this three-variable system was expanded to also include nominal wages and real output, reflecting the prominent role often attributed to nominal wages and supply shocks in price determination for developing countries. The inclusion of these variables also allows for their possible influences on base money and on the nominal exchange rate. It remains true, of course, that the exclusion of other possibly relevant variables is itself a use of prior information which, if unwarranted, could bias the results. Nonetheless, the five variables

^{1/} Vector autoregressions have also been employed to examine money and output dynamics in developing countries (Colombia and Mexico) by Leiderman (1984).

included here are those which figure most prominently in structural investigations of price behavior in developing countries. 1/

The procedure followed here was to estimate the unrestricted five-variable vector autoregressions for each country using quarterly data on the variables listed above for samples beginning with the first quarter for which data were easily available and ending in the quarter immediately preceding the inception of the recent stabilization programs. The sample periods were 1976:3 - 1985:1 for Argentina, 1975:2 - 1985:4 for Brazil, and 1973:2 to 1985:2 for Israel. 2/ Data description and sources are contained in an appendix. To induce stationarity in the time series, all variables were transformed into percentage-change form. The regressions included, in addition to the five endogenous variables, a constant and a time trend.

The estimated vector autoregressions convey little information in themselves, but they can be used to solve for a moving average representation of the system, which expresses the current value of each variable as an infinite distributed lag of past innovations in all the variables in the system plus the dependent variable's own current innovation (see Sims (1980)). Specifically, let Y_t be the (5×1) column vector containing the five variables in the vector autoregression discussed above. Its moving average representation is given by:

$$(2) \quad Y_t = X_t\beta + \sum_{s=0}^{\infty} A_s U_{t-s},$$

where $X_t\beta$ is the deterministic part of the model, A_s is a (5×5) matrix, and U_t is a (5×1) vector of innovations with $E(U_t) = E(U_t U_{t-j}') = 0$ for $j \neq 0$, but $E(U_t U_t') = \Sigma$, where Σ , the contemporaneous covariance matrix of the innovations, is not necessarily diagonal (i.e. innovations may be correlated across equations).

1/ See, for example, Bruno and Fischer (1985). More recently, Marshall and Morande (1987) have constructed a structural model of inflation for Brazil which includes precisely these variables.

2/ An exception to the "data availability" rule was made for Argentina, where 1976:2 was dropped since a strong case can be made that this observation belongs to a different policy regime. The stabilization that followed the military overthrow of Isabel Peron had not been completed as of the second quarter of 1976.

In cases where the covariance matrix Σ is approximately diagonal, the absence of correlation among the innovations to the five variables makes it natural to regard the innovations to each variable as an exogenous shock to that variable. If the innovations do not satisfy this orthogonality property, then innovations in a given variable may be due to exogenous shocks to any or all variables, depending on the contemporaneous interaction among the variables in the system. To overcome this problem, the contemporaneous innovations need to be decomposed into variable-specific exogenous shocks--i.e., they need to be orthogonalized. To see how this is done, note first that the moving average representation (2) is equivalent to:

$$(3) \quad Y_t = X_t \beta + \sum_{s=0}^{\infty} B_s V_{t-s},$$

where $B_s = A_s G^{-1}$; $V_t = GU_t$, and G is any nonsingular matrix. If G is chosen so that $G \Sigma G' = I$ (with I the identity matrix), then the innovations V_t will be mutually orthogonal (since $E(V_t V_t') = I$). Unfortunately, for a given Σ , the matrix G is not unique (i.e., there is no unique way to choose the orthogonalized moving average representation of the system). We follow the common procedure of coping with this problem by adopting a Choleski factorization of Σ --i.e., the matrix G^{-1} is taken to be lower triangular, with positive elements on the diagonal.

Though this produces a unique G associated with a given Σ , it presents a further problem. Since $U_t = G^{-1}V_t$ and G^{-1} is lower triangular, the Choleski factorization implies that each successive element of U_t , say U_{it} , is represented as a linear combination of its own exogenous shock V_{it} and the shocks to the variables preceding it in order in the vector U_t (i.e., all the V_{jt} for which $j < i$). Thus, exogenous shocks to the first variable affect the innovations in all variables, while shocks to the second variable affect all variables but the first, and so on. The Choleski factorization therefore imposes an essentially arbitrary (in the sense that it must be imposed a priori) ranking on the variables in the system. To gauge the extent to which our results were sensitive to this a priori ordering, the effects of changing the initial ranking of the variables in systematic ways are compared below in cases for which Σ is not diagonal.

The orthogonalized moving average representation (3) is used in two ways in this section:

1. The basic premise of Section II--that exogenous changes in base money and the nominal exchange rate have been the primary sources of

variation in the rate of inflation in high-inflation countries--is tested by computing the proportion of the variance of the forecast error for the inflation rate that can be attributed to variation in each of these variables at various forecast horizons for Argentina, Brazil and Israel. 1/

2. Secondly, we examine historical decompositions of the inflationary episodes described earlier for each of the three countries: these were computed using the procedures incorporated in the RATS software package (Doan and Litterman (1986)). Specifically, let T denote the quarter immediately preceding an inflationary episode. Then for each quarter $T + j$ of that episode, we can write:

$$(4) \quad Y_{T+j} = [X_{T+j}\beta + \sum_{s=j}^{\infty} B_s V_{T+j-s}] + \sum_{s=0}^{j-1} B_s V_{T+j-s}.$$

The term in square brackets is the portion of Y_{T+j} that could have been predicted on the basis of information available at time T . The remaining term is the portion of Y_{T+j} that can be attributed to exogenous shocks in the five variables of the system from time $T+1$ up to and including time $T+j$. Thus the observed value of inflation at time $T+j$ is decomposed into the sum of the portion that was predictable at time T , and the cumulative effect of exogenous shocks in all variables from time $T+1$ to time $T+j$. 2/ To the extent, therefore, that the inflationary episodes under examination can be attributed to innovations in the growth rate of base money, the rate of depreciation of the nominal exchange rate, or other variables included in the system, the relative contributions of each of these can be identified. 3/

1/ The proportion of the forecast error variance of variable i which is contributed by variable j over an N -period horizon is an intuitively appealing way of summarizing the relative importance of j in causing movements in i over the sample period. The reason is that the contribution of j will depend both on the estimated coefficients of the first N innovations of j in the moving average representation for i and on the estimated variance of j . Thus j will make a relatively large contribution to the forecast error variance of i if a one-unit change in j has a relatively large effect on future values of i and/or if j has exhibited relatively pronounced variability over the sample period (see Sims (1980)).

2/ Note that since the moving average representation is of infinite order, historical decomposition under this procedure always requires the choice of some base period T from which innovations can be computed.

3/ Burbridge and Harrison (1985) apply this methodology to assess the role of monetary factors in the Great Depression.

2. Results

Table 1 presents decomposition of the forecast error variance at four-quarter intervals for Argentina, based on estimates of the orthogonalized moving average representation given by (3). Panels A-C present three different orderings of the variables, since contemporaneous correlation among the elements of U_t proved to be strong in Argentina. Because placing wages and output at the top of the variable ordering attributes the largest possible amount of each period's innovations to exogenous shocks in these variables, it is to be expected that such an ordering would assign a larger role to these variables in explaining the inflation forecast error. This is borne out by comparisons of Panel A to Panel B and C of Table 1. However, even in Panel A, base money growth always explains a larger proportion of the forecast error variance than either wages or output, and the contribution of the exchange rate increases rapidly while those of wages and output diminish, as the forecast horizon lengthens. After 12 quarters, both base money and the nominal exchange rate account for much more of the forecast error variance than do either nominal wages or output. If the ordering is reversed, so that either base money (Panel B) or the nominal exchange rate (Panel C) is placed first, very little of the forecast error variance can be attributed to wages and output in Argentina over any forecast horizon.

In the case of Brazil, the evidence for an effect of nominal wages and output shocks on future inflation rates is somewhat stronger. In the ordering which gives primacy to these variables (Panel A of Table 2), output shocks account for the largest proportion of the forecast error variance after 8 quarters. However, even in this case, the joint contributions of the monetary base and the nominal exchange rate are comparable to those of nominal wages and real output at all forecast horizons. When the variable ordering is reversed--with the monetary base and the exchange rate (in either order) preceding the nominal wage and real output--the former variables clearly dominate the latter (Panels B and C in Table 2). Although output shocks continue to be of greater importance in Brazil than in Argentina, both the monetary base and the nominal exchange rate account for significantly larger shares of the forecast error variance in Panels B and C.

The evidence for Argentina and Brazil thus suggests that exogenous movements in base money and the nominal exchange rate indeed have played the dominant roles in determining the time path of the rate of inflation over the period under investigation. The same cannot be said in the case of Israel. Table 3 makes clear that the most important variable in explaining movements in future inflation for Israel is the nominal wage. Regardless of the ordering of the variables and of the length of the forecast horizon, nominal wage movements account for more than three quarters of the variance of the forecast error for the inflation rate in

Table 1. Argentina: Composition of Forecast
Error Variance for Inflation

(In percent)

A. Ordering W-Y-B-E-P ^{1/}

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	47.9	2.9	15.9	27.7	5.6
8	35.0	17.1	17.2	18.6	12.0
12	27.0	24.3	17.4	15.6	15.7
16	30.7	24.8	14.8	11.9	17.9
20	32.1	26.5	13.7	8.3	19.3
24	31.3	28.9	13.5	5.8	20.5
28	31.7	29.9	13.1	4.0	21.3
32	32.4	30.4	12.7	2.7	21.8

B. Ordering B-E-W-Y-P

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	52.2	21.1	2.2	3.8	20.7
8	32.5	36.2	7.0	1.8	22.5
12	30.2	38.6	7.1	1.7	22.4
16	31.6	38.3	6.4	1.3	22.3
20	30.4	39.8	6.4	0.9	22.4
24	29.4	40.8	6.6	0.7	22.6
28	29.5	40.9	6.5	0.5	22.6
32	29.5	41.0	6.5	0.4	22.6

C. Ordering E-B-W-Y-P

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	3.5	69.8	2.2	3.7	20.7
8	16.0	52.7	7.0	1.8	22.5
12	16.6	52.2	7.1	1.7	22.4
16	15.1	54.8	6.4	1.3	22.4
20	15.6	54.6	6.4	0.9	22.5
24	16.0	54.2	6.6	0.6	22.6
28	15.8	54.5	6.5	0.5	22.6
32	15.7	54.8	6.5	0.4	22.7

^{1/} W is the rate of nominal wage inflation, Y is the rate of growth of real output, B is the rate of base money growth, E is the rate of depreciation of the nominal exchange rate, and P is the inflation rate.

Table 2. Brazil: Composition of Forecast
Error Variance for Inflation

(In percent)

A. Ordering W-Y-B-E-P 1/

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	46.2	11.5	4.2	9.8	28.2
8	29.3	10.6	7.1	34.7	18.3
12	27.8	10.9	10.6	33.4	17.3
16	27.8	10.5	11.1	32.8	17.9
20	27.3	10.2	11.4	32.2	18.9
24	27.2	10.1	11.6	32.1	19.0
28	27.7	10.0	11.8	31.6	18.9
32	28.0	9.9	11.9	31.2	18.9

B. Ordering B-E-W-Y-P

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	40.2	7.9	14.4	9.3	28.2
8	34.4	21.1	9.2	17.0	18.3
12	32.1	23.4	10.6	16.5	17.3
16	32.1	22.9	10.8	16.2	17.9
20	31.9	22.9	10.5	15.8	18.9
24	31.2	23.3	10.5	16.0	19.0
28	31.4	23.3	10.6	15.9	18.9
32	31.5	23.2	10.7	15.7	18.9

C. Ordering E-B-W-Y-P

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	29.8	18.3	14.4	9.3	28.2
8	19.8	35.8	9.2	17.0	18.3
12	20.0	35.5	10.6	16.5	17.3
16	20.4	34.7	10.8	16.2	17.9
20	20.1	34.6	10.5	15.8	18.9
24	20.4	34.2	10.5	16.0	19.0
28	21.1	33.5	10.6	15.9	18.9
32	21.6	33.1	10.7	15.7	18.9

1/ For definitions of the variables see footnote 1 in Table 1.

Israel. Thus, whatever may be the case for specific inflationary episodes, for the sample period as a whole it is evident that inflation is not well explained by either the fiscal or balance of payment views. Instead, exogenous nominal wage movements which are subsequently accommodated by changes in base money and the nominal exchange rate seem to drive Israeli inflation.

Historical decompositions of the inflationary episodes described previously are presented in Tables 4-6. These tables report historical decompositions based on two alternative orderings of the variables: B-E-W-Y-P and E-B-W-Y-P. In addition, for Argentina and Brazil a non-orthogonalized representation is presented in which innovations in all variables are treated as mutually orthogonal, in spite of observed sample correlations among them. Finally, in view of the results above, Table 6 also includes the ordering W-B-E-Y-P for Israel.

In the case of Argentina, a substantial component of the post-1982:3 inflationary acceleration is attributed to post-1982:2 exogenous shocks. The prediction errors in column 4 of Table 4 average 10.3 percent of the inflation rate reported in column 2. The attribution of this rather large inflationary innovation, however, is extremely sensitive to the orthogonalization procedure. If innovations in base money are treated as exogenous (columns 5-7), then much of the "surprise" inflation after 1982:2 is attributed to exogenous shocks in base money growth, consistent with the fiscal view. On the other hand, if the nominal exchange rate is considered exogenous (columns 8-10), then the balance of payments view is supported, since innovations in inflation are traced to exogenous movements in the nominal exchange rate (column 9). The reason for this result is that the sample correlation between growth in base money and exchange-rate depreciation is extremely high (0.93) and both variables exhibited extremely large positive innovations in the third quarter of 1982. Because of the high positive correlation between them, the ordering chosen will tend to attribute both innovations to whichever variable is taken as exogenous in the Choleski factorization, and that variable will therefore tend to account for subsequent inflationary developments, to the exclusion of the other.

An alternative procedure is to avoid taking a position on contemporaneous exogeneity by decomposing innovations in inflation into the separate contributions of innovations in the system's variables, rather than of exogenous shocks to those variables. In this case, the historical decomposition would be expressed in terms of the nonorthogonalized representation (2), rather than the orthogonalized version (3). This decomposition is presented in columns (11)-(13). Clearly, post-1982:3 innovations in the rate of inflation are largely accounted for by innovations in exchange-rate depreciation, rather than in base money growth. This would indicate that the inflationary episode experienced by Argentina in 1982:3-1985:1, can be attributed to exogenous shocks in base money only to the extent that these are perceived as causing simultaneous exchange-rate depreciation.

Table 3. Israel: Composition of Forecast
Error Variance for Inflation

(In percent)

A. Ordering W-Y-B-E-P 1/

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	1.4	1.7	80.6	1.3	15.0
8	1.4	3.3	82.7	1.1	11.6
12	1.5	3.8	82.2	1.2	11.3
16	1.6	4.2	81.7	1.3	11.2
20	1.7	4.6	81.2	1.4	11.1
24	1.8	5.0	80.7	1.5	11.1
28	1.9	5.2	80.3	1.6	11.0
32	1.9	5.5	80.0	1.7	11.0

B. Ordering B-E-W-Y-P

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	4.3	2.3	77.4	1.1	15.0
8	4.7	2.2	80.7	0.8	11.6
12	4.8	3.1	80.0	0.9	11.3
16	4.8	3.6	79.4	0.9	11.2
20	4.9	4.0	79.0	1.0	11.1
24	4.9	4.5	78.5	1.0	11.1
28	4.9	4.9	78.1	1.0	11.0
32	5.0	5.1	77.8	1.1	11.0

C. Ordering E-B-W-Y-P

<u>Step</u>	<u>Variable</u>				
	B	E	W	Y	P
4	4.8	1.8	77.4	1.1	15.0
8	4.7	2.3	80.7	0.8	11.6
12	5.0	2.9	80.0	0.9	11.3
16	5.1	3.3	79.4	0.9	11.2
20	5.1	3.8	79.0	1.0	11.1
24	5.2	4.3	78.5	1.0	11.1
28	5.2	4.6	78.1	1.0	11.0
32	5.2	4.9	77.8	1.1	11.0

1/ For definitions of the variables see footnote 1 in Table 1.

Table 4. Argentina: Historical Decompositions of Inflation, 1982:3-1985:1

Quarter	Inflation Rate	Predicted	Error	Ordering B-E-W-Y-P <u>1/</u>			Ordering E-B-W-Y-P			Nonorthogonal		
				B	E	Other	B	E	Other	B	E	Other
82:3	43.5	35.1	8.4	8.9	0.0	-0.5	-0.3	9.2	-0.5	---	---	8.4
82:4	45.0	42.7	2.3	4.1	-0.2	-1.6	-0.4	4.3	-1.6	-2.2	3.9	0.6
83:1	44.7	38.9	5.8	4.4	0.0	1.4	-0.5	4.9	1.4	-4.5	8.5	1.8
83:2	37.3	36.2	1.2	2.1	-0.6	-0.3	-0.9	2.4	-0.3	-9.4	8.9	1.7
83:3	52.3	48.2	4.1	3.2	-0.1	1.0	-0.9	4.0	1.0	-2.6	-0.8	7.5
83:4	66.5	53.4	13.1	11.6	0.2	1.3	-1.2	13.0	1.3	-3.5	2.9	13.7
84:1	57.1	47.6	9.5	10.5	-1.1	0.1	-3.1	12.5	0.1	-16.0	13.8	11.7
84:2	65.5	59.2	6.3	8.0	-0.9	-0.8	-3.2	10.2	-0.7	-16.2	18.2	4.3
84:3	74.5	67.7	6.8	7.0	0.6	-0.8	-1.7	8.8	-0.3	-10.6	12.8	4.6
84:4	73.7	69.7	4.0	7.9	1.0	-4.9	-2.5	11.4	-4.9	-16.5	10.6	9.9
85:1	82.3	77.8	4.5	4.2	0.8	-0.5	-3.3	7.5	0.3	-17.2	12.4	9.3

1/ See footnote 1 on Table 1.

Table 5. Brazil: Historical Decompositions of Inflation, 1983:1-1985:4

Quarter	Inflation Rate	Predicted	Error	Ordering B-E-W-Y-P <u>1/</u>			Ordering E-B-W-Y-P			Nonorthogonal		
				B	E	Other	B	E	Other	B	E	Other
83:1	25.2	26.9	-1.7	-0.4	-0.0	-1.3	-0.7	0.2	-1.2	---	---	-1.7
83:2	27.1	27.1	0.0	-0.2	-0.0	0.2	-0.6	0.4	0.2	-0.2	0.1	0.1
83:3	34.2	32.3	1.9	-0.2	0.6	1.5	-0.3	0.7	1.5	-0.0	0.9	1.0
83:4	28.6	26.6	2.0	0.6	1.2	0.2	0.7	1.1	0.2	-0.0	1.6	0.4
84:1	31.1	30.8	0.3	-0.2	2.0	-1.5	0.0	1.8	-1.5	0.6	2.0	-2.3
84:2	30.5	29.4	1.1	0.4	1.1	-0.4	-0.2	1.6	-0.3	-0.4	1.2	0.3
84:3	33.4	34.6	-0.8	-0.0	0.9	-1.7	-0.3	1.2	-1.7	0.3	0.7	-1.8
84:4	33.2	31.0	2.2	-0.6	1.6	-1.2	-0.9	1.9	1.2	-0.7	1.8	1.1
85:1	39.0	35.2	3.8	0.3	1.9	1.6	0.4	1.7	1.7	0.5	2.0	1.3
85:2	28.3	28.6	-0.3	-1.0	1.8	-1.1	-1.2	2.1	-1.2	-1.0	1.5	-0.8
85:3	37.6	34.6	1.0	0.8	-0.3	0.5	0.2	0.3	0.5	0.5	-0.6	1.1
85:4	36.4	32.0	4.4	2.6	1.0	0.8	2.9	0.7	0.8	0.4	-0.0	4.0

1/ See footnote 1 on Table 1.

Table 6. Israel: Historical Decompositions of Inflation, 1983:2-1985:3

Quarter	Inflation Rate	Predicted	Error	Ordering B-E-W-Y-P <u>1/</u>				Ordering E-B-W-Y-P				Ordering W-B-E-Y-P			
				B	E	W	Other	B	E	W	Other	B	E	W	Other
83:2	25.6	34.7	-9.1	0.0	-10.0	0.1	0.8	-2.8	-7.2	0.1	0.8	0.8	-5.9	-4.8	0.8
83:3	19.5	30.0	-10.5	-0.3	-5.8	0.1	-4.5	-0.1	-5.9	0.1	-4.6	0.8	-4.1	-2.6	-4.6
83:4	50.0	36.6	13.4	5.8	7.2	0.2	0.2	1.6	11.4	0.2	0.2	2.8	3.3	7.0	0.3
84:1	44.4	34.2	12.2	4.2	3.8	-0.0	4.2	1.4	6.5	-0.0	4.3	2.7	-0.3	5.5	4.3
84:2	53.0	47.9	5.1	4.7	2.5	-0.7	-1.4	1.8	5.4	-0.7	-1.4	3.3	0.5	2.6	-1.3
84:3	51.5	40.9	10.6	3.7	7.4	0.5	-1.0	4.2	6.9	0.5	-1.0	2.8	2.8	6.2	-1.2
84:4	68.8	48.9	19.9	7.0	9.9	-1.4	4.4	3.5	13.4	-1.4	4.4	3.7	6.3	5.5	4.4
85:1	29.4	43.0	-13.6	0.5	-13.7	0.8	-1.2	-2.4	-10.8	0.8	-1.2	2.2	-4.6	-9.9	-1.3
85:2	46.9	52.5	-5.6	3.7	-8.8	-1.9	1.4	-1.9	-3.2	-1.9	1.4	3.5	-4.2	-6.3	1.4
85:3	47.7	45.3	2.4	3.8	-2.3	-0.7	1.6	0.8	0.7	-0.7	1.6	3.2	-0.9	-1.5	1.6

1/ See footnote 1 on Table 1.

The average quarterly inflation rate in Brazil increased to 32.1 percent in 1983:1-1985:4, compared to 18.5 percent over the preceding 3-year period. Yet, as Table 5 indicates, relatively little of this acceleration of inflation can be attributed to post-1982 exogenous shocks, since the predicted average inflation rate for this period amounts to about 31 percent. Nevertheless, to the extent that post-1982 exogenous shocks did contribute to the acceleration of inflation during 1983:1-1985:4 it is clear that in relative terms the dominant role was played by exchange-rate movements, rather than changes in base money. This conclusion is not sensitive to the ordering of the variables (the contemporaneous correlation between innovations in base money growth and in nominal exchange-rate depreciation is only 0.28 for Brazil), as can be seen by comparing columns 6 and 9. Monetary shocks contribute significantly to explaining the innovation in inflation only in the last half of 1985. Prior to that the contribution of this variable is more often negative than positive, and is in every case much smaller than that of exchange-rate depreciation. Unlike the Argentine experience, therefore, Brazilian inflation during 1983:1-1985:4, represents more the cumulation of an ongoing process than the outcome of severe new shocks. However, to the extent that the inflationary episode was exacerbated by new exogenous shocks, these tended to emanate from exchange rate depreciation for most of the period. Only in the last two quarters is there an important role for monetary shocks.

The final inflationary episode considered is that of Israel in 1983:2-1985:3. As indicated in Table 6, though the rate of inflation predicted for this period on the basis of shocks already observed as of mid-1983 shows a noticeable increase, Israel resembles Argentina in that post-1982:2 innovations are also very important in explaining the behavior of the inflation rate over the duration of this episode. The mean absolute value of the prediction error reported in column 4 of Table 6 averages 23.4 percent of the average inflation rate. Unlike the experience of Argentina, however, the Israeli episode is also characterized by large negative errors at the beginning and near the end of the episode. Inspection of columns 6 and 9 of Table 6 reveals that these errors are much more likely to be attributable to the effects of exogenous exchange-rate shocks than to shocks in base money growth. Regardless of the ordering of these variables, the path of the prediction error is tracked much more closely--for both negative and positive values--by the effects of exchange-rate shocks rather than by those of base money shocks.

However, recall that, unlike for Argentina and Brazil, the variance of the forecast error for inflation in Israel over the sample period used here is dominated by the effects of nominal wage shocks. This raises the possibility that the dominance of the exchange rate factor in Table 6 is accounted for by a closer contemporaneous correlation between exchange rate movements and nominal wage shocks than between the latter and base

money growth. In fact, the contemporaneous correlation between exchange-rate innovations and nominal wage innovations is 0.71, compared to only 0.28 between base money growth innovations and innovations in nominal wage inflation, lending some credence to this hypothesis.

To test whether the results of Table 6 are simply due to orderings which allow the exchange rate to pick up effects which are really attributable to nominal wage shocks, historical decompositions of inflation were computed using the variable ordering W-B-E-Y-P. The results are reported in columns 13-16 of Table 6. When accorded a primary role in the variable ordering, nominal wage shocks indeed appear to play a significant role in explaining innovations in the rate of inflation (column 13), but exchange-rate depreciation remains important (column 15). The contribution of base money growth, though not negligible, remains secondary. In particular, shocks to base money growth made positive contributions to the innovation in the inflation rate during the periods 1983:2-1983:3 and 1985:1-1985:3, when the latter was negative. The relative rankings of the contributions of exchange rate depreciation and base money growth thus prove to be robust to the ordering of the variables, while an important role for nominal wage shocks appears only when this variable is given primacy. For Israel, then, a prudent conclusion would be that exchange rate shocks appear to have been important, nominal wage shocks may have been important, and base money shocks played a decidedly secondary role in explaining innovations in the inflation rate during 1983:2-1985:3.

IV. Conclusions

The empirical results of this paper tend to favor the "balance of payments" over the "fiscal" view of the causes of high inflation, at least for the particular episodes studied. As indicated by the theory, sustained high inflation requires both monetary and exchange-rate accommodation, so that if these views differ at all, it must be with respect to the sources of exogenous shocks that launch inflationary episodes. Since either base money growth or nominal exchange rate depreciation could in principle perform this role, the issue concerns the relative empirical importance of these variables in specific episodes. For Argentina and Brazil, both base money growth and nominal exchange rate movements appear to have driven inflation over the sample period as a whole, but the recent inflationary episodes which gave rise to the attempts at heterodox stabilization seem to have been much more closely associated with nominal exchange-rate movements than with base money growth.

The case of Israel also does not provide support for the fiscal view. The dominant exogenous force driving the inflation rate in Israel over the sample period as a whole appears to be the behavior of nominal wages. Although historical decompositions of the most recent inflationary

surge which give primacy to base money or the exchange rate do--consistently with what is observed in Argentina and Brazil--tend to trace innovations in inflation primarily to nominal exchange-rate shocks, part of this influence may be traceable to the effects of nominal wage movements. Exogenous movements in both nominal wages and the exchange rate may have been important in Israel's most recent high-inflation episode, with a secondary role played by base money growth.

The fact that Israel differs from Argentina and Brazil both with respect to the importance of exogenous nominal wage shocks and to the success of its heterodox program raises the intriguing possibility that these phenomena may be related. This remains a subject for future research. In the meantime, the primary contribution of this paper is to provide empirical evidence in favor of the oft-cited maxim--generally based only on theoretical reasoning--that the macroeconomic effects of changes in nominal exchange rates will depend on the nature of accompanying macroeconomic policies. In particular, the empirical support provided here to the balance of payments view suggests an important shortcoming of accommodative policy regimes. In such settings, the pursuit of external adjustment through nominal exchange rate devaluation may be associated with a substantial, sustained, and as recent experience with heterodox programs in Argentina and Brazil has shown, extremely stubborn increase in the rate of inflation.

Data Sources

The data used in this paper consisted of quarterly series for the stock of base money, the nominal exchange rate, an index of industrial production, the consumer price index, and an index of a representative nominal wage for each of Argentina, Brazil, and Israel. The data for the monetary base, the nominal exchange rate, industrial production, and the consumer price index were taken from International Financial Statistics. The relevant series were, respectively: Reserve Money (line 14), the period-average exchange rate at market rates expressed as units of domestic currency per U.S. dollar (line rf), Industrial Production (line 66), and Consumer Prices (line 64). Wage data for Israel were also taken from IFS (Wages: Daily Earnings, line 65). The wage data for Argentina were quarterly averages of monthly wages for all manufacturing workers, taken from various issues of Indicadores de Coyuntura, published by FIEL (Fundacion de Investigaciones Economicas Latino-americanas). Finally, the wage series for Brazil consisted of quarterly averages of monthly wages for production workers in manufacturing, taken from Conjuntura Economica (Getulio Vargas Foundation).

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