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Boston University

Center for Latin American Development Studies

ON THE MONETARY-MACRO DYNAMICS OF COLOMBIA AND MEXICO

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Discussion Paper Series
Number 54
September 1982

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* Most of this paper was completed in the Fall of 1981 during my stay at the Center for Latin American Development Studies (CLADS) of Boston University, whose support is gratefully acknowledged. This study benefited from the comments of participants at a CLADS' Seminar, and from suggestions and help given by Oldrich Kyn and Daniel Schydlowsky.

ON THE MONETARY-MACRO DYNAMICS OF COLOMBIA AND MEXICO

I. Introduction

This paper presents an empirical analysis of the stochastic dynamic interrelationships among money growth, inflation, and output growth for two major Latin American economies: Colombia and Mexico. At the very least, the paper reports a set of economically interesting empirical regularities (or "stylized facts") on the macro dynamics of these countries. These regularities relate to questions such as: Do monetary shocks mainly affect real or nominal variables?; Is there monetary accommodation in response to inflation and output growth shocks?; Do monetary shocks account for a substantial portion of observed macro fluctuations?; and others. Thus, the evidence discussed in the paper bears, directly or indirectly, on issues frequently debated in controversies on monetary stabilization policies in Latin America.[1]

The methodology used in the paper to investigate the joint stochastic behavior of money, inflation, and output time series is the vector autoregression.[2] This approach has proven to be a convenient one for attempting to detect the dominant patterns of variables' mutual dependence in a given data sample. It sharply differs from the approach used in most previous studies of the money, inflation, and output interrelationships on Latin American countries. Most of these studies proceeded by a-priori

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[1]For recent discussions of these issues see Harberger (1978), Diaz Alejandro (1981), Dornbusch (1981), and Khan and Knight (1981b).

[2]See Sims (1980a).

restricting the set of possible patterns of variables' interdependence. For example, models that were estimated under the assumption of money exogeneity rule out the existence of monetary accommodation. Imposing this type of a-priori restrictions may not be supported by the data, and thus may bias the results of the analysis. In contrast, the vector autoregression technique implemented in this paper allows for an unrestricted assessment of the links among the three variables of interest.

Section II discusses alternative theories that interrelate money growth, inflation, and output growth as well as previous relevant empirical evidence. Section III presents the vector autoregression analysis of Colombian and Mexican data covering the 1953-1978 period. Concluding comments are included in Section IV.

II. Theories and Previous Empirical Evidence

This section briefly reviews some of the most popular macro models that have been used, in a Latin-American context, to analyze the interrelationships among money growth, inflation, and output growth. This review should be regarded as a selective, and non-exhaustive, one. It deals with models that presumably capture key arguments put forward by different participants in Latin American macro controversies. The discussion here focuses on highly aggregative models, and it will be limited to a brief restatement of the main available hypotheses and results.

There are two main sets of competing macro models that yield hypotheses on the money, inflation, output interrelationship. While the first set emphasizes the active role of changes in money in affecting output growth and inflation, the second set emphasizes a passive response of money to inflation and real activity.[3]

The first set of models includes both equilibrium and disequilibrium analyses. The former generally assume full price flexibility; i.e. these are classical-type models. In these models, changes in money are viewed as autonomous and generally precede movements in output and inflation. Rational expectations versions of these models brought to attention the distinction between anticipated and unanticipated changes in money. It is hypothesized that anticipated changes in money have no effects on real output; instead, they have full effects on nominal variables (such as the price level). On the other hand, unanticipated monetary changes are assumed to have non-neutral effects on both output and prices.[4] Open economy versions of these models generally preserve the above neutrality of anticipated money and non-neutrality of unanticipated money from the standpoint of output determination. In terms of inflation determination, however, it becomes crucial to specify the exchange rate regime: the closed-economy results of above generally continue to hold under a flexible exchange rate, but not under a fixed exchange rate. In the latter case, pure monetary models hypothesize that increases in domestic credit will lead to offsetting international reserves' movements, thus leaving the inflation rate unchanged.[5]

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[3]Analysis of some of these models in a developing countries context is presented by Dornbusch and Fischer (1981).

[4]See for example Lucas (1973) and Sargent and Wallace (1975).

[5]Work along these lines is contained in Frenkel and Johnson (1976).

Disequilibrium analyses involve some type of price (or wage) stickiness, and/or market imperfections. These setups generally yield similar hypotheses than those of above, except that the distinction between anticipated and unanticipated monetary changes becomes less relevant. Changes in money are mostly regarded as non-neutral in terms of their short run effects on output and inflation, and this holds for both closed and open economy versions of these models. Some of these non-neutralities of money may involve a very different transmission mechanism than the one of unanticipated money in equilibrium models. For example, a set of models emphasize the existence of capital market segmentation, production lags, and the implied effects of liquidity constraints on the economy's supply sector. Under these conditions, increases in money (e.g. through increased credit by the Central Bank) lead to an outward shift of both aggregate demand and supply schedules (in the price-output plane). Thus, these models hypothesize stronger output effects, and milder inflation effects, of monetary changes than models in which money does not directly affect the economy's aggregate supply.[6]

A second set of models emphasizes monetary feedbacks to inflation and output growth developments. Here the relevant literature postulates several channels for this passive role of money. First, the authorities may want to smooth out output fluctuations in an economy subject to dominant supply shocks. If that is the case, and to the extent that monetary policy is effective, then a rule of monetary accommodation of supply

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[6] See for example Bruno (1979), Cavallo (1981), and L.Taylor (1979, Ch.9).

shocks will be observed.[7] In other words, here money is reacting to shocks in output and inflation in an attempt to stabilize some macro variable in the economy. Second, changes in inflation and output may alter the government's budget deficit and this, in turn, may lead to changes in the monetary base and the money supply.[8] Third, changes in money may reflect induced balance of payments effects of price and output shocks, especially under a fixed exchange rate regime. However, in this case there can still be an autonomous monetary policy instrument; namely through changes in the domestic credit component of the monetary base.

Summing up, two competing views of the interrelationships among money growth, inflation, and output growth have been presented. The first view emphasizes an autonomous role for money, and envisions monetary changes as being important determinants of fluctuations in output and inflation. In particular, increases in money are generally expected to lead to increases in both output and prices. The second view postulates a passive role for money in response to changes in output and inflation. The specific form of such a monetary feedback, however, tends to vary from model to model in line with differences in the postulated channels that give rise to passive money responses.

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[7] To the extent that the authorities aim at smoothing out inflation fluctuations, then a policy of nonaccommodation will be followed in this case. The role of monetary accommodation for macro stability has been discussed by J.Taylor (1981). Open economy analyses are presented by Dornbusch (1982) and Leiderman (1982), and some evidence for Brazil is reported by Cardoso (1981).

[8] These changes may well originate in wage disturbances; see Dornbusch and Fischer (1981).

There is only partial available empirical evidence on the relative accuracy of these two approaches for Colombia and/or Mexico.[9] One branch of the previous literature dealt with econometric estimation of the dependence of inflation on money, as well as on other factors; see for example the studies by Vogel (1974), Blejer (1977), Diaz Alejandro (1977), Aghevli and Khan (1978), and Khan and Knight (1981a). Another branch has focused on estimation of output equations as functions of monetary, as well as nonmonetary, variables; see for example Barro (1979), Blejer and Fernandez (1980), Hanson (1980), and Khan and Knight (1981a). A general finding emerging from these studies is that, generally speaking, fluctuations in money play a relatively important role in accounting for inflation fluctuations, but an unimportant one for real output variations. (The latter holds for both actual and unanticipated changes in money). This provides support to some of the models included in the first set of above. Direct empirical evidence on the second set of models, that emphasize passive monetary responses, is almost nonexistent. Only the studies by Aghevli and Khan (1978) and Khan and Knight (1981a) explicitly allowed for changes in money to respond to fluctuations in output and inflation, yet in a restricted form dictated by their specific models.

A common element in most of these previous informative studies is the imposition of a-priori restrictions on the interrelationships among money growth, inflation, and output growth; restrictions that usually are not statistically tested. In practice, the links among these three variables

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[9] Some of the evidence relevant to other countries is discussed in Behrman and Hanson (1979).

may be more complicated than those embodied in these studies. For example, output shocks may lead to inflation responses over and above those corresponding to the implied change in money; inflation may well depend on monetary shocks, but also autonomous inflation shocks may lead to monetary responses; and so on. Thus, it is possible that previous studies' procedure of imposing a-priori restrictions has produced bias in their empirical results, and has left unexplored other economically plausible channels for mutual feedbacks among the three variables considered here. It is in the spirit of this argument that the present study implements a methodology that uses a minimum of a-priori theory to restrict the interrelationships among these variables. The approach followed here should be regarded as a complement to the more structural-type approaches of previous investigations.

III. Methodology and Results

The procedure used here to investigate in a relatively unrestricted form the interrelationships among money growth, inflation, and output growth is Sims' vector autoregression. This methodology treats each one of these three variables as potentially endogenous. As implemented here, the vector autoregression analysis follows three stages. At the first stage, each variable is expressed as a function of a constant, lagged values of itself, lagged values of the other variables, and a disturbance term. This yields the autoregressive form of the system, which is the one actually estimated. From this form, however, it is difficult to derive conclusions on the specific pattern of interrelationships in the data sample. To overcome this difficulty, the second stage of the analysis solves the vector autoregression to express each variable as a function of the entire history of the shocks associated with it and with the other variables. This is the moving average representation of the system, also called impulse response functions. It enables one to examine system-wide responses to shocks in the different variables, and thus to characterize the relationships in the data. The last stage in the analysis involves calculating variance decompositions of forecast errors for each one of the three variables into parts attributable to variance in their corresponding disturbances. This calculation is aimed at assessing the relative importance of each one of the three types of shocks considered here in (statistically) accounting for money, inflation, and output fluctuations.

More specifically, let X_t be a (3 x 1) vector giving the stochastic processes followed by inflation (DP_t), output growth (DY_t) and money growth (DM_t):

$$X_t = \begin{bmatrix} DP_t \\ DY_t \\ DM_t \end{bmatrix}$$

The second-order vector autoregression for this process is

$$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + u_t \,, \qquad (1)$$

where A_0 is a (3 x 1) vector of constants; A_1 and A_2 are (3 x 3) matrices of least-squares coefficients; and u_t is a (3 x 1) vector of least-squares disturbances. The latter are also termed innovations; the parts of X_t that cannot be predicted linearly from two lagged values of X. Equation

(1) is the form actually estimated in this study, using annual data for Colombia and Mexico for the 1953-1978 period. DP is the logarithmic first difference of the consumer price index; DY is the growth rate of real gross domestic output; and DM is the growth rate of (Money + Quasi Money).[10] All data were taken from International Financial Statistics, published by the International Monetary Fund (various issues). The estimated coefficients are difficult to interpret in the present framework, and are thus reported in the Appendix.

Given the estimated coefficients of the A matrices, it is possible to solve equation (1) for X_t backward in terms of the u process:

$$X_t = C_0 + u_t + C_1 u_{t-1} + C_2 u_{t-2} + \dots + C_i u_{t-i} \qquad (2)$$

Equation (2) is the system's vector moving average representation. The u process is composed of disturbances that may not be contemporaneously uncorrelated. If that is the case, then it becomes helpful to transform the u process into one in which disturbances are orthogonal contemporaneously. This can be done by assuming a specific ordering of the variables, one that should be checked later on for results' robustness, thus yielding the orthogonalized moving average representation - or impulse response function

$$X_t = K_0 + e_t + K_1 e_{t-1} + K_2 e_{t-2} t\dots + K_i e_{t-i} , \qquad (3)$$

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[10] At a very preliminary stage of the investigation, I explored using the WPI for DP, and domestic credit or the monetary base for DM. Initial results suggested that these alternatives generally produced less precise patterns of variables' mutual feedbacks than those to be reported below.

where by construction the e process contains mutually orthogonal disturbances that are functions of the u's. The coefficients of the impulse response functions in (3) represent dynamic multipliers, in that they display the current and subsequent responses of the system to shocks in the components of e. The specific variables' ordering used in this study is:

$$e_{3t} = u_{3t}$$

$$e_{2t} = u_{2t} - a_1 e_{3t}$$

$$e_{1t} = u_{1t} - a_2 e_{2t} - a_3 e_{3t}$$

That is, money growth enters first, output growth second, and the inflation rate last. Empirically, the a_i coefficients (i = 1 to 3) turned out to be small and insignificantly different from zero, implying that the results of the analysis are quite robust with respect to the choice of ordering.

Table 1 reports the correlation matrices of contemporaneous disturbances for Colombia and Mexico. It can be seen that residuals' intercorrelations indeed have a small, and insignificant, order of magnitude.

Table 1: Correlation Matrices of Contemporaneous Disturbances

	DP_t	DY_t	DM_t
Colombia			
DP_t	1.00		
DY_t	.01	1.00	
DM_t	.21	.29	1.00
Mexico			
DP_t	1.00		
DY_t	.18	1.00	
DM_t	.14	-.05	1.00

Note: This Table is based on the disturbances of the vector autoregressions reported in the Appendix.

Tables 2 and 3 report information on the derived impulse response functions for Colombia and Mexico respectively. On the basis of this information, Charts 1 through 3 display the systems' responses to shocks in money growth, output growth, and inflation.

Consider first the effects of money growth shocks; see the e_3 panels of Tables 2 and 3 and Chart 1. To be specific, the analysis proceeds by focusing on the effect of a money growth innovation of one unit in year 1. In the case of Colombia, output growth and inflation generally show a positive response to this monetary shock. Output growth returns to its base level after one year, and subsequently remains at that level. The inflation rate first accelerates, reaches peak values in years 2 and 3, and then decreases though not fully to its base level. Money growth increases by one unit in year 1, obtains a small negative value in year 2, and then tends to converge to its base level. Interestingly, money growth exceeds inflation in period 1, yet in subsequent periods the opposite occurs (i.e. there is some "overshooting" of the inflation rate in these subsequent periods). Overall, the cumulative responses of money growth and inflation are of a similar order of magnitude so that to a first approximation the level of real money balances remains unaltered (after 3 years). In the case of Mexico, money innovations induce more volatile and persistent changes in all the variables than in that of Colombia. A positive money growth shock leads to an increase in the inflation rate in subsequent years (with a peak value in year 2). This increase in inflation persists even after 8 years. A similar persistence shows up in money growth's response to its own initial shock. In line with the results for Colombia, money growth is greater than inflation in year 1, but is smaller than inflation in years 2 and 3 - as well as in some of the subsequent periods. The cumulative (i.e. after 8 years) response of output growth to the monetary shock is quite negligible, in line with the results for Colombia. However, at variance with the latter, output growth first shows negative and subsequently alternating responses to the initial positive money growth shock, and there is a cumulative increase in real money balances.

Information on systems' responses to unit output growth shocks is provided in the e_2 panels of Tables 2 and 3, and in Chart 2. The results for Colombia indicate that after its initial unit shock, output growth smoothly converges to its base period value. However, the cumulative own effect is positive, so that the level of real output shows a persistent increase (even after 8 years). The response of the inflation rate is quite volatile. It is negative in years 1 and 2, and positive in subsequent years. The initial decline in inflation following a positive output growth shock suggests interpreting the latter as a supply shock.[11] Money growth responds positively to the initial output shock, and it reaches a peak response in year 3. The implied cumulative response of real money balances is positive; this need not be surprising in the light of the persistent increase in the level of output mentioned above. In the case of Mexico, the response of output growth to its own positive initial shock is quite similar to the Colombian one. Specifically, output growth tends to return to its base period value and the implied cumulative

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[11] In principle, output growth shocks may represent demand and/or supply shocks. The former are likely to lead to movements in output growth and inflation in the same direction, and the latter to movements in opposite directions. The same applies to inflation shocks, to be analyzed in the next paragraph.

Table 2: Impulse Response Functions for Colombia

Shocks	Responses of		
	DP_t	DY_t	DM_t
e_{1t}	1.00	0.00	0.00
e_{1t-1}	-0.05	0.08	0.36
e_{1t-2}	0.07	0.00	0.10
$\Sigma(3)e_{1t}$	1.02	0.08	0.45
$\Sigma(6)e_{1t}$	1.51	0.08	0.72
$\Sigma(8)e_{1t}$	1.65	0.08	0.79
e_{2t}	-0.20	1.00	0.00
e_{2t-1}	-1.53	0.22	0.52
e_{2t-2}	0.17	0.16	1.31
$\Sigma(3)e_{2t}$	-1.56	1.38	1.83
$\Sigma(6)e_{2t}$	0.42	1.50	2.92
$\Sigma(8)e_{2t}$	1.24	1.50	3.36
e_{3t}	0.16	0.07	1.00
e_{3t-1}	0.50	0.01	-0.07
e_{3t-2}	0.51	-0.01	0.30
$\Sigma(3)e_{3t}$	1.17	0.07	1.23
$\Sigma(6)e_{3t}$	1.69	0.09	1.62
$\Sigma(8)e_{3t}$	1.87	0.09	1.72

Notes to Table 2

a) Orthogonalization was imposed as follows:

$$u_{1t} = 0.16e_{3t} - 0.20e_{2t} + e_{1t}$$

$$u_{2t} = 0.07e_{3t} + e_{2t}$$

$$u_{3t} = e_{3t} \quad ,$$

where the u_{it}'s have been defined in Eq.(1) of the text.

b) Standard Deviations (S) of the orthogonalized disturbances:

$S(e_1) = 0.047$, $S(e_2) = 0.014$, and $S(e_3) = 0.064$

c) $\Sigma(i)$ indicates cumulative response after i years.

Table 3: Impulse Response Functions for Mexico

Shocks	Responses of DP_t	DY_t	DM_t
e_{1t}	1.00	0.00	0.00
e_{1t-1}	0.17	-0.66	0.25
e_{1t-2}	0.38	-0.11	0.88
$\Sigma(3)e_{1t}$	1.55	-0.77	1.13
$\Sigma(6)e_{1t}$	3.62	-0.93	2.93
$\Sigma(8)e_{1t}$	5.10	-0.91	4.16
e_{2t}	0.16	1.00	0.00
e_{2t-1}	0.25	0.51	0.10
e_{2t-2}	-0.12	0.03	-0.49
$\Sigma(3)e_{2t}$	0.29	1.54	-0.39
$\Sigma(6)e_{2t}$	-0.55	1.76	-1.12
$\Sigma(8)e_{2t}$	-1.26	1.79	-1.62
e_{3t}	0.11	-0.04	1.00
e_{3t-1}	0.60	-0.03	0.06
e_{3t-2}	0.11	-0.13	0.00
$\Sigma(3)e_{3t}$	0.82	-0.19	1.06
$\Sigma(6)e_{3t}$	1.72	-0.14	1.94
$\Sigma(8)e_{3t}$	2.26	-0.05	2.60

Notes to Table 3

a) Orthogonalization was imposed as follows:

$$u_{1t} = 0.11e_{3t} + 0.16e_{2t} + e_{1t}$$

$$u_{2t} = -0.04e_{3t} + e_{2t}$$

$$u_{3t} = e_{3t} \quad ,$$

where the u_{it}'s have been defined in Eq.(1) of the text

b) Standard Deviations of the orthogonalized disturbances:

$S(e_1) = 0.031$, $S(e_2) = 0.038$, and $S(e_3) = 0.041$

c) $\Sigma(i)$ indicates cumulative response after i years

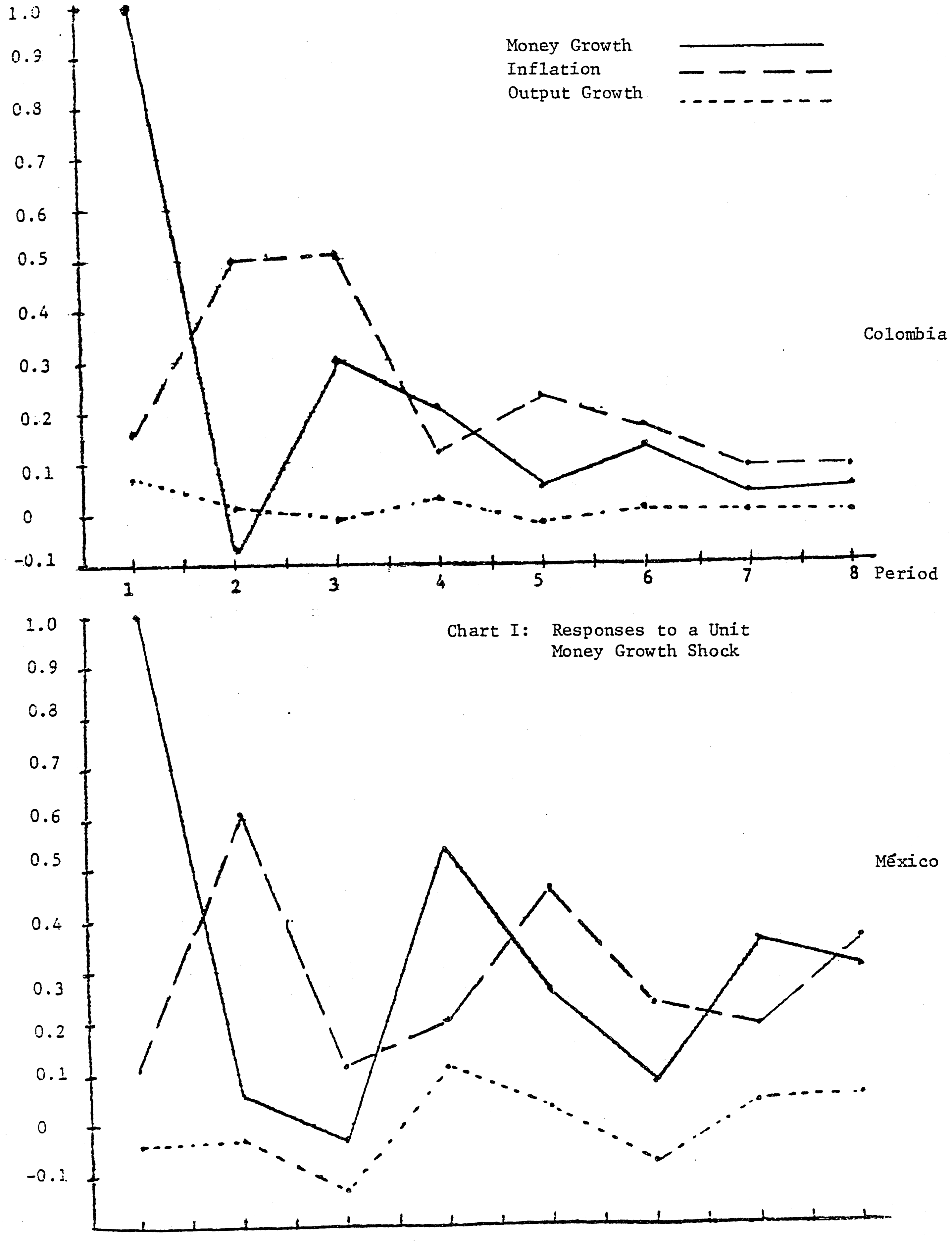


Chart I: Responses to a Unit Money Growth Shock

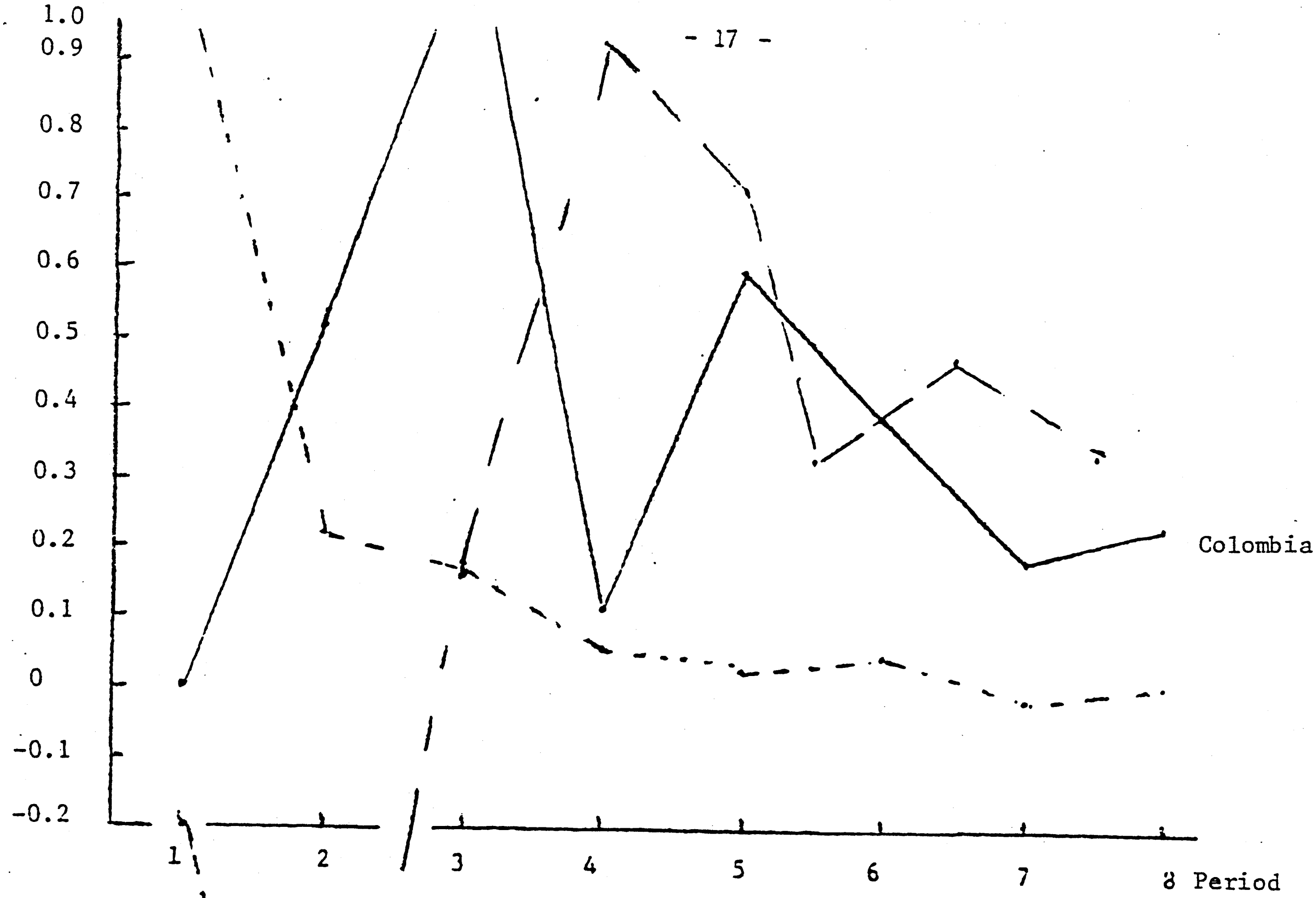
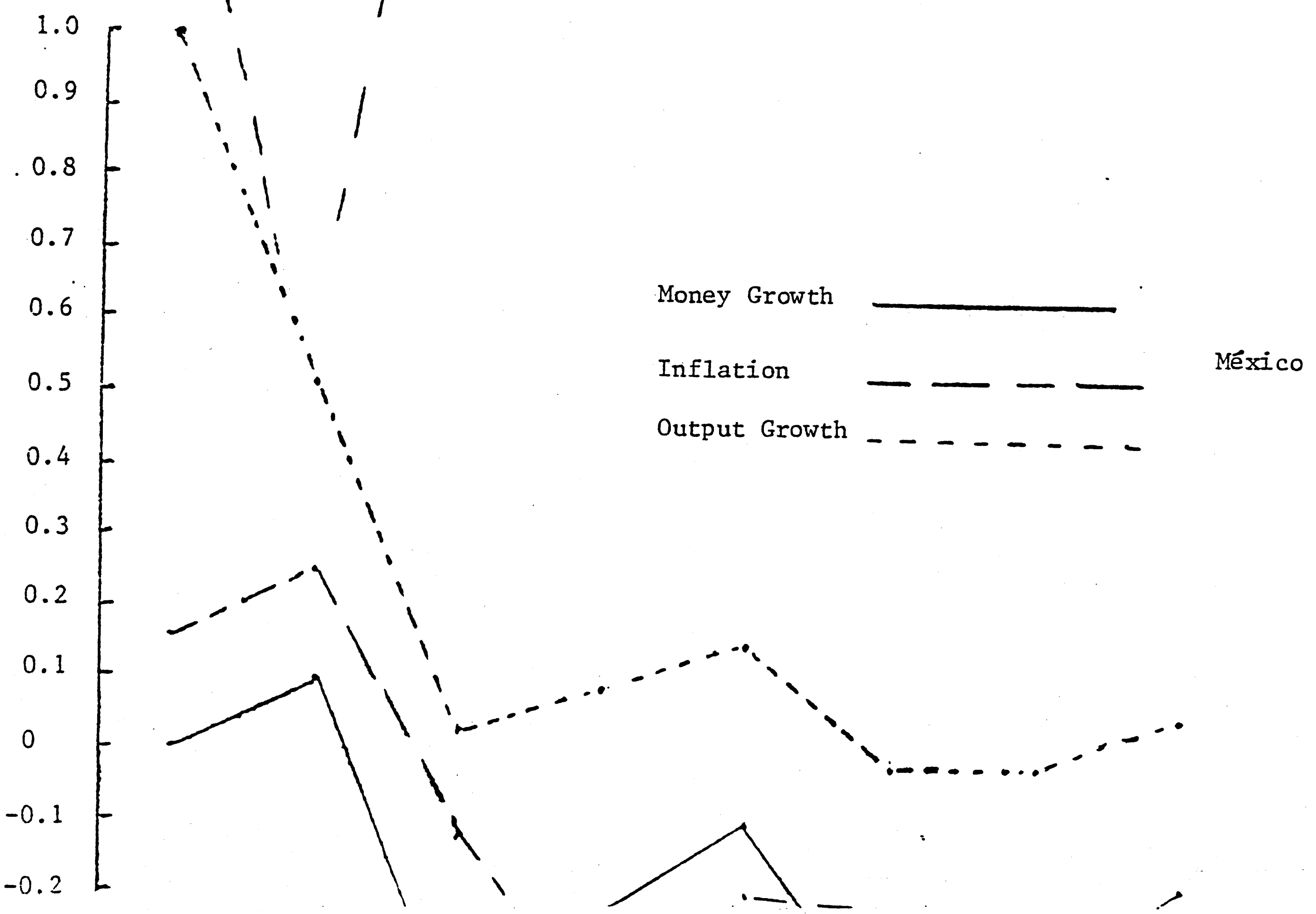


Chart 2: Responses to a Unit Output Growth Shock



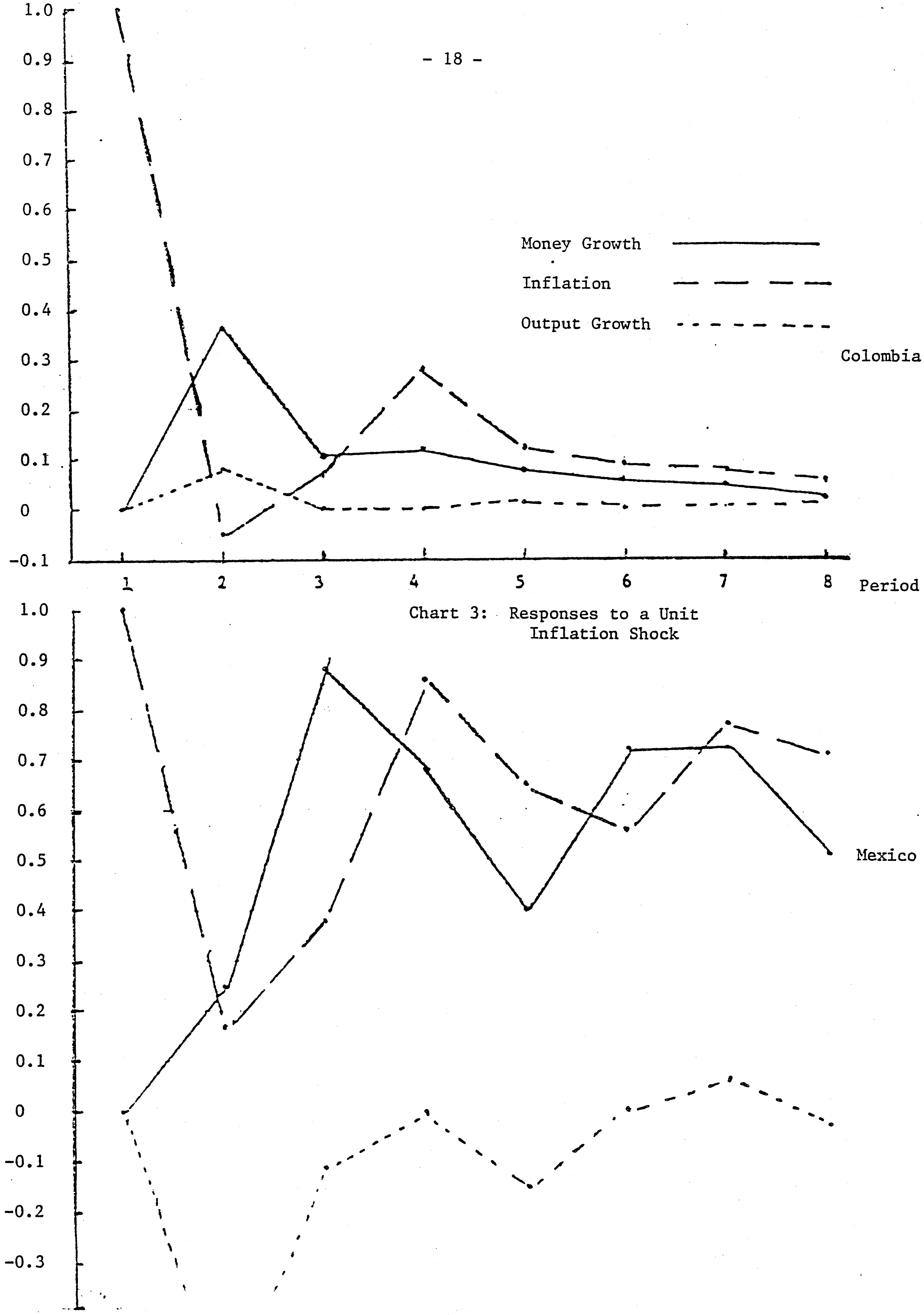


Chart 3: Responses to a Unit Inflation Shock

effect on the level of output is positive. However, the responses of money growth and inflation differ from those of Colombia. After showing minor initial increases, both money growth and inflation attain negative values beginning from year 3 and this pattern persists even in year 8; and there is a cumulative decrease in real money balances.

Consider now the patterns of response induced by inflation innovations; i.e. a unit shock to inflation (see the e_1 panels of Tables 2 and 3, and Chart 3). In Colombia, this shock tends to temporarily increase money growth and output growth. Both these responses reach peaks in year 2. Output growth's response, though, is quite negligible. These results are consistent with the notion that inflation shocks, in Colombia, represent demand shocks. Stronger and more volatile responses to inflation shocks appear in the case of Mexico. Money growth increases following a positive inflation shock, yet this shock leads to a reduction in output growth. Thus inflation shocks seem to represent supply shocks in Mexico. Interestingly, these shocks have also more persistent effects in Mexico than in Colombia, especially on money growth and inflation.

So far, the analysis has been confined to tracing out the systems' responses to innovations. Each variable has generally shown, for each country, a different type of behavior in response to different shocks. Given this, it is important to attempt to assess the relative importance of each variable in statistically explaining the others. This can be done by calculating variance decompositions, which give the proportions in the forecast error of each variable that is accounted for by shocks in itself and in the other variables. The i-year ahead error in forecasting X_t linearly from its own past is given by

$$X_t - E_{t-i}X_t = e_t + K_1 e_{t-1} + K_2 e_{t-2} + \ldots + K_{i-1} e_{t-i+1} \quad (4)$$

where $E_{t-i}X_t$ is the linear least-squares forecast of X_t given $X_{t-1}, X_{t-i-1}, X_{t-i-2}$, etc.

Table 4 reports two sets of variance decompositions for each country. These correspond to two different horizons for forecast errors: 3 and 8 years ahead. In general, it is expected that the longer the horizon, the weaker the role of own innovations and the larger the role for other innovations in accounting for a specific variance of forecast error. This is confirmed by the results reported in Table 4, which are now discussed in more detail.

The variance decompositions for Colombia show the following main results. On the one hand, money growth and output growth are mostly explained by their own innovations. On the other hand, inflation is mainly explained by its own innovations and by money growth innovations, with output innovations playing a smaller role. These results hold for both of the horizons considered. A somewhat different pattern of results emerge for Mexico. It is still true that variations in money growth and output growth are mostly accounted for by their own shocks. However, the role of inflation shocks in accounting for these variations is far from being negligible. In fact, these shocks have the same degree of importance than shocks in money growth in accounting for variations in the latter. Moreover, there is here a greater role for inflation shocks in accounting for variance in their own forecast error than in Colombia. Money shocks, though, still play an important role in accounting for inflation variance.

Table 4: Variance Decompositions of Forecast Errors

By Innovations in:		Number of Periods	DP	DY	DM
Colombia	DP	3	45	6	6
		8	41	6	6
	DY	3	9	85	7
		8	14	83	9
	DM	3	46	9	87
		8	45	11	85
Mexico	DP	3	59	19	28
		8	60	19	42
	DY	3	7	79	12
		8	15	78	14
	DM	3	34	2	60
		8	25	3	44

Note: DP, DY, DM are columns under "Variables Explained".

The interrelationships among money growth, inflation, and output growth implied by the above findings can be briefly summarized as follows. In Colombia, money growth and output growth are largely autonomous. The main interrelationship found here runs from money growth to inflation. A greater degree of variables' mutual feedbacks was found for Mexico. While output growth is mostly autonomous--with a small but not unimportant role of inflation shocks--, the money growth-inflation relationship shows strong two-way feedbacks.

What are the main implications of the above combined findings for the relative empirical validity of the alternative sets of macro models discussed in the previous section? Obviously, one cannot provide a full and formal answer to this question solely on the basis of this paper's empirical evidence. The latter was obtained from unrestricted reduced-form type formulations. Thus, the above findings may be consistent with a whole variety of structural models. Having stated this there is, in my opinion, room for drawing some preliminary country-specific conclusions on this issue. The patterns of results for Colombia largely fit monetarist-type frameworks: Money growth and output growth are mostly autonomous, and there are important effects of money growth shocks on inflation. The findings for Mexico, on the other hand, yield a more mixed picture. Money growth shocks have a nonnegligible role in accounting for inflation variations. However, inflation shocks in turn are important determinants of fluctuations in money growth and to a smaller extent in output growth. Note that these shocks were shown to induce responses that characterize those of supply shocks, and that money growth increased following a positive inflation shock. Thus, the Mexican sample information supports, among others, models that emphasize supply shocks and monetary accommodation to them, in addition to the usual effects of autonomous changes in money growth.

IV. Concluding Comments

This paper has investigated the dynamic interrelationships among money growth, inflation, and output growth for Colombia and Mexico on the basis of implementation of a vector autoregression methodology. Typical systems' responses to shocks in each one of these variables suggest that (i) money shocks appear to have neutral effects on the outputs of both countries, and important effects on their inflation rates; (ii) positive output growth shocks generally lead to negative money growth and inflation responses in Mexico, and to positive ones in Colombia; (iii) positive inflation shocks are followed by accommodative monetary responses in both countries, and by nonpersistent fluctuations in output growth. Regarding the dominant shocks in accounting for variation in the three variables of interest during the sample period, the results suggest that in Colombia money growth and output growth are largely autonomous and there are important effects of innovations in money growth on inflation; results that generally are in line with monetarist-type frameworks. In Mexico, however, there are strong two-way feedbacks among money growth and inflation and output growth is less autonomous than in Colombia. These findings place restrictions on the class of macroeconomic models that can be compatible with the sample information of the two countries considered.

Do these results suggest that monetary policy is ineffective in terms of its effects on real output growth?; or that policies aimed at reducing inflation can be implemented without important loss of output growth? The answer to these types of questions is generally negative. The vector autoregression analysis is concerned only with the responses of the variables of interest to random disturbances that, in some cases, may represent unanticipated policy changes. Other types of policy changes may have different effects on the system, and these cannot be fully assessed with a vector autoregression. Therefore, caution is suggested in attempting to draw policy, and/or structural, implications from the above findings. The foregoing analysis can be extended in at least two promising directions, which may help overcome some of the present limitations. First, it seems desirable to perform a similar study on quarterly, or even monthly, data. This may produce richer patterns of dynamic interrelationships than those of annual data, and also enable one to test the stability of the different autoregressions through time. Obviously, this was not done here because of lack of data and/or degrees of freedom. Second, larger macro systems than the present trivariate one could be considered. In particular, it would be interesting to check whether inclusion of government deficits, wages, interest rates, and foreign-sector variables will alter the results of this investigation.[12]

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[12]Work by Sims (1980b) for the U.S. indicates a high degree of results' sensitivity with respect to the inclusion or exclusion of a nominal interest rate in the system.

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Appendix: Estimated Vector Autoregressions

Table A1: Vector Autoregression for Colombia (1953-1978)

Explanatory Variables:	Dependent Variable DP_t	DY_t	DM_t
Constant	-.012 (.059)	.036 (.018)	0.46 (.079)
DP_{t-1}	-.052 (.174)	.076 (.051)	.356 (.232)
DP_{t-2}	-.032 (.172)	-.009 (.051)	.129 (.223)
DY_{t-1}	-1.540 (.857)	.231 (.254)	.590 (1.144)
DY_{t-2}	.100 (.844)	.223 (.250)	1.839 (1.126)
DM_{t-1}	.613 (.175)	-.017 (.052)	-.167 (.233)
DM_{t-2}	.595 (.195)	-.070 (.057)	-.049 (.258)
Statistics:			
R^2	.597	.157	.259
DW	1.81	1.65	2.266
SER	.055	.016	.074
MDP	.120	.052	.183

Notes: R^2 is the coefficient of determination, DW is the Durbin-Watson statistic, SER is the standard error of the regression, and MDP is the mean of dependent variable. Figures in parenthesis are coefficients' standard errors.

Table A2: Vector Autoregression for Mexico (1953-1978)

Explanatory Variables:	Dependent Variable DP_t	DY_t	DM_t
Constant	-.02 (.033)	.026 (.040)	.161 (.043)
DP_{t-1}	.173 (.215)	-.664 (.254)	.249 (.280)
DP_{t-2}	.345 (.196)	.393 (.232)	.864 (.256)
DY_{t-1}	.218 (.196)	.613 (.231)	.055 (.255)
DY_{t-2}	-.383 (.178)	-.186 (.210)	-.719 (.231)
DM_{t-1}	.591 (.145)	.072 (.172)	.035 (.189)
DM_{t-2}	-.078 (.192)	.233 (.227)	-.277 (.250)
Statistics:			
R^2	.785	.400	.647
DW	1.80	1.74	2.12
SER	.036	.043	.047
MDP	.071	.078	.143

Note: See note to Table A1.

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