NBER WORKING PAPER SERIES

THE SHORT-RUN RELATION BETWEEN INFLATION AND GROWTH IN LATIN AMERICA

Sebastian Edwards

Working Paper No. 1065

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

January 1983

I am indebted to Michael Darby, Alejandra Cox and Max Fry for helpful comments. The research reported here is part of the NBER's research program in International Studies. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper #1065
January 1983

The Short-Run Relation Between Inflation and Growth in Latin America

ABSTRACT

This paper investigates the relationship between monetary policy and growth in five Latin American countries (Brazil, Chile, Colombia, Mexico and Peru). The analysis focuses on the effects of expected and unexpected monetary growth on output, and explicitly incorporates the relationship between fiscal deficits and money creation in these countries. Open economy considerations are explicitly introduced into the analysis.

Contrary to previous findings (Hanson, 1980), the results obtained in this paper indicate that these countries exhibit very different behavior with respect to the relationship between unexpected money and growth: While for Chile and Brazil no evidence was found of a positive relation between monetary policy (expected or unexpected) and growth, for Colombia, Mexico and Peru a positive relationship was found between unexpected monetary policy and growth.

Sebastian Edwards
Department of Economics
University of California, Los Angeles
405 Hilgard Ave.
Los Angeles, CA 90024
(213) 825-7520

In analyzing the relationship between unanticipated monetary policy and growth for a group of Latin American countries, using the approach of Lucas (1973) and Barro (1977), James Hanson (1980, p. 987) concludes that for these countries "[A]s a rule of thumb, ten percentage points of unexpected inflation raise output about one percentage point above trend...". However, Hanson's results are not robust and depend critically on the functions he uses to generate expectations of monetary growth. If more general monetary processes are used, and open economy considerations are introduced into the analysis, Hanson's results are substantially changed.

The purpose of this note is to show that when a monetary process that explicitly incorporates the role of fiscal deficits is considered, Hanson's general result -- that suggests an elasticity of .10 between output growth and unexpected money for all these countries -- does not hold.[1/] In particular, this alternative monetary process indicates that these countries exhibit very different behavior with respect to the relationship between unexpected money and growth. Furthermore, Lucas' (1973) proposition of an inverse relationship between the effect of (unexpected) monetary policy and the variability of the money supply seems to hold for these countries. The paper also incorporates into the analysis the fact that these countries are open economies. This is done in three ways: (1) changes in the terms of trade are explicitly incorporated as possible determinants of growth; (2) for the case of Mexico -- which maintained a fixed exchange rate during most of the period -- unexpected domestic credit is also used as the relevant policy variable; (3) the possibility that all these countries are subject to <u>common</u> external shocks is incorporated explicitly in the estimation procedure.[2/]

Hanson's study is based on the estimation of equations for Brazil, Chile, Colombia, Mexico and Peru of the following type:

$$DY_t = a_2 + a_1 DMR_t + u_t, \qquad (1)$$

where Y_t is the log of real output, $DY_t = (\log Y_t - \log Y_{t-1})$, and DMR_t is the unexpected change in the log of the quantity of money. Hanson tries several specifications for DMR_t. Some of his best results are obtained when DMR_t is replaced by actual changes in the quantity of money DM_t (Hanson, Table 1), and when DMR_t is defined as actual growth of the quantity of money minus past inflation -- $DMR_t = DM_t - DP_{t-1}$ (Hanson, Table 4). Table 1 presents the results obtained from the estimation of equation (1) using these definitions of DMR_t. Even though the data used do not correspond exactly to Hanson's, the results are very similar.[3/] These results were obtained, as in Hanson's paper, using a narrow definition of money (M_1). When a broad definition of money is used, however, the results are similar. These results, together with pooled estimations, constitute the base of Hanson's analysis. However, as is shown below, once fiscal deficits and open economy factors are introduced, the similarity across countries of output response to monetary changes reported in Table 1 tends to disappear.

I. Fiscal Deficit and Monetary Growth in Latin America

A well-known feature of developing countries in general, and Latin-American countries in particular, is that money creation is an important source of government revenue (see, for example, Harberger, 1964, 1978; Ffrench-Davis, 1973; and Baer and Beckerman, 1974). In this section, I present results obtained from the estimation of monetary growth equations that incorporate explicitly the role of the fiscal deficit in money creation. Specifically, it is assumed that in every period the growth of the quantity of money responds partially to the current fiscal deficit, and to past rates of money creation:

$$DM_t = \alpha_o + \sum_{i=1}^{k} \alpha_i DM_{t-i} + \beta DEF_t + w_t, \qquad (2)$$

Table 1

GROWTH OF OUTPUT AND MONEY GROWTH
IN LATIN AMERICA

	Brazil 1952-1974	Chile 1952-1970	Colombia 1951-1974	Mexico 1950-1974	Peru 1951-1974
	A. $DY_t = a_2' + a_1 DM_t + w_t$				
a_2'	.107	.040	.018	.036	.033
	(4.340)	(1.930)	(1.107)	(2.889)	(3.019)
a_1	-.103	-.012	.190	.227	.131
	(1.481)	(.198)	(1.926)	(2.220)	(2.448)
R^2	.109	.003	0.171	.206	.261
D.W.	1.123	1.303	2.047	2.046	1.227
	B. $DY_y = a_2^{*'} + a_1^{*}(DM_t - DP_{t-1}) + w_t^{*}$				
$a_2^{*'}$	.063	.032	.049	.045	.042
	(7.428)	(6.258)	(8.821)	(8.197)	(5.906)
a_1^{*}	.159	.142	.002	.239	.148
	(2.073)	(3.035)	(.031)	(3.711)	(2.748)
R^2	.193	.365	.001	.420	.308
D.W.	1.400	2.263	1.825	2.074	1.192

Note: The data sources are described in the Appendix. Absolute t-statistics in parentheses.

R^2 refers to the coefficient of correlation D.W. in the Durbin-Watson statistic.

where DEF_t is the ratio of the fiscal deficit to the quantity of money in t-1. The residuals obtained from the estimation of this equation [$\hat{w}_t = \hat{DM}_t - DM_t$] are used in section II as a measure of unexpected money.[4/]

Table 2 presents the estimates of (2) for these five Latin-American countries. In most cases, k equals 3. For Chile, however, k equals 2, and for Peru k equals 4, to produce white noise residuals. In addition, for Mexico -- the only country in the sample that had a fixed exchange for most of the period -- an equation for domestic credit is also reported.[5/] As may be seen, in most cases DEF_t is positive and significant. One might also note that in all cases, the F statistic indicates that the regression is significant at conventional levels. The Durbin-Watson statistic, and analysis of the autocorrelation functions of the residuals using the Box-Jenkins (1976) procedure show that the residuals of these monetary equations are white-noise, indicating that they are appropriate candidates for the measure of unexpected money. An important characteristic of the money equations presented in Table 2 is that, when measured by the standard deviation of the prediction error, they outperform simple autoregressions and past inflation in predicting actual changes in the money stock.[6/]

II. Monetary Shocks and Growth in Latin America

This section re-examines the relationship between growth and unexpected monetary policy in Latin America, using the residuals from the money supply equations reported in Table 2 as a measure of unexpected money. The possible role of changes in the terms of trade ($DTOT_t$) in these countries' growth is also investigated. For each country, the following equation was estimated:

$$DY_t = \delta_o + \sum_{i=0}^{k} \gamma_i \, DMR_{t-i} + \theta \, DTOT_t + (\phi \, TIME) + \varepsilon_t, \qquad (3)$$

Table 2

Monetary Growth and Fiscal Deficit in Latin America

$$DM_t = \alpha_o \sum_{i=1}^{4} \alpha_i DM_{t-i} + \beta DEF_t + u_t$$

EQ. NO.	COUNTRY	MONETARY AGGREGATE	CONSTANT	α_1	α_2	α_3	α_4	β	S.E.	D.W.	R^2	F
(2.1)	Brazil	M2	.054 (1.455)	.904 (4.585)	-.529 (1.992)	.343 (1.870)	--	.392 (3.285)	.0530	1.858	.829	18.17
(2.2)	Chile	M2	.138 (.880)	.739 (2.844)	-.358 (1.175)	--	--	.083 (.709)	.0797	1.632	.427	3.98
(2.3)	Colombia	M2	-.064 (.878)	.598 (3.152)	-.067 (.279)	.730 (2.538)	-- --	.576 (3.719)	.0336	1.918	.594	5.60
(2.4)	Mexico	M1	.107 (2.993)	.901 (4.507)	-.971 (5.406)	.212 (1.262)	-- --	.088 (2.487)	.0189	1.676	.746	11.75
(2.5)	Mexico	Domestic Credit	.021 (.307)	.987 (3.563)	-.806 (3.042)	.696 (2.129)	-- --	-.403 (.424)	.0592	1.807	.525	10.87
(2.6)	Peru	M1	.085 (1.353)	.164 (.790)	-.329 (1.519)	.062 (.291)	.332 (1.573)	.343 (3.165)	.0782	1.631	.613	3.80

Notes: Absolute t statistics in parentheses.

S.E. refers to the standard error of the regression.

where DMR_{t-i} are residuals from the estimation of (2).[7/] The time variable is included only for Brazil in order to reduce the degree of serial correlation observed in the residuals.

In the analysis k ranges from zero to three. There are several ways to justify the inclusion of lagged values of DMR in equation 3. First, as Barro (1978, p. 553) has argued, lagged DMRs may capture the effects of unexpected monetary shocks on stock variables (like capital) that are carried forward. The inclusion of lagged values of DMR also pick up both short-run and long-run effects of monetary shocks on growth. While γ_o captures the short-run effect of unexpected monetary shocks, $\sum_{i=0}^{k} \gamma_i$ captures the long-run effect of these shocks. This interpretation of the coefficients of lagged values of DMR in an equation of the type of (3) has recently been suggested by Kormendi and McGuire (1981). Furthermore, if the natural rate hypothesis is true, $\sum_{i=0}^{k} \gamma_i$ should not be significantly different from zero.

Equation (3) was estimated in two alternative ways. First, OLS were applied for each country, using the residuals from the monetary process equations reported in Table 2 as measures of unexpected money. Second, equation (3) was also estimated using Zellner's (1962) seemingly-unrelated regression procedure (SURE) for the cases of Brazil, Colombia, Mexico and Peru for 1954-1974. Since all these countries are open economies, and hence are subject to common external shocks, the residuals (εs) from the growth equations for each of them could be correlated. The use of this GLS procedure is superior to simply pooling the different equations since it still allows for differences in the γ_i's across countries.

The results obtained from the OLS estimation of (3) are reported in Table 3. Table 4, on the other hand, contains the seemingly unrelated regression results from the simultaneous estimation of equations (3.1), (3.3), (3.4) and (3.6)

for Brazil, Colombia, Mexico and Peru.[8] As one can see the results are very different across countries. For Brazil and Chile, no evidence was found of a significant effect of unexpected money on output growth. On the other hand, for Colombia, Mexico and Peru, some evidence of significant positive effects of unexpected money on growth was found. However, the significant coefficients for unexpected money changes vary widely in both magnitude and lags.[9] The results for Mexico are particularly interesting. While none of the γ_i's is significant when unexpected changes in domestic credit are used, a positive, significant coefficient for γ_1 is found when M_1 is used as the relevant monetary aggregate. This is, to some extent, surprising, since one would expect that in the case of a small open economy with fixed exchange rates, domestic credit would be the relevant policy variable.[10] The results presented in Tables 3 and 4 also indicate that changes in the terms of trade are positively related to output growth in these countries (θ is positive in all cases). However, these coefficients are only significant at the conventional levels for the cases of Chile and Mexico.

III. Money, Inflation and Growth in Brazil and Chile

According to the discussion presented in the preceding section, for Brazil and Chile, unexpected monetary changes have no effects on output growth. These results, however, appear to be inconsistent with Hanson's findings -- reported in panel B of Table 1 of this paper. This inconsistency is more apparent than real, and is due to the peculiar definition of unexpected money used by Hanson.[11] In order to investigate this problem further, I re-estimated Hanson's equations without restricting the coefficients of DM_t and DP_{t-1} to be equal and opposite. The results for Brazil and Chile are:

Table 3

Output Growth and Unexpected Money in Latin America:
Ordinary Lease Squares Results

$$DY_t = \delta_o + \Sigma \gamma_i DMR_{t-i} + \theta DTOT_t + \emptyset TIME + \varepsilon_t$$

EQ. NO.	COUNTRY	MONETARY AGGREGATE	δ_o	γ_o	γ_1	γ_2	γ_3	θ	$\emptyset$	D.W.	R^2	F^a	F^b
3.1	Brazil	M2	-6.106 (1.235)	-.040 (.176)	-.087 (.382)	-.423 (1.775)	-.273 (1.252)	.023 (1.136)	.003 (1.248)	1.813	.546	1.60	1.02
3.2	Chile	M2	.035 (4.609)	-.031 (.348)	-.064 (.581)	-.086 (.866)	-.012 (.132)	.163 (2.075)	--	1.587	.413	.99	.35
3.3	Colombia	M2	.055 (13.474)	.153 (1.093)	.113 (.669)	.021 (.116)	.289 (1.566)	.028 (.611)	--	2.367	.419	1.30	1.11
3.4	Mexico	M1	.073 (11.835)	.472 (1.494)	.741 (2.139)	.526 (1.326)	.176 (.472)	.188 (1.961)	--	1.966	.484	1.69	1.35
3.5	Mexico	Domestic Credit	.063 (11.114)	-.084 (.680)	-.060 (.482)	-.222 (1.667)	.024 (.207)	.116 (1.164)	--	1.998	.377	1.09	.73
3.6	Peru	M1	.053 (8.269)	.303 (2.750)	.118 (1.253)	.054 (.600)	.064 (.689)	.062 (.949)	--	1.861	.524	1.98	2.23

Notes: Absolute t-statistics in parentheses.

a. F-test for the significance of the regression.

b. F-test for the significance of the γ_i's as a group. The null hypothesis is $\gamma_o = \gamma_1 = \gamma_2 = \gamma_3 = 0$.

Table 4

Output Growth and Unexpected Money in Latin America:
Seemingly Unrelated Regressions Results

$$DY_t = \delta_o + \Sigma \gamma_i DMR_{t-i} + \theta DTOT_t + \phi TIME + \epsilon$$

EQ. NO.	COUNTRY	MONETARY AGGREGATE	δ_o	γ_o	γ_1	γ_2	γ_3	θ	ϕ
(4.1)	Brazil	M2	-6.134	-.048	-.052	-.445	-.296	.020	.003
			(1.312)	(.217)	(.235)	(1.940)	(1.409)	(1.001)	(1.326)
(4.3)	Colombia	M2	.055	.195	.069	.060	.298	.016	--
			(13.718)	(1.839)	(.481)	(.404)	(2.058)	(.412)	
(4.4)	Mexico	M1	.074	.246	.632	.538	.202	.269	--
			(12.749)	(.942)	(2.237)	(1.553)	(.647)	(3.637)	
(4.6)	Peru	M1	.052	.325	.138	.066	.051	.060	--
			(8.198)	(2.965)	(1.481)	(.751)	(.553)	(.941)	

Note: Absolute t-statistics in parentheses.

Brazil:

$$DY_t = \underset{(4.439)}{.098} + \underset{(.536)}{.050}\ DM_t - \underset{(2.250)}{.159}\ DP_{t-1}$$

D.W. = 1.747
R^2 = .313
F = 3.87

Chile:

$$DY_t = \underset{(1.980)}{.040} + \underset{(.611)}{.045}\ DM_t - \underset{(1.361)}{.065}\ DP_{t-1}$$

D.W. = 2.167
R^2 = .119
F = .95

As may be seen, in both cases the coefficient of actual money changes is not significant, while for Brazil the coefficient for past inflation is significantly negative. Furthermore, for Brazil the restriction imposed by Hanson of equality (with opposite signs) of the coefficients of DM_t and DP_{t-1} is rejected at the conventional levels. When these results are looked at from this perspective, they are perfectly consistent with our previous findings reported in section II: in these highly inflationary countries, money growth (actual and unexpected) has no effect on output growth. However, inflation tends to have a significantly negative effect on growth in these countries.

DATA APPENDIX

1. Real Income: For Colombia it is real GDP taken from the International Financial Statistics. For Peru and Brazil, real GDP obtained from U.N. National Accounts was used. For Mexico, real GDP from ECLA, as reported in UCLA's Statistical Abstract of Latin America, was used. For Chile, data on real GDP taken from Ffrench-Davis (1973) was used.

2. Money (M1 and M2) and Domestic Credit: For Brazil, Colombia, Mexico and Peru, yearly averages constructed from the IFS raw data were used. For Chile, the series reported in Ffrench-Davis (1973) were used.

3. Prices: For Brazil, Colombia, Mexico and Peru, the data was taken from the IFS. For Chile, Ffrench-Davis series were used.

4. Terms of Trade: Taken from ECLA's "America Latina: Relación de Términos de Intercambio, 1928-1976".

5. Fiscal Deficit: For Brazil, Colombia, and Peru the data was taken from the IFS. For Chile, data from Ffrench-Davis (1973) was used. For Mexico, from Anuario Estadístico Compendiado (various issues).

FOOTNOTES

1/ On the relationship between money creation and fiscal deficits see, for example, Harberger (1964, 1978), Ffrench-Davis (1973), Agheveli and Khan (1978) and Baer and Beckerman (1974). Hanson (1980), p. 975) acknowledges the importance of monetary emission as a source of government revenue in Latin America. However, he does not incorporate the fiscal deficit as an explanatory variable in his money supply processes,

2/ On the relationship between growth and monetary policy in an open economy using a Lucas-Barro type of framework see Leiderman (1979), Blejer and Fernandez (1980) and Darby (1982). Barro (1978) also included a terms of trade variable in his study of the U.S. case. An alternative way of introducing open economy considerations is to include the growth of international reserves in the money supply equation. Results obtained using this formulation for the case of Latin America do not alter the results presented in this paper.

3/ I have followed, as far as possible, the indications in Hanson's (p. 979) paper to construct my data. However, I have deliberately introduced some changes. In particular, I have used ECLA's data on GDP for Brazil and Mexico, since it is well known that the IFS data set contains serious flaws in these series for the earlier periods. In private communication, Hanson has indicated to me that his monetary data for Colombia was taken from the Banco de la Republica Bulletin. In this study, however, the monetary data for Colombia and other countries -- except Chile -- are yearly averages constructed from the IFS data. See the Appendix for further details on the data. The non-significance of a_1^* for Colombia contrasts with Hanson's results. The reason for this is the different monetary series used.

4/ It is important to note that the use of equations of this type to generate expectations of money growth implicitly assumes that their parameters are stable through the period. The reason for this is that, as Barro (1977, p. 105-6) has pointed out, this procedure uses future information (not available at t-i) to generat the estimated $\hat{\alpha}$ parameters. If these parameters are not stable, however, a period by period sequential up-dating procedure should be implemented.

5/ For all countries, equations for M_1, M_2 and domestic credit were fitted. However, due to space considerations, only the "best" results -- as measured by the standard error of the regression -- are reported in Table 2. For the

cases of Brazil, Colombia and Peru, the residuals from the domestic credit equations exhibited serially-correlated errors.

6/ With the exception of one case (Chile when three-period lagged inflation is used to predict money), these equations' predictive power outperforms those used by Hanson.

7/ It is important to note that the parameters of equations (2) and (3) are related, and that both equations could be estimated simultaneously imposing cross-equation restrictions. Results obtained using this approach for these Latin-American countries confirm the main conclusions presented in this paper.

8/ Chile was not included in the SURE estimations in order for the estimations to be based on a longer time period. Other sets of equations were also simultaneously estimated using SURE. The results are not reported here due to space considerations. Equation (3) was also estimated in terms of levels. The results obtained support the conclusions presented in this paper.

9/ As may be seen in Table 3, the null hypothesis that the γ_is are significant as a group cannot be rejected at the conventional levels. Also, for all countries -- except Peru -- the hypothesis $\sum_{i=0}^{k} \gamma_i = 0$ cannot be rejected at the 5% level.

10/ Blejer and Fernandez (1980), in a study on Mexico that distinguishes between tradable and non-tradable goods, have found a positive effect of unexpected increases in domestic credit on non-tradables output.

11/ However, it may be noted that theoretically, under certain restrictive assumptions (expected money growth equals growth in nominal money demand, and expected rate of inflation equals past inflation), it is possible to relate $(DM_t - DP_{t-1})$ to unexpected money growth.

REFERENCES

Agheveli, Bijan B. and Khan, Mohsin S., "Government Deficit and the Inflationary Process in Developing Countries," IMF Staff Papers, September 1978, 25, 383-416.

Barro, Robert, "Unanticipated Money Growth and Employment in the United States," American Economic Review, March 1977, 67, 101-115.

_____, "Unanticipated Money, Output, and the Price Level in the United States," Journal of Political Economy, August 1978, 86, 549-580.

Baer, Werner W., and Beckerman, Paul, "Indexing in Brazil," World Development, Oct./Dec. 1974, 2, 35-48.

Blejer, Mario J. and Fernandez, Roque B., "The Effects of Unexpected Money Growth on Prices and on Output and its Composition in a Fixed Exchange Rate Open Economy," Canadian Journal of Economics, February 1980, 13, 82-95.

Box, George E.P., and Jenkins, Gwilym M., Time Series Analysis: Forecasting and Control, second edition, San Francisco: Holden, Day, 1976.

Darby, Michael R., "Unanticipated or Actual Changes in Aggregate Demand Variables: A Cross-Country Analysis," in M.R. Darby, et al., The International Transmission of Inflation, forthcoming 1982.

Ffrench-Davis, Ricardo, Politicas Economicas en Chile, Santiago de Chile: Editorial Nueva Universidad, 1973.

Hanson, James, "The Short-Run Relation Between Growth and Inflation in Latin America," American Economic Review, December 1980, 70, 972-989.

Harberger, Arnold C., "Notes on Inflation," in W. Baer and I. Kenstenetzky (eds.), Inflation and Growth in Latin America, Illinois: Homewood, 1964.

_____, "A Primer on Inflation," Journal of Money, Credit and Banking, August 1978, 10, 505-521.

Kormendi, Roger C. and Meguire, Philip G., "The Real Output Effect of Monetary Shocks: Cross Country Tests of Rational Expectations Propositions," Report 8123, Center for Mathematical Studies in Business and Economics, The University of Chicago, 1981.

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

Lucas, Robert E., Jr., "Some International Evidence on the Output-Inflation Trade-Offs," American Economic Review, June 1973, 63, 326-334.

Zellner, Arnold G., "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias," Journal of the American Statistical Association, June 1962, 57, 348-368.