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MONEY, THE DYNAMICS OF INFLATION AND THE BALANCE OF PAYMENTS IN LATIN AMERICA 1947-1976

BY

ANTHONY CASSESE

A DISSERTATION SUBMITTED TO THE GRADUATE FACULTY OF THE DEPARTMENT OF ECONOMICS OF THE CITY UNIVERSITY OF NEW YORK IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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This manuscript has been read and accepted for the Graduate faculty in Economics of the City University of New York in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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TO MY WIFE, CAROL

MONEY, THE DYNAMICS OF INFLATION AND THE BALANCE

OF PAYMENTS IN LATIN AMERICA,

1947-1976

by

Anthony Cassese

Advisor: Alvin L. Marty

Abstract

The main focus of this dissertation is to empirically test a number of assumptions of simple monetary models of the balance of payments using annual data on sixteen Latin American countries. The usual assumption of rapid price arbitrage is shown not to hold for most of these countries. Moreover, by using the technique developed by Granger, it is shown that the domestic rate of inflation is not an exogenous determinant of the respective official settlements balance of payments for most of these countries. Therefore, single equation models of the balance of payments which use the domestic rate of inflation as a regressor suffer from simultaneity bias. In addition, estimates of the demand for real cash balances per capita indicate a stable relationship for all countries.

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As with most doctoral dissertations, the writing of an acknowledgement focuses on the past for valuable help given during the most difficult period of graduate work. Frequently, the effect of some input is forgotten. Unfortunately, the longer-run effects are ignored or unappreciated. I hope I can continue to acknowledge the help I have received through improved output.

A supervisory committee is expected to read and comment on the progression of a dissertation. I was fortunate to have, in addition to a helpfull committee, a number of economists read and comment on my work. In this regard, I would like to thank Dr. Arthur E. Gandolfi for several comments on an early draft of results presented at a seminar at CITIBANK. Professor Michael Grossman provided some comments on early drafts of parts of this dissertation which demonstrated his overwhelming concern for students more than his own particular academic interests. I am most grateful to Dr. Anna J. Schwartz for imparting her expert knowledge of data analysis--from collection to estimation, for a greater appreciation of the monetarist perspective and for a constant source of references on relevant material usually in pre-publication form, something all too often overlooked by students during the dissertation stage.

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As the chairman of the supervisory committee, Professor Alvin L. Marty constantly prodded and insisted on rigor in thinking and application. The adage "for your own good" may never be more applicable. I hope that I can carry that tough-mindedness through my career.

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Finally, I would like to express my appreciation to my wife, Carol, to whom this dissertation is dedicated. During the various stages of the work, the weight of anxiety and effort affected my behavior more than I could admit at the time. Through this period of development and the numerous lost weekends, Carol tried her best to operate within that difficult framework. Her effort is in large measure responsible for the completion of this dissertation.

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CHAPTER I

INTRODUCTION

One issue of importance to many nations is their national economic position regarding changes in liabilities to and claims on other countries. As a matter of policy, attention is directed toward maintaining a balance on international payments along with achieving domestic macroeconomic goals, e.g., price level stability. Recently, a great deal of attention has been directed toward developing the proposition that the official settlements balance of payments is a monetary phenomenon and that effective exchange rates reflect the relative purchasing power of national currencies. This monetary approach to balance of payments theory is the basic framework within which this paper is presented.

In particular, I focus on several assumptions made by researchers in the field which have allowed them to simplify the model greatly and draw several implications. Specifically, the model, in its most highly distilled form, suggests that a small open economy cannot operate an independent monetary policy and maintain a fixed exchange rate of its currency with that of a reserve currency country. This means that the stock of money existing in a small economy is determined by world conditions. Given the positive relationship between the rate of inflation and money supply growth, the small open economy is expected to experience a rate of inflation determined by world money growth and hence the rate of inflation is outside of its control.

The main arguments of this paper are that the reliance on the law of one price which has taken a prominent role in the presentation of the monetary approach is an invalid empirical approximation, that the rate of inflation experienced by a small open economy cannot, in general, be treated as an exogenous variable, and that monetary independence is less of an all-or-nothing proposition than might be supposed.

The monetary approach to the balance of payments begins with the definition of the balance of payments as the change in official reserve assets, under a fixed exchange rate regime. Hence, the operation of monetary policy is certainly affected by the balance of payments as the following diagram indicates. Suppose the following T-account represents the assets and liabilities of the central bank of a non-reserve currency country:

Assets	Liabilities
Gold	Currency in Circulation
Foreign Exchange	Required Reserves of Commercial Banks
SDR's	Accounts of the Treasury
Government Securities	Outstanding Borrowings

Suppose further that a reserve currency country, such as the United States, increases its nominal stock of money. This increase in world money, under a fixed exchange rate system, will be distributed in proportion to the share in world money each country enjoys. Thus, other things constant, the central bank of a small open economy will have its assets increased via an inflow of reserves--gold, foreign exchange, and SDR's.

The central bank must then take appropriate action to balance its accounts. Several courses of action are open to it. First, it could try to sterilize the inflow by reducing one of its other assets. This is likely to take the form of a sale of government securities. The end result of this process is to bring the accounts of the central bank back into balance at the initial level of assets and liabilities. That is, an inflow of reserves is matched by the requisite increase in domestic currency necessary to purchase the foreign reserves. The central bank then sells governemnt securities and its liabilities are drawn down in one or more of the liability categories depending on who purchases the securities. Generally such sterilization is ruled out as being impossible to carry out over the long run--the securities held by the central bank are finite and will not increase if the central bank chooses to try to prevent an expansion of the money stock.

A second alternative open to the central bank in the face of an inflow of reserves is simply to purchase the foreign exchange, i.e., passively accept the inflow. This purchase could take the form of an increase in currency in circulation or some other liability. Thus, if we rule out sterilization, then a foreign reserve inflow results in an increase in the nominal stock of money above what the central bank had planned. In this way, the monetary policy of the small country is dependent upon monetary conditions in the rest of the world.

In this paper, I analyze these issues on an empirical level using annual data on sixteen Latin American countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela. This data base is useful in this context for several reasons. First, each of these countries are small in the sense that conditions in each of these countries cannot affect the rest of the world. Second, this group of countries affords a wide variety of economic experiences which will place the additional burden on the hypotheses of the simplistic version of the monetary approach, outlined above, of having to explain that variety. Finally, the group of countries analyzed here permit me to make several cross-country comparisons.

The analysis proceeds as follows. In Chapter II, I present descriptive statistics on the background of Latin America. These statistics describe average rates of growth of several variables for each of the countries as well as the respective measures of variability. In Chapter III the simple monetary approach is described and empirical estimates are obtained and compared to previous work in the area. In Chapter IV I analyze the demand for money in each of the sixteen countries. In Chapter V, I analyze the proposition that the rate of inflation experienced by a small country will not differ significantly from the "world" rate of inflation. Finally, in Chapter VI, I analyze the issue of the exogeneity of the domestic rate of inflation of each of these countries with respect to their respective balance of payments and their rates of monetary growth. In addition, I present an appendix describing the sources of the data and notes on the method of constructing several series. I also present another appendix which describes the construction of rest-of-the-world price indices for each of the sixteen countries.

CHAPTER II

BACKGROUND ON LATIN AMERICA

In this chapter I describe, in broad terms, some economic characteristics of the sixteen Latin American nations analyzed in this study[1]: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela. In addition, I provide comparable statistics for the United States.[2] The purpose of this chapter is generally one of description rather than explanation. No particular theoretical hypothesis is rigorously tested in the discussion. The simple statistical analyses, of changes in specific characteristics, offered here indicate a wide variety of experience to which a few theoretical issues will be subjected to empirical testing in subsequest chapters.

A. The Real Sector

The variety of economic experience that exists across Latin American countries is evident in all sectors of their economies. I define the real sector to be those elements of the macroeconomy which are non-financial in nature: output, expenditure, prices, and their components, e.g., domestic versus foreign, public versus private.

1. Real Domestic Characteristics

The real gross domestic product of the Latin American countries grew, in per capita terms, at average annual percentage rates varying from -0.46 for Uruguay to 4.72 for Brazil over the period 1947-1976. The corresponding rate for the United States was 1.82% per annum over the same period. Only five countries experienced real per capita income growth greater than 2.5%: Brazil, Costa Rica, El Salvador, Nicaragua, and Peru. Table 1 lists the average annual growth rates of selected variables as well as their respective standard deviations.

With respect to real per capita income growth, $\widehat{y/N}$, two observations are apparent. Firstly, in most cases the average rate of growth was not significantly different than the rate for the U.S., in a statistical sense.[3] Specifically, only the economies of Brazil and Uruguay grew, in real per capita terms, at rates different than the U.S. Brazil had the fortune of developing through real growth, whereas Uruguay suffered from declining real output per man.

However, the variety of countries with rates of growth similar to the U.S. is remarkable. From countries with long histories of continuous and variable inflationary experiences and political unrest, such as Argentina and Chile, to countries with acceptable inflation rates and subdued political problems--such as the five Central American countries--Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua, virtually no difference exists between these nations and the U.S. in real per capita income growth. This suggests that in a model of a world economy with, for example, the United States acting as the rest of the world, the difference in real income growth as between these small countries and the rest of the world will not be important in explaining reserve flows, i.e., the balance of payments in a fixed exchange rate system, as in a monetary model of the balance of payments.[4]

A second observation concerning the rate of real per capita income growth is that the standard deviation was one-and-a-half to two times larger for nearly all of the Latin American countries than it was for the United States. The significance of this phenomenon is suggested by reference to the Lucas (1973) analysis of output-inflation tradeoffs and the "natural rate" hypothesis.

Specifically, Lucas decomposes real output into secular and cyclical elements. As Lucas points out "with a stable Phillips tradeoff, policies which lead to wide variation in prices must also induce comparable variation in real output." Moreover, as Lucas states the main implication of the "natural rate" hypothesis: "the higher the variance of demand, the more unfavorable are the terms of the Phillips tradeoff." As columns 4, 6, and 8 of Table 1 indicate, the standard deviations of nominal gross domestic product (a proxy for demand shifts), the GDP price deflator and consumer prices, respectively, imply that the Latin American countries were likely to have experienced less favorable tradeoffs[5] and have experienced more variable inflation than the United States.

This can be supported, in a rough-and-ready way, for the Latin American countries by rank-correlating the standard deviation of <u>nominal</u> income growth and the standard deviation of the growth in the GDP price deflator.[6] That is, I let dispersion in nominal income growth proxy for demand shifts--fluctuations about trend. The greater is the dispersion in inflation the greater will be the dispersion in

TABLE 1

ANNUAL GROWTH RATE OF INCOME AND THE PRICE LEVEL (%)
1947-1976[1]

Country	$\widehat{(y/n)}$ Mean	$\widehat{(y/n)}$ S.D.	$\hat{Y}$ Mean	$\hat{Y}$ S.D.	$\hat{P}_{GDP}$ Mean	$\hat{P}_{GDP}$ S.D.	$\hat{P}_{CPI}$ Mean	$\hat{P}_{CPI}$ S.D.
Argentina	1.92	5.42	29.15	18.74	25.56	20.48	30.72	33.19
Bolivia	1.85	6.27	27.37	28.54	23.01	30.36	22.63	28.06
Brazil	4.72	5.69	30.34	15.54	22.74	17.28	23.97	14.71
Chile	1.07	5.19	45.84	45.66	42.74	48.12	43.23	45.34
Colombia	2.35	2.65	16.36	5.74	11.19	5.68	11.02	7.24
Costa Rica	2.94	4.13	10.39	6.18	4.19	5.69	4.76	5.94
Ecuador	2.29	4.14	10.92	7.74	5.49	6.05	5.22	5.52
El Salvador	2.66	5.86	8.43	7.15	2.94	6.53	4.73	6.52
Guatemala	2.11	5.94	8.19	7.73	3.01	5.20	3.22	4.83
Honduras	1.04	3.51	6.92	3.92	2.90	2.52	2.96	3.39
Mexico	2.23	3.62	12.39	5.93	6.87	4.79	6.80	5.31
Nicaragua	3.66	7.19	8.81	8.10	2.30	5.95	4.23	7.31
Paraguay	0.99	4.53	19.67	15.18	16.16	17.18	16.58	19.26
Peru	2.75	3.90	16.56	7.12	11.23	7.03	11.08	7.00
Uruguay	-0.46	2.91	37.38	22.10	36.54	21.88	27.98	22.88
Venezuela	2.22	4.50	9.06	9.87	3.40	9.27	3.49	4.66
United States	1.82	2.99	6.98	3.32	3.78	3.04	3.61	3.41

A circumflex indicates a percentage rate of change of the variable.
y ≡ real gross domestic product; N ≡ population; Y ≡ nominal gross domestic product; P_{GDP} ≡ GDP implicit price deflator = Y/y, 1970 = 1.00; P_{CPI} ≡ Consumer Price Index, 1970 = 1.00.

1. Income growth rates for Uruguay cover 1955-1975; for Costa Rica and Ecuador, 1950-1976; for Bolivia, 1950-1975.

demand about its trend.[7] For the sixteen Latin American countries the rank correlation between the standard deviation of the rate of growth of the GDP deflator and the standard deviation of the rate of growth of nominal GDP is 0.92, significant at the one percent level (see Table 2).

While this sort of casual empiricism is not strictly conclusive it does yield some information regarding the economic situation of the Latin American countries. Specifically, relative to the U.S., these countries were more susceptible to unstable "Phillips" tradeoffs and hence were less likely to adequately achieve inflation and employment goals for their respective economies with a given amount of policy action. Honduras is one possible exception among the sixteen countries. The standard deviations of inflation and nominal income growth for Honduras were not significantly different from the respective measures of variability for the U.S.

Another characteristic of some interest is the role of central government expenditure in Latin America. I list in Table 3 the mean and standard deviation of the annual growth in real per capita central government expenditure, $\widehat{g/N}$, and the respective statistics for the annual growth in nominal central government expenditure, $\hat{G}$, for each country. In addition, I list the statistics for the ratio of nominal central government expenditure to nominal income, G/Y.

The central government sector of the Latin American countries, as a demander of resources, generally grew, both in nominal and real per capital terms, faster than in the U.S. (0.9%). In fact, ten nations had an average $\widehat{g/N}$ of more than 2.5%: Argentina, Bolivia,

TABLE 2

RANK-ORDER CORRELATIONS OF ANNUAL GROWTH RATES[1]

		$\hat{Y}$		$\hat{P}_{GDP}$		$\hat{P}_{CPI}$		$\hat{y}$	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
$\hat{P}_{GDP}$	Mean	0.98**							
	S.D.	0.81**	0.92**						
$\hat{P}_{CPI}$	Mean	0.99**		0.96**					
	S.D.	0.85**	0.78**	0.79**	0.82**				
$\hat{y}$	Mean	-0.46†		-0.56*		-0.50*			
	S.D.	-0.08	0.48†	-0.12	0.32	-0.01	-0.29		
$\hat{G}$	Mean	0.83**		0.80**		0.80**			
	S.D.	0.54**	0.70**	0.49†	0.68**	0.49†	0.51*	-0.20	0.21
$\hat{TR}$	Mean	0.94**		0.88**		0.96**		-0.39	
	S.D.	0.81**	0.94**	0.78**	0.94**	0.79**	0.82**	-0.40	0.33

A circumflex, ˆ , indicates a percentage rate of change of the variable: Y ≡ nominal GDP; y ≡ real GDP; P_{GDP} ≡ implicit price index; P_{CPI} ≡ consumer price index; G ≡ nominal central government expenditure; TR ≡ sum of nominal current account exports and imports.

†significant at α = 0.10; * significant at α = 0.05; ** significant at α = 0.01.

1. Correlations are across the 16 Latin American countries only, i.e., they exclude the U.S.

TABLE 3

ANNUAL GROWTH RATE OF CENTRAL GOVERNMENT EXPENDITURES AND ITS AVERAGE PROPORTION IN GDP (%) 1947-1976[1]

Country	$(\hat{g/N})$ Mean	$(\hat{g/N})$ S.D.	$\hat{G}$ Mean	$\hat{G}$ S.D.	G/Y Mean	G/Y S.D.
Argentina	2.96	13.90	32.89	45.05	10.95	2.43
Bolivia	4.00	9.88	16.55	15.56	12.52	1.70
Brazil	5.42	11.70	30.94	16.57	13.28	4.17
Chile	1.42	20.17	53.29	49.04	18.72	4.26
Colombia	1.43	13.89	15.29	12.26	8.54	1.55
Costa Rica	6.96	11.18	20.98	7.32	17.22	1.23
Ecuador	4.46	11.26	13.06	12.40	11.50	2.40
El Salvador	1.99	10.75	7.08	11.56	13.19	1.50
Guatemala	1.17	9.57	8.46	11.88	9.74	0.87
Honduras	3.98	12.41	9.85	11.83	10.90	2.64
Mexico	5.44	9.48	17.96	10.58	12.89	1.72
Nicaragua	6.52	16.02	11.43	15.79	10.49	2.27
Paraguay	0.08	0.09	9.86	7.89	10.07	1.20
Peru	4.21	12.66	18.02	12.73	15.90	2.57
Uruguay	0.61	14.06	50.92	18.46	15.75	1.73
Venezuela	7.09	14.46	13.15	19.98	19.18	5.12
United States	0.85	15.37	6.01	13.71	19.29	2.93

A circumflex indicates a percentage rate of change of the variable.

g ≡ real central government expenditure per calendar year, deflated by the GDP implicit price index.

G ≡ nominal central government expenditure per calendar year.

Y ≡ nominal GDP.

1. Data on central government budgets were not available for all years; see Appendix A for limitations for each country.

Brazil, Costa Rica, Ecuador, Honduras, Mexico, Nicaragua, Peru, and Benezuela. In terms of variability in $\hat{G}$, the U.S. lies somewhere in the middle of the distribution across the Latin American countries. However, the U.S. growth in real per capita central government expenditure was more variable than these countries, except for Chile and Nicaragua.

Also of interest, with respect to the role of the central government, is the fact that none of these countries had as great a proportion of nominal GDP emanating from the central government as did the U.S.---only Chile and Venezuela differ from the U.S. insignificantly in this regard. Moreover, in only three countries--Brazil, Chile and Venezuela--was the fraction of GDP attributable to the central government more variable than in the United States.

Referring to the Lucas model (see footnote 7), greater variability in demand should reflect itself in greater variability in inflation. I calculated the rank-correlation of the standard deviation of the rate of inflation (as measured by the growth in the GDP implicit price deflator) and the standard deviation of the rate of growth of nominal government expenditure--used as a proxy for demand fluctuations. The cross-country rank correlation is 0.68, significant at the one percent level. The implication being that those Latin American countries which had greater variability in central government demand were more susceptible to inflationary variability.

2. Real International Characteristics

I present in Table 4 statistics on several measures of the importance of the foreign sector in Latin America. I define nominal

TABLE 4

ANNUAL GROWTH RATE OF TOTAL TRADE
EXPENDITURE AND ITS AVERAGE PROPORTION IN GDP (%)
1947-1976[1]

Country	$(\hat{tr}/N)$ Mean	$(\hat{tr}/N)$ S.D.	$\hat{TR}$ Mean	$\hat{TR}$ S.D.	TR/Y Mean	TR/Y S.D.
Argentina	-0.24	22.42	32.34	41.02	14.59	3.98
Bolivia	5.78	66.94	27.86	68.52	33.36	14.51
Brazil	4.62	19.07	29.74	20.47	9.99	1.20
Chile	1.48	38.22	54.69	76.45	19.86	4.34
Colombia	2.51	11.11	16.74	13.22	19.48	2.48
Costa Rica	3.68	9.00	12.18	11.60	45.31	6.89
Ecuador	4.31	14.06	13.12	17.41	28.96	5.75
El Salvador	5.64	10.02	11.41	12.47	41.53	8.77
Guatemala	4.06	10.85	10.66	12.40	26.12	4.59
Honduras	2.94	10.84	8.81	11.40	46.52	7.68
Mexico	1.29	9.74	11.68	12.16	16.18	4.64
Nicaragua	8.23	15.17	13.38	16.04	39.72	12.51
Paraguay	0.36	16.16	19.04	19.54	20.01	3.24
Peru	1.63	15.29	14.79	15.94	30.40	5.23
Uruguay	-1.67	18.70	28.94	29.34	23.59	6.01
Venezuela	3.99	13.82	10.73	17.99	44.50	6.36
United States	4.13	9.67	9.29	11.23	8.00	2.15

A circumflex indicates a percentage rate of change of the variable.

tr ≡ real trade expenditure (exports plus imports) deflated by GDP implicit price index.

TR ≡ nominal trade expenditure.

Y ≡ nominal GDP.

1. Data on exports and imports were not available for all years; see Appendix A for limitations for each country.

trade expenditure, TR, as simply the sum of nominal current account exports and imports. The mean and standard deviation of growth for the real foreign sector expenditure flow per capita, $\widehat{tr/N}$, and the corresponding statistics for growth in nominal trade flow, $\widehat{TR}$, are listed in the columns 1 to 4 in Table 4. In addition, the statistics for the ratio of nominal trade flow to nominal income, TR/Y, are listed in Table 4.

In terms of mean values, most of the Latin American countries experienced lower growth in real per capita trade flows than the U.S. (4.1%). Indeed, only six countries had their real per capita trade flows grow faster than 4% per annum: Bolivia, Brazil, Ecuador, El Salvador, Guatemala, and Venezuela. The average nominal trade growth, however, was greater for Latin American countries than for the U.S. As might be expected, the average ratios of nominal trade to GDP were significantly greater for Latin America than the U.S., with the notable exception of Brazil.

On the other hand, in nearly every case for the three measures for the foreign sector, the Latin American countries had greater variability in these measures than did the U.S. For example, although the U.S. did have relatively high real per capita trade growth, only Costa Rica and Mexico had a variability as low as that for the U.S.

Again referring to the Lucas model (see footnote 7), I computed a rank-correlation between the variability of growth in nominal demand --as proxied by the standard deviation of the rate of growth of nominal trade flows--and the variability in the rate of inflation--as measured by the standard deviation of the rate of growth of the GDP implicit price deflator. Once again the higher was the variability in demand, across countries, the higher was the variability of inflation --the rank correlation is 0.94, significant at the one percent level. The strength of the correlation suggests that the Latin American countries which experienced greater variability in the growth of foreign trade were more likely to experience greater inflationary variability.

B. The Monetary Sector

As indicated in the last section, the experience of the Latin American countries was varied with respect to "real" variables over the period 1947-1976. Specifically, the average growth of output, prices, government expenditure and foreign trade differ greatly across these countries. Moreover, so did the standard deviation of these growth rates. The variety of the experiences in these characteristics allowed us to draw some inferences in regard to stabilization policy, as reflected in Lucas' (1973) model.

The experience of the Latin American nations in the monetary sector was also diverse in several respects. I define the -onetary sector, broadly, as being represented by aggregate measures of the demand for and supply of money. Again I present statistics on annual growth rates of a number of monetary aggregates and also include statistics on a few behavioral parameters.

Specifically, the narrow money (M1) and high powered money (H) stocks, both in nominal terms, are used to represent the overall supply of money. In addition, the stock of high powered money is decomposed into its foreign component (F) and the domestic component (DH). I also analyze the income velocity of money, the money multiplier, and the proportion of high powered money held by the respective central bank in the form of official international reserves.

Several general aspects of the monetary sector vis-a-vis the real sector are apparent in looking at Tables 5 to 8. First, the distribution across Latin America in average growth rates of monetary variables was equally as varied as the distribution for mean growth rates in "real variables. In some cases monetary variables were more diverse, notably the domestic component of high powered money. An exception to this generalization was the money multiplier. This parameter showed marked similarity across Latin America.

Second, the distribution (across countries) in the standard deviation of annual growth rates (within countries) was generally more diverse for the monetary variables than the "real" variables. The money multiplier was again an exception. The multiplier was fairly well concentrated about its mean over time for all countries. The coefficient of variation always being less than one and frequently very much so.

Finally, only when the high powered money stock is decomposed does a difference in orders of magnitude show clearly mis-a-vis growth rates of "real" mariables. But for nearly all monetary variables, the statistics for the United States were very much different than those for Latin America. This is in contrast to the real sector where,

TABLE 5

ANNUAL GROWTH RATES OF MONETARY AGGREGATES (%)

1947 - 1976[1]

	$\hat{M}1$		$\hat{H}$	
Country	Mean	S.D.	Mean	S.D.
Argentina	31.64	28.64	29.28	35.17
Bolivia	26.16	25.02	26.78	24.95
Brazil	29.18	13.27	27.62	15.33
Chile	44.12	37.23	47.03	38.77
Colombia	16.38	5.84	16.75	10.28
Costa Rica	11.05	7.78	11.01	9.49
Ecuador	11.90	11.70	11.19	12.27
El Salvador	8,38	9.00	8.82	8.11
Guatemala	7.81	8.48	8.37	10.01
Honduras	7.84	9.08	8.02	10.30
Mexico	12.36	6.19	12.82	12.33
Nicaragua	10.60	11.06	10.34	9.89
Paraguay	19.72	15.58	21.17	15.21
Peru	15.68	8.80	17.22	11.51
Uruguay	26.07	20.68	27.01	21.50
Venezuela	11.14	10.16	10.34	10.51
United States	3.56	2.58	3.25	3.82

A circumflex, ^ , indicates a percentage rate of change of the variable: M1 ≡ nominal narrow money stock; H ≡ nominal high powered money.

1. Data on money were not available for 1976 for Chile and Uruguay.

TABLE 6

RANK-ORDER CORRELATIONS OF ANNUAL GROWTH RATES[1]

		$\hat{Y}$		$\hat{P}_{GDP}$		$\hat{P}_{CPI}$		$\hat{y}$	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
$\hat{M1}$	Mean	0.97**		0.95**		0.96**		-0.41	
	S.D.	0.65**	0.91**	0.62**	0.83**	0.64**	0.73**	-0.48†	0.39
$\hat{H}$	Mean	0.99**		0.95**		0.99**		-0.41	
	S.D.	0.88**	0.73**	0.88**	0.74**	0.84**	0.67**	-0.55*	-0.01
$\hat{F}$	Mean	0.84**		0.84**		0.83**		-0.51*	
	S.D.	0.63**	0.48†	0.58*	0.51*	0.64**	0.73**	-0.33	0.14
$\hat{DH}$	Mean	0.41		0.46†		0.38		-0.44†	
	S.D.	-0.10	0.50*	-0.11	0.21	-0.14	0.05	-0.32	0.08
V	Mean	-0.28		-0.10		-0.06		-0.25	
	S.D.	0.44†	0.65**	0.44†	0.63**	0.45†	0.61*	-0.57*	0.37

A circumflex, ^ , indicates a percentage rate of change of the variable: Y ≡ nominal GDP; y ≡ real GDP; P_{GDP} ≡ implicit price deflator; P_{CPI} ≡ consumer price index; M1 ≡ nominal narrow money stock; H ≡ nominal high powered money stock; F ≡ foreign reserves; DH ≡ domestic component of high powered money; V ≡ income velocity of money = Y/M1.

† significant at $\alpha = 0.10$; * significant at $\alpha = 0.05$; ** significant at $\alpha = 0.01$.

1. All variables are growth rates except velocity. These correlations are across the 16 Latin American countries only, i.e., they exclude the U.S.

TABLE 7

ANNUAL GROWTH RATE OF THE FOREIGN AND DOMESTIC COMPONENTS OF HIGH POWERED MONEY AND THE RATIO OF THE FOREIGN COMPONENT TO TOTAL HIGH POWERED MONEY (%) 1947-1976[1]

Country	F		DH		Θ = F/H	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Argentina	29.16	78.97	41.56	53.00	18.29	9.85
Bolivia	26.14	75.70	58.90	133.51	37.08	21.15
Brazil	28.82	47.62	40.80	64.56	32.18	20.46
Chile	44.86	77.52	110.42	157.83	50.48	42.67
Colombia	16.11	37.36	39.71	121.82	41.98	17.21
Costa Rica	13.39	41.96	11.72	15.76	30.64	9.98
Ecuador	10.87	28.36	15.24	23.24	55.76	12.65
El Salvador	6.57	19.08	16.00	249.73	67.09	21.66
Guatemala	7.88	21.07	26.71	98.24	65.42	17.31
Honduras	13.78	35.33	42.57	258.52	60.18	25.98
Mexico	9.64	28.67	18.71	26.10	38.70	16.53
Nicaragua	11.54	38.73	17.51	177.72	67.59	28.78
Paraguay	21.03	101.54	43.05	151.87	35.84	35.02
Peru	14.77	31.50	22.14	21.81	38.56	13.04
Uruguay	25.77	33.60	-2792.35	15805.76	109.28	37.15
Venezuela	12.89	28.65	-386.46	1894.63	124.76	50.26
United States	-1.23	5.68	5.16	6.64	32.20	14.05

A circumflex indicates a percentage rate of change of the variable.

F ≡ Official international reserve assets = gold, foreign exchange and special drawing rights.

DH ≡ Residual difference between high powered money and its foreign component, i.e., DH = H - FH.

1. Data on money were not available for 1976 for Chile and Uruguay, and on foreign reserves for 1976 for Mexico.

TABLE 8

RANK CORRELATIONS OF

THE RATIO OF FOREIGN RESERVES TO HIGH POWERED MONEY

WITH THE AVERAGE ANNUAL GROWTH RATE OF SELECTED VARIABLES

Real Sector	$\theta \equiv F/H$	Monetary Sector	θ
$\hat{Y}$	-0.59*	$\hat{M1}$	-0.50*
$\hat{P}_{GDP}$	-0.60*	$\hat{H}$	-0.61*
$\hat{P}_{CPI}$	-0.50*	$\hat{F}$	-0.49†
$\hat{y}$	0.28	$\hat{DH}$	-0.49†
$\hat{G}$	-0.55*		
$\hat{TR}$	-0.55*		
TR/Y[1]	0.51*		

A circumflex, ˆ , indicates a percentage rate of change of the variable: $Y \equiv$ nominal GDP; $y \equiv$ real GDP; $P_{GDP} \equiv$ implicit price deflator; $P_{CPI} \equiv$ consumer price index; $G \equiv$ nominal central government expenditure; $TR \equiv$ sum of nominal current account exports and imports; $M1 \equiv$ nominal narrow money stock; $H \equiv$ nominal high powered money; $F \equiv$ nominal foreign reserves; $DH \equiv$ nominal domestic component of high powered money.

† statistically significant at $\alpha = 0.10$; * statistically significant at $\alpha = 0.05$.

1. This variable and θ are measured in percent and not as a rate of change as are all other variables.

as I noted earlier, real per capita income growth for Latin America was very similar to the U.S. This last point (greater differences between the U.S. and Latin America) holds even more strongly with respect to the standard deviation of the monetary growth rates. The only exception to this rule was the proportion, θ, of the high powered money stock held as foreign reserve assets.

1. Domestic Monetary Aggregates

I have listed in Table 5 the mean and standard deviation of the annual growth rates of the stock of narrow money--currency held by the non-bank public and demand deposits at commercial banks, and high powered money--total currency in circulation and commercial bank reserves, for each country. As alluded to above, the statistics for Latin America were between two and ten times the respective magnitude for the United States. It is therefore not surprising to note, given the quantity theory of money, that the Latin American countries, in general, experienced greater nominal income growth than the U.S. Moreover, when we recall that average real per capita income grew in Latin America at a similar rate to the U.S., it is also not surprising to note that average rates of inflation in Latin America were correspondingly greater than for the U.S. Only three countries had average annual growth rates in these money aggregates of less than 10%: El Salvador, Guatemala, and Honduras.

Indeed, as suggested by the quantity theory, in the long run nominal income growth and nominal money growth should be equivalent, holding velocity constant. I compiled several rank-order correlations of statistics of growth rates in Table 6. These correlations indicate a strong correspondence between average nominal income and money growth across countries--between 0.97 and 0.99, as well as a strong correspondence between average inflation and average nominal money growth --between 0.95 and 0.99. Furthermore, no significant correlation exists between average nominal money growth and real income growth rates across these countries as implied by the classical (money) neutrality proposition (see Lucas, 1972); these correlations were approximately -0.41, insignificant at the 10% level.

Another interesting aspect of the data refers to a corollary to the neutrality proposition as expressed by Barro (1968, 1977).[8] Under a rational-expectations model of expected price formation, the effect of deliberate and fully anticipated monetary policy on real output and employment is negligible. Therefore, as Barro reasons, it is only the unanticipated component of nominal money supply growth that affects real variables. I used a simple method of judging whether the variety of experience in Latin America was consistent with this idea. I let the standard deviation of nominal income growth represent a demand shift, a la Lucas. Furthermore, I let the standard deviation of money stock growth proxy as fluctuations about its trend, i.e., a measure of unanticipated money growth. I then rank-correlated these measures across Latin America.

The correlations for unanticipated narrow money and base money growth and the proxy for demand shifts are 0.91 and 0.73, respectively --both significant at the one percent level (see Table 6). This result conforms with Barro's hypothesis (and his results for the U.S.

--see Barro, 1977, p. 555), that unanticipated money growth has a strong expansionary effect. I also rank-correlated the average growth rate of nominal income with the standard deviation of money growth across countries. These correlations are 0.65 and 0.88 for narrow and base money, respectively--also highly significant.

In terms of the rate of inflation, I noted earlier that nominal money growth was very strongly and positively related to inflation. As Barro points out, this represents both anticipated and unanticipated influences. By rank-correlating the standard deviation of money growth with average rates of inflation, the partial effect of the unanticipated portion can be obtained. For narrow money, the correlations are 0.62 and 0.64 for the GDP price deflator and the consumer price measures of inflation, respectively. For base money, the correlations are 0.88 and 0.84 (see Table 6).

These correlations are not consistent with Barro's results in that his analysis implies that unanticipated money growth should have a negative effect on the price level, i.e., lowering the rate of inflation as compared to what it would be if money growth were fully anticipated, possibly causing deflation. However, Lucas' model suggests that greater variability in demand can also affect the rate of inflation and greater variability in real output relative to trend can negatively affect inflation. It then becomes an empirical question as to which is larger. Since unanticipated money growth is strongly related to fluctuations in demand but not to fluctuations in real output growth relative to trend for Latin American countries (see Table 6), the positive effect of unanticipated money growth on inflation could be rationalized (ad hoc) as an effect through aggregate nominal demand. Indeed, fluctuations in real output growth relative to trend exhibit an (insignificant) negative correlation with measures of average inflation (see Table 2).

Overall, there seems to be a significant relationship between monetary growth and inflation, nominal income growth, and fluctuations in nominal income growth about trend across the range of economic experience exhibited in Latin America. No inferences in terms of causality should be drawn since these statistics merely represent coincident movements with no statements made about linearity of the relationship or origin of influence.[9]

2. The Components of High Powered Money

I define the foreign component, F, of high powered money as the sum of (gross) official international reserve assets[10]: gold, foreign exchange and special drawing rights. The domestic component, DH, is simply the residual difference between high powered money and its foreign component. An increase in the foreign component represents an inflow on international accounts, hence a balance of payments surplus. Moreover, it indicates a potential source through which an economy can be influenced by rest-of-the-world economic and political factors.

The domestic component of high powered money, on the other hand, represents the assets of the central bank of a country which are of a purely domestic (and public) nature. Specifically, DH indicates the level of obligations of the central government to the central bank. In this respect, the domestic component demonstrates the source through which domestic monetary policy can influence an economy.

I compiled the mean and standard deviation of the annual growth rates of both components of high powered money in Table 7. I also included there statistics on the proportion, θ, of high powered money of a foreign origin. This ratio can be thought of as a policy parameter because θ represents the degree to which a nation has assets useable in international transactions relative to assets it has available for all transactions. Barring easily available international credit, e.g., unlimited low-cost loans from the International Monetary Fund, a low value of θ implies a limited amount of "world" money. Thus, in the event of needing a larger amount of ("world") cash than is available, substantial transactions costs might be incurred in shifting the central bank portfolio to a higher concentration of foreign reserves in its high powered money than it has at that moment, in a fixed exchange rate system.

As alluded to earlier, the average growth rates of the foreign and domestic oomponents of high powered money were generally larger, more variable and more frequently statistically different from U.S. aggregates than were the overall monetary aggregates and the real variables. In only three cases was foreign reserve growth less than ten percent: El Salvador, Guatemala and Honduras. Except for Uruguay and Venezuela, the central banks of Latin America expanded domestic credit at rates in excess of 10% per annum. Also, for only six countries was the mean proportion of high powered money held as foreign reserves similar to the U.S.: Bolivia, Brazil, Costa Rica, Mexico, Paraguay and Peru.

The relationship between growth in the foreign and domestic components and other variables is of some interest, particularly in monetary models of the balance of payments. I computed rank-correlations across countries for the components of high powered money and other variables. In general, the correlations involving the growth in the foreign component were significant, whereas the correlations were insignificant for the domestic component (see Table 6).

Counter to the Barro model predictions, unanticipated money growth in the form of the standard deviation of foreign reserve growth was positively correlated with average inflation--the rank-correlations were 0.58 and 0.64 for the GDP price deflator and the CPI, respectively. However, the domestic component was (insignificantly) negatively rank-correlated with inflation--the rank correlation of the standard deviation of the growth in DH and average inflation was -0.11 for the GDP deflator and -0.14 for the CPI. It is tempting to rationalize these results, again in an ad hoc fashion. I refrain from doing that here, only restating that these correlations represent partial effects with no assurance that the <u>ceteris paribus</u> condition holds.[11]

One interesting statistic is the significant negative correlation between average real income growth and average foreign reserve growth. As implied by the monetary approach to the balance of payments,[12] as the real growth in income of a small country rises, *ceteris paribus*, it should experience a deficit balance of payments. The rank-correlation across Latin America between average real income growth and average foreign reserve growth was -0.51, significant at the 5% level.

With respect to the parameter, θ, the ratio of foreign reserves to high powered money, for the Latin American countries, a higher average ratio was associated with lower growth of monetary aggregates, lower growth in the components of high powered money, lower growth in nominal income, and lower average inflation (see Table 8). In addition, a higher θ was associated with a higher ratio of nominal trade expenditure relative to nominal income. Again, no conclusions regarding causality can be validly drawn from these simple correlations.

3. Other Parameters

I compiled statistics on two additional parameters for the Latin American countries. The means and standard deviations of the income velocity of money and the money multiplier are listed in Table 9.

As indicated in the table, velocity--the ratio of nominal income to the nominal narrow-money stock, was not extremely variable relative to other characteristics of these countries. However, except for Argentines and Brazilians, Latin American residents generally "turned over" their currency one-and-a-half to three times more rapidly, on

TABLE 9

INCOME VELOCITY AND THE MONEY MULTIPLIER

1947 - 1976[1]

Country	V ≡ Y/M1 Mean	V ≡ Y/M1 S.D.	M1/H Mean	M1/H S.D.
Argentina	4.52	1.50	1.21	0.43
Bolivia	10.87	5.10	1.12	0.09
Brazil	4.80	0.88	1.77	0.20
Chile	9.10	2.11	1.65	0.55
Colombia	6.57	0.60	1.77	0.23
Costa Rica	6.13	0.62	1.67	0.12
Ecuador	7.41	1.27	1.31	0.08
El Salvador	7.11	0.77	1.22	0.16
Guatemala	9.72	0.97	1.13	0.06
Honduras	9.32	1.30	1.42	0.10
Mexico	8.02	0.51	1.49	0.26
Nicaragua	8.69	1.38	1.53	0.11
Paraguay	10.41	1.77	1.08	0.19
Peru	7.02	1.47	1.33	0.17
Uruguay	6.42	1.29	1.11	0.07
Venezuela	7.45	0.81	1.55	0.15
United States	3.51	0.92	2.73	0.18

A circumflex, ^ , indicates a percentage rate of change of the variable: Y ≡ nominal GDP; M1 ≡ nominal narrow money stock; H ≡ nominal high powered money; V ≡ income velocity of money.

1. Data on income were not available for all years, see Appendix A. for data availability.

average, than residents of the U.S. In other words, Latin Americans held less, one-third to two-thirds less, of their nominal income in the form of cash.

The money multiplier--the ratio of narrow money to base money --was also not extremely volatile over the period. While the mean multipliers were lower for Latin American countries than for the U.S. there was no statistical difference. The magnification to narrow money of impulses to base money was between 1.5 and 2.5 times greater in the U.S. than the impact effect for Latin America.

I also computed rank-correlations between velocity and some "real" variables, listed in Table 6. These statistics indicate that the greater the unpredictability of prices, as measured by the standard deviation of the rate of inflation, the greater were fluctuations in velocity about its trend, as measured by the standard deviation of velocity. The correlations were 0.63 and 0.61 for the GDP price deflator and CPI, respectively. Moreover, countries with greater fluctuations in demand relative to trend, as measured by the standard deviation in nominal income growth, had greater fluctuations in velocity relative to trend--a rank-correlation of 0.65, significant at the one percent level.

C. Exchange Rate Regimes

Throughout the discussion no mention was made as to the exchange rate policy of the Latin American countries analyzed here. I now turn to this issue. Its importance for other policy issues is conveyed, almost by definition, in the ability, or lack thereof, of a small country to operate an independent monetary policy.

Two extreme forms of exchange rate regime can be identified. A fixed exchange rate system is one in which the monetary authorities of a small (non-reserve currency) country agree to purchase or sell at a fixed price the quantity of "world" money required to settle the balance of payments accounts. For example, if greater demand for the small country's goods exists than that country demands from abroad, then the authorities must purchase the "world" money used by foreigners to pay for the exported goods of the small country.

The fixed price can be changed, but the essential attribute of the system remains. If the demand for the goods of a small country on such a system increases, relative to the country's imports, say because of greater growth in rest-of-the-world money relative to demand, then the foreign reserves of the small country will increase. Assuming no sterilization, the high powered money of the small country will increase. Hence, even if the monetary authorities of the small country are not applying an easy monetary policy, their money supply will increase.

At the opposite extreme is a completely flexible exchange rate system. Such a system allows the reserve currency (e.g., the U.S. dollar) price of a small country's currency to be completely market determined. For example, if greater demand for the currency of a small country exists relative to its supply, then the price of that currency will rise--the currency will appreciate.

Thus in terms of adjustments to balance of payments, under a flexible exchange rate regime, disequilibria will be resolved by the adjustment of price rather than quantity of small country currency. That is, since the demand for the goods of a country, generated abroad, can be translated into the supply of "world" money[13] to the small country, an excess demand for the goods of a country can be represented as an inflow of "world" money--foreign reserves. The fixed exchange rate regime resolves this disequilibrium by intervening in the market for, in this case purchasing at a fixed price, the currency of the world. The flexible exchange rate system resolves the disequilibrium by adjusting the price at which currencies are exchanged, via the "invisible hand."

Over the period 1947-1976, only three Latin American currencies were fixed in terms of the U.S. dollar: El Salvador's colon, Guatemala's quetzal, and Honduras' lempira. No country in this sample operated under a freely floating exchange rate regime. In fact, nearly all countries operated essentially a fixed exchange regime but adjusted the fixed exchange price periodically. Brazil and Chile are two notable exceptions. Brazil adopted a regime sometimes referred to as a crawling peg (see Heller, 1978). Chile devalued its currency frequently and changed its currency unit twice in the period under study.

I have grouped the countries into three categories: a fixed exchange regime, an intermittently-adjusted fixed exchange rate regime, and a step-up fixed exchange rate regime. In the first category, I have, of course, placed the three Central American countries mentioned above. In the second category I have placed seven countries: Costa Rica, Ecuador, Mexico, Nicaragua, Paraguay, Peru and Venezuela. In the last category I have placed the remaining six countries: Argentina, Bolivia, Brazil, Chile, Colombia and Uruguay.

I have calculated simple average growth rates for each group for three variables: real per capita income, the GDP implicit price deflator, and the narrow money stock. These average growth rates are listed in Table 10. Realizing that as we move from Group I to Group III the exchange rate system goes from a fixed system to a system which is closest to a freely floating system, several points are noticed.

In terms of real per capita income growth, those countries in the second category, intermittent exchange rate adjustments, had the highest real growth. The countries which frequently adjusted their exchange rate had the lowest real growth. These differences are not great. Furthermore, I do not attribute the differences to the exchange rate regime.

The differences across groups in terms of average rates of narrow money growth and average rates of inflation are great. As we move from the first group to the last, both the average rate of monetary expansion and the average rate of inflation increase in obvious steps. Moreover, the steps in inflation seem to correspond to the steps in money growth.

That I have grouped these countries in this way allows us to see the effects of the exchange rate regime vis-a-vis other policy goals. Specifically, the statistics in Table 10 indicate that those

TABLE 10

AVERAGE ANNUAL GROWTH RATES OF SELECTED

VARIABLES BY EXCHANGE RATE REGIME

REGIME	$\hat{y/N}$	$\hat{M1}$	$\hat{P}_{GDP}$
GROUP I: CONSTANT	1.94	8.01	2.95
El Salvador, Guatemala, Honduras			
GROUP II: INTERMITTENT CHANGES	2.44	13.21	7.09
Costa Rica, Ecuador, Mexico, Nicaragua, Paraguay, Peru, Venezuela			
GROUP III: FREQUENT CHANGES	1.90	28.93	26.96
Argentina, Bolivia, Brazil, Chile, Colombia, Uruguay			

A circumflex, ˆ , indicates a percentage rate of change of the variable: $y \equiv$ real GDP; $N \equiv$ population; $M1 \equiv$ nominal narrow money stock; $P_{GDP} \equiv$ implicit price deflator.

countries which adjust their currency price of a reserve currency, such as the U.S. dollar, generally experience greater inflation. This should not be construed as evidence of instability of floating regimes. Rather the results suggest that by adjusting the domestic currency price of a reserve currency, whether intermittently, frequently or freely, a country can operate a monetary policy which is less susceptible to outside influences and more responsive to the policy goals of that nation. Thus, the countries in Group III have experienced monetary expansion but also because they have decided that greater monetary expansion was a relevant policy aim.

FOOTNOTES TO CHAPTER II

1. See Appendix A for a discussion of the sources of the data, the definition of variables, a description of problems in constructing a number of series and solutions undertaken to resolve these problems. All variables are measured in domestic currency units, except where noted otherwise.

2. While the U.S. is vastly different in many ways from all these nations, e.g., standard of living, comparisons are drawn in general terms. That is, no attempt is made here to suggest that the U.S. should be considered the model to which these nations should gear their policy goals. Rather the comparisons are made to point up these differences so that treating the U.S. as the rest of the world will be a useful way of framing these countries as "small" countries in the terminology of international trade theory.

3. This is judged by dividing the difference in growth rates by the square root of the sum of the variance of each rate divided by the number of observations, assuming the growth rates are independent. This statistic has a Student-t distribution.

4. See Swoboda (1977), p. 23. This will be tested later in the discussion of the relationship between the domestic and world rates of inflation.

5. It is not my intention to test Lucas' model. However, these implications should be drawn explicitly. Moreover, the test results reported by Lucas for the five Latin American countries he studied are consistent with my conclusions. Specifically, Lucas' results indicate unfavorable tradeoffs for Argentina and Paraguay. As Table 1 indicates these two countries have significantly different means and standard deviations in nominal income growth and inflation rates than the U.S. Favorable tradeoffs exist for Guatemala, Honduras and Venezuela--countries which have means and standard deviations of these growth rates similar to the U.S.

6. The correlation between the variance of nominal income growth and the rate of change of the GDP price deflator might be expected to be large if real income is constant. That is, if nominal income is $Y = Py$, where p is the GDP price deflator and y is real GDP, then $\hat{Y} = \hat{P} + \hat{y}$ where a circumflex indicates a percentage rate of change. Thus,

$$VAR(\hat{Y}) = VAR(\hat{P}) + VAR\ (\hat{y}) + 2\ COV(\hat{P},\hat{y}).$$

If $VAR(\hat{y}) = 0 = COV(\hat{P},\hat{y})$ then a nearly perfect positive correlation between $VAR(\hat{Y})$ and $VAR(\hat{P})$ should exist. However, neither $VAR(\hat{y})$ nor $COV(\hat{P},\hat{y})$ is zero. Therefore, the correlation between $VAR(\hat{Y})$ and $VAR(\hat{P})$ will only be significant and close to one if $VAR(\hat{y})$ is unimportant.

7. Lucas (1973) estimates the following relationship:

$$\hat{P}_t = a_0 + a_1 \hat{x}_t + a_2 \hat{x}_{t-1} + a_3 \hat{y}_{ct-1}, \qquad (i)$$

where a circumflex indicates a percentage change, x is nominal income. Taking expected values and subtracting from (i), I obtain

$$\hat{P}^d_t = a_1 \hat{x}^d_t + a_2 \hat{x}^d_{t-1} + a_3 \hat{y}_{ct-1}, \qquad (ii)$$

where a "d" superscript indicates deviations from the respective mean. I then square (ii) and take expected values to obtain:

$$\begin{aligned} Var(\hat{P}_t) = (a_1^2 + a_2^2)\ VAR(\hat{x}_5) &+ a_3^2\ VAR(\hat{y}_{ct-1}) \\ &+ a_3(a_1 + a_2)\ COV(\hat{x}_t, \hat{y}_{ct-1}) \\ &+ a_1 a_2\ COV(\hat{x}_t, \hat{x}_{t-1}) \qquad (iii) \end{aligned}$$

assuming $VAR(\hat{x}_t) = VAR(\hat{x}_{t-1})$. Note that

$$\frac{\partial Var(\hat{P}_t)}{\partial Var(\hat{x}_t)} = a_1^2 + a_2^2 > 0.$$

Thus the effect of an increase in demand variance on inflation variance is positive, holding other things constant. Empirically, from Lucas' estimates (p. 332) for the U.S., $a_1^2 + a_2^2 = 0.589$ and for Argentine $a_1^2 + a_2^2 = 1.306$.

8. As with the Lucas model, I also make no attempt at specifying and rigorously testing Barro's model. The simple tests applied here are merely expressing some familiarity with the recent literature on the important questions of economic policy. The models of Barro and Lucas (as well as Sargent and Wallace, 1975) can well stand on their own, but they are useful for policy implications as even the simplistic correlations suggest.

9. Pierce (1976) discusses the notion that correlation can imply causality in the case of linear relationships but reminds us that even in the linear case the direction is unknown a priori.

10. For a discussion of problems that can arise in using this definition, see Appendix A.

11. For example, the monetary approach to balance of payments theory suggests that if a small country expands its domestic money

supply at a rate faster than the demand for its money is growing, then domestic dishoarding will take place, i.e., a balance of payments deficit will occur. From Table 5 we see that many countries in Latin America have expanded their money supplies rapidly, yet they have also experienced inflows of foreign reserves--a balance of payments surplus. In using these simple correlations we have not held the demand for the currencies of these countries to growing at a fixed rate. Moreover the demand for the Latin American currencies also comes from the rest of the world through the demand for the produce of Latin America.

12. See, for example, Swoboda (1977).

13. See, for example, Stern (1972).

CHAPTER III

EMPIRICAL ESTIMATES OF THE SIMPLE MONETARY MODEL OF THE BALANCE OF PAYMENTS

In this chapter, I focus on attempts to empirically implement tests of a simple monetary model of the balance of payments. I do not critically review the empirical literature; Magee (1976) has adequately done so.[1] Rather, I derive the typical specification of the simple model, copy (for the purpose of comparison) some results of other researchers and present the estimates of the model for Latin America. In passing, I mention several econometric points regarding the application of the tests.[2]

The monetary approach to the balance of payments emphasizes the essential role of money in the process of resolving divergences between (gross national) income and (domestic) expenditure, which a balance of payments disequilibrium represents. That is, an excess of expenditure--on all goods including capital goods--over income within a country implies an excess demand for goods. Within the context of that nation's economy, this further implies, via Walras' Law, an excess (flow) supply of money.[3] In the context of the world economy, this is met by an offsetting excess (flow) demand for the currency of the deficit country (equivalent to the supply of goods forthcoming) to satisfy the original divergence of expenditure from income.

The model, in its most highly distilled form, suggests that an economy which is small, in terms of world trade, but open to trade, cannot operate an independent monetary policy and maintain a fixed exchange rate of its currency with that of other nations. This, of course, implies--given the strong evidence[4] available regarding the relationship between money supply growth and inflation--that the rate of inflation is an exogenous variable--for a small open economy--determined by world money growth.

A. A Simple Model of the Monetary Approach

A simple (and frequently used[5]) model of the monetary approach to the balance of payments can be derived as follows. Suppose real cash balances demanded are a function of real income and a nominal interest rate; the nominal money supply is proportional to the monetary base. The latter being, for my purposes, decomposed[6] into the foreign and domestic assets of the monetary authorities (or, for simplicity, the central bank).

That is,

$$\frac{M^d}{P} = L(y,i) \qquad (1)$$

$$M^s = h \cdot H \qquad (2)$$

$$H = F + DH \qquad (3)$$

where y is real income, i is a nominal interest rate, h is the money multiplier, and F and DH are the foreign (international reserves) and domestic components, respectively, of the monetary base, H. A serious flaw in specification (1) is the lack of a term for population, i.e., the demand for real cash balances is generally specified in per capita terms.

Assuming (continuous) stock equilibrium:

$$M^d = M^s$$

or

$$P\ L(y,i) = h \cdot (F + DH).$$

Taking logarithmic derivatives I obtain, as a flow equilibrium, the following:

$$d \log P + d \log L = d \log h + d \log (F + DH).$$

Letting a ^ denote percentage changes, I have:

$$\hat{P} + \hat{L} = \hat{h} + \frac{F}{H} \quad \hat{F} + \frac{DH}{H} \quad \widehat{DH}$$

Solving for the (official settlements) balance of payments, I obtain[7]:

$$\theta \cdot \hat{F} = \hat{P} + \frac{L_y}{L} \cdot dy + \frac{L_i}{L} \cdot di - \hat{h} - (1 - \theta) \cdot \widehat{DH}, \qquad (4)$$

where $\theta = F/H$, $\theta > 0$, "d" is the differential operator, and the subscript indicates a partial derivative of the liquidity preference function with respect to the variable in the subscript.

The model expressed in equation (4) relates the balance of payments position of a small open economy, under a fixed exchange rate regime, to domestic variables. Implicitly, the influence of the rest of the world is incorporated in the domestic rate of inflation, $\hat{P}$, which is determined by rest-of-the-world money supply and real income growth.[8]

Factors which affect changes in the domestic demand for real cash balances (and therefore foreign reserve flows) but which do not affect the rest of the world are also incorporated in equation (4). For example, holding constant rest-of-the-world real income and money growth (impounded by holding $\hat{P}$ constant), if a small country's rate of real income growth increases its growth in the demand for real cash balances will increase inducing an inflow of reserves. Thus, the coefficient on the change in real income, dy, should reflect the real income elasticity of demand for real cash balances.

B. An Empirical Comparison

Putting aside a rigorous treatment of specific criticisms of previous empirical work in this area, I present results of work done by other researchers and a comparative analysis of similar estimation for Latin American nations. Recall that the simple model expresses a behavioral relationship for real cash balances demanded, an institutional relationship for the money supply process (proportionality of the money supply and the monetary base), a definition of the monetary base, and an equilibrium condition equating the nominal stocks of money demanded and supplied. From this model I obtain an equation to be estimated of the form:

$$\theta\hat{F} = \beta_1 \hat{P} + \beta_2 dy + \beta_3 di + \beta_4 \hat{h} + \beta_5(1-\theta)\hat{D}\hat{H} + u \qquad (4')$$

Estimates of the β coefficients have been obtained using the ordinary least squares method.[9]

I estimated an ordinary least squares regression of a form given below, similar to equation (4'), using annual data for sixteen Latin American countries. The data sources are given in Appendix A. Actually, I performed two regressions for each country: the first uses as the dependent variable a measure of the official settlements balance of payments scaled by the level of high powered money. The first estimated equation is[10]:

$$\theta\hat{F} = \beta_0' + \beta_1' \hat{P} + \beta_2' \hat{y} + \beta_3' \hat{h} + \beta_4'(1-\theta)\cdot\hat{DH} + v \qquad (5)$$

where $\hat{P}$ is the rate of growth[11] of the Consumer Price Index with 1970 = 1.00; $\hat{y}$ is the growth in real gross domestic product in 1970 prices; $\hat{h}$ is the growth in the money multiplier; $\hat{DH}$ is the growth in domestic credit; θ is the ratio of foreign reserves to high powered money, F/H; and

$$\begin{aligned}\theta_t\hat{F}_t &= (F_t/H_t)\cdot(\log F_t - \log F_{t-1}) \\ &= (F_t/H_t)\cdot(F_t - F_{t-1})/F_t \\ &= (F_t - F_{t-1})/H_t \\ &= B_t/H_t\end{aligned}$$

where B_t is the official settlements balance of payments in time period t.

In the second specification I use, as the dependent variable, the same measure of the official settlements balance--the first difference in foreign reserves—however scaling it by the level of foreign reserves; hence the dependent variable is the growth in foreign reserves:

$$\hat{F} = \beta_0'' + \beta_1'' \hat{P} + \beta_2'' \hat{y} + \beta_3'' \hat{h} + \beta_4''((1-\theta)/\theta)\cdot\hat{DH} + w \qquad (6)$$

where the explanatory variables are the same as those in specification (5) and the error terms, v and w, are assumed to be normally distributed serially uncorrelated random variates with zero mean and constant variance.

The coefficient on the rate of inflation, β_1', is expected to obtain the value of unity. This reflects the linearly homogenous nature of the demand for nominal cash balances with respect to the price level (nominal income and population). As the price level rises nominal cash holdings must rise to maintain the level of real cash holdings. The greater is the increase in the price level (the greater is the rate of inflation), the greater is the required increase in nominal cash balances. If the money supply is outside the control of the monetary authorities, as is assumed in the simple monetary model, then the adjustments of nominal money demand to a higher price level will be through the adjustment of foreign reserve holdings. The coefficient β_1' represents the effect of an increase in the price level on the nominal stock of foreign reserves, i.e., the official settlements balance of payments.

The coefficient on the rate of growth of real income, β_2', has an expected positive sign. If the variable were real <u>per capita</u> income growth and we were reasonably certain that velocity were constant or that the country under analysis were highly developed and its population level did not change, then we would expect β_2' to be equal to +1 inasmuch as the coefficient would be the per capita income elasticity of the demand for real cash balances per capita. However, as alluded to earlier, the typical specification used by other researchers has been one which does not incorporate the notion that the demand for real cash balances is not an aggregate relationship, rather it is one which is appropriately defined in per capita terms.

The coefficient on the rate of change of the money multiplier, β_3', is expected to obtain the value of minus unity. This reflects the relationship of the components of high powered money to the money multiplier when the nominal money stock is determined in the rest of the world. When the money supply is fixed, changes in the money multiplier are distributed over the components of the high powered money stock in proportion to the shares of those components in the total money base. The share for the foreign component of the base, F, is θ. Hence, the share of the domestic component of the base DH, is $(1 - \theta)$. Therefore, when $\theta \hat{F}$ is the dependent variable, the rate of change of the money multiplier, $\hat{h}$, will have a coefficient of minus unity. However, when $\hat{F}$ is the dependent variable [specification (6)], the appropriate independent variable, corresponding to the money multiplier, should be $\hat{h}/\theta$ in order for the coefficient to be minus one. Hence, I do not expect β_3'', the coefficient on the rate of change of the money multiplier when $\hat{F}$ is the dependent variable, to be -1.

The coefficients on the rate of change of the domestic credit component of high powered money, $(1 - \theta)\hat{DH}$ and $((1 - \theta)/\theta)\hat{DH}$, are expected to obtain the value of minus unity. This also reflects the money supply relationship, with money supply constant and the money multiplier held fixed. The problem faced with respect to the proper specification of the variable when $\hat{F}$ is the dependent variable [specification (6)] is avoided in that the growth in domestic credit times its share in high powered money is divided by the foreign reserve share, θ . I present results from estimating (5) and (6) in Tables 11 and 12, repectively.

I note several general similarities. First, with a few exceptions, an analysis of the residuals failed to indicate the presence of serial correlation. Those countries for which there was an indication of such correlation in the residuals, have had the variables transformed by an estimate of the first-order autocorrelation coefficient and the results I present are for the transformed variables. The general lack of first order serial correlation is to be expected since the variables in the regressions are essentially first differences. But the fact that some of the regressions do show some sign of autocorrelation in the residuals indicates the possibility of a higher order correlation which the Durbin-Watson statistic is not useful for indicating.

A second similarity across countries, which I note, is that nearly all the regressions, and both specifications, are significant. While this in itself is not surprising, we should also note that the coefficient for the scaled domestic credit growth is almost always

TABLE 11

ESTIMATION OF THE SIMPLE MODEL FOR LATIN AMERICA[1]

DEPENDENT VARIABLE: $\theta \cdot \hat{F}$

Time Period	Country (1)	Constant (2)	$\hat{P}_{CPI}$ (3)	$\hat{y}$ (4)	$\hat{h}$ (5)	$(1-\theta)\hat{D}H$ (6)	$\bar{R}^2$ (7)	DW (8)
1947-75	Argentina	-0.014 (0.050)	0.499* (0.174)	0.346 (0.499)	-0.260 (0.217)	-0.213* (0.095)	0.152	2.19
1951-75	Bolivia	0.081 (0.076)	0.518* (0.190)	0.127 (0.795)	1.641 (0.977)	-0.187 (0.098)	0.293†	1.73
1947-76	Brazil	0.187 (0.096)	0.320 (0.293)	-0.358 (0.552)	-0.174 (0.483)	-0.415* (0.126)	0.252†	c
1947-75	Chile	0.010 (0.105)	0.463* (0.170)	1.098 (1.193)	-0.745 (0.377)	-0.155* (0.064)	0.195†	c
1947-75	Colombia	0.048 (0.077)	0.508 (0.368)	-0.140 (1.090)	-0.866 (0.513)	-0.127* (0.040)	0.234†	2.12
1951-76	Costa Rica	0.051 (0.039)	0.404 (0.208)	0.928* (0.439)	-0.641 (0.385)	-0.712* (0.151)	0.561†	2.04
1951-76	Ecuador	0.015 (0.039)	0.845* (0.411)	1.819* (0.528)	-1.150 (0.819)	-0.892* (0.176)	0.608†	2.49
1947-76	El Salvador	0.018 (0.030)	0.332 (0.320)	0.316 (0.323)	0.272 (0.458)	-0.059 (0.111)	-0.010	c
1947-75	Guatemala	0.102* (0.030)	1.141* (0.426)	-0.906* (0.385)	-0.614 (0.592)	-0.448* (0.089)	0.454†	2.03

(continued)

TABLE 11 (continued)

Time Period	Country (1)	Constant (2)	$\hat{P}_{CPI}$ (3)	$\hat{y}$ (4)	$\hat{h}$ (5)	$(1-\theta)\hat{D}H$ (6)	$\bar{R}^2$ (7)	DW (8)
1947-76	Honduras	0.210* (0.087)	1.746 (1.156)	-2.369 (1.367)	-1.938* (0.836)	-0.396* (0.116)	0.384†	2.08
1947-75	Mexico	0.071 (0.038)	1.181* (0.289)	0.838* (0.429)	-2.250* (0.398)	-1.071* (0.138)	0.711†	c
1947-76	Nicaragua	0.066 (0.055)	-0.083 (0.535)	1.454* (0.542)	1.050 (0.655)	-0.206* (0.091)	0.311†	2.19
1947-76	Paraguay	0.296 (0.423)	1.154 (1.409)	-7.361 (6.177)	-5.541 (6.085)	-0.022 (0.234)	-0.034	2.37
1946-76	Peru	0.090 (0.060)	0.511 (0.303)	0.052 (0.561)	-0.039 (0.268)	-0.534* (0.167)	0.278†	2.09
1956-75	Uruguay	-0.006 (0.141)	0.820* (0.306)	-4.105 (2.381)	-1.871 (1.241)	0.002* (0.0005)	0.582†	2.02
1947-75	Venezuela	-0.101 (0.177)	1.959 (2.287)	2.800 (2.089)	3.259 (1.899)	0.061* (0.020)	0.228†	c

1. Standard error in parenthesis.
A circumflex, ^, indicates a percentage rate of change for the variable: F ≡ foreign reserves; P_{CPI} ≡ consumer price index; y ≡ real GDP; h ≡ the money multiplier; DH ≡ the domestic component of high powered money; θ ≡ the ratio of F to high powered money.

* coefficient statistically different than zero; † regression statistically significant.

c regression corrected for autocorrelation.

TABLE 12

ESTIMATION OF THE SIMPLE MODEL FOR LATIN AMERICA[1]

DEPENDENT VARIABLE: $\hat{F}$

Time Period	Country (1)	Constant (2)	$\hat{P}_{CPI}$ (3)	$\hat{y}$ (4)	$\hat{h}$ (5)	$\frac{(1-\theta)}{\theta}\hat{DH}$ (6)	$\bar{R}^2$ (7)	DW (8)
1947-75	Argentina	-0.320	2.757*	2.928	-1.410	-0.095*	0.362†	2.02
		(0.203)	(0.661)	(1.959)	(0.814)	(0.040)		
1951-75	Bolivia	0.111	1.868*	-1.147	5.470	-0.052*	0.411†	2.25
		(0.227)	(0.563)	(2.411)	(2.940)	(0.116)		
1947-76	Brazil	0.209	1.765*	-1.416	-0.867	-0.135*	0.281†	c
		(0.218)	(0.682)	(1.290)	(1.077)	(0.043)		
1947-75	Chile	-0.138	1.314*	0.730	-1.718*	-0.028	0.535†	1.86
		(0.178)	(0.268)	(2.139)	(0.662)	(0.014)		
1947-75	Colombia	0.068	1.261	0.390	-2.461*	-0.128*	0.299†	2.37
		(0.164)	(0.787)	(2.315)	(1.085)	(0.040)		
1951-76	Costa Rica	0.133	1.516	2.482	-1.943	-0.571*	0.549†	1.94
		(0.138)	(1.007)	(1.576)	(1.428)	(0.122)		
1951-76	Ecuador	0.051	1.315	2.412*	-2.683	-0.592*	0.490†	2.22
		(0.076)	(0.804)	(1.032)	(0.600)	(0.136)		
1947-76	El Salvador	0.072	0.587	0.439	0.094	-0.314*	0.203†	c
		(0.054)	(0.545)	(0.517)	(0.771)	(0.108)		
1947-75	Guatemala	0.153*	1.456*	-1.210*	-1.258	-0.467*	0.480†	2.03
		(0.045)	(0.620)	(0.550)	(0.856)	(0.089)		

(continued)

TABLE 12 (continued)

Time Period	Country	Constant (2)	$\hat{P}_{CPI}$ (3)	$\hat{y}$ (4)	$\hat{h}$ (5)	$\frac{(1-\theta)}{\theta}\hat{DH}$ (6)	$\bar{R}^2$ (7)	DW (8)
1947-76	Honduras	0.293* (0.090)	1.879 (1.283)	-2.541 (1.392)	-2.327* (0.922)	-0.438* (0.069)	0.622†	2.28
1947-75	Mexico	0.111 (0.115)	1.792 (1.111)	1.726 (1.328)	-2.705* (1.149)	-0.220* (0.086)	0.165	c
1947-76	Nicaragua	0.106 (0.069)	-0.140 (0.636)	2.043 (0.643)	0.532 (0.776)	-0.307* (0.056)	0.641†	2.53
1947-76	Paraguay	0.345 (0.286)	0.539 (0.941)	-4.025 (4.052)	-3.680 (4.091)	-0.022* (0.008)	0.116	2.35
1947-76	Peru	0.180 (0.134)	1.350 (0.730)	0.113 (1.322)	-0.550 (0.566)	-0.376* (0.080)	0.399†	1.83
1956-75	Uruguay	-0.010 (0.122)	0.902* (0.264)	-4.019* (2.045)	-2.027 (1.071)	0.002* (0.0007)	0.513†	1.92
1947-75	Venezuela	-0.049 (0.094)	0.836 (1.210)	1.896 (1.057)	1.008 (0.968)	0.031* (0.013)	0.161	c

1. Standard error in parenthesis.

A circumflex, ^, indicates a percentage rate of change for the variable: F ≡ foreign reserves; P_{CPI} ≡ consumer price index; y ≡ real GDP; h ≡ money multiplier; DH ≡ domestic component of high powered money; θ ≡ ratio of F to high powered money.

* coefficient statistically different than zero; † regression statistically significant. c regression corrected for autocorrelation.

statistically different from zero for all countries and both specifications, but no such regularity exists for the other variables either across countries or between specifications. The one notable exception to this is Guatemala. However, in only seven cases, for both specifications, are the corrected R^2's greater than 0.5: Chile, Costa Rica, Ecuador, Honduras, Mexico, Nicaragua and Uruguay.

An even more startling similarity is that when I test the coefficients of these regressions against their theoretical values, the imprecision of the estimation becomes apparent in that the range of acceptance is relatively large. For example, the coefficient, β_1', is expected to obtain a value of +1. A t-test is used to judge whether the estimated coefficient, $\tilde{\beta}_1'$, is significantly different from the hypothesized value, β_1°. The interesting similarity is that, of the coefficients which are statistically different from zero, most are also statistically different from the theoretical value. Indeed, for only two countries, Ecuador and Mexico, is the estimated coefficient of the domestic credit expansion variable, β_4', not significantly different from the hypothesized value, and this occurs for specification (5) only. In other words, in nearly all cases the coefficient for domestic credit expansion is statistically different from zero and minus unity. I present similar hypotheses tests in Table 13. This table shows the t-ratio as calculated for those coefficients from Tables 11 and 12 which are statistically different from zero. Those coefficients which I consider being consistent with my expectations are denoted by an asterisk in either Table 11 or 12.

TABLE 13

T-RATIOS FOR HYPOTHESIS ON COEFFICIENTS FOR LATIN AMERICA

	From Table 11			From Table 12	
	$\hat{P}_{CPI}$	$\hat{y}$	$\hat{h}$	$(1-\theta)\cdot\hat{D}H$	$[(1-\theta)/\theta]\cdot\hat{D}H$
Country	$H_0: \beta_1^o = 1$	$H_0: \beta_2^o = 1$	$H_0: \beta_3^o = -1$	$H_0: \beta_4^o = -1$	$H_0: \beta_4^o = -1$
Argentina	-2.877	---	---	8.308	22.792
Bolivia	-2.533	---	---	---	58.514
Brazil	---	---	---	4.645	20.006
Chile	-3.150	---	---	13.142	70.942
Colombia	---	---	---	21.572	22.042
Costa Rica	---	-0.163**	---	1.904	3.521
Ecuador	-0.376**	1.552**	---	0.611**	3.001
El Salvador	---	---	---	---	6.350
Guatemala	0.330**	-4.945	---	6.201	5.991
Honduras	---	---	-1.121**	5.203	8.182
Mexico	0.628**	-0.378**	-3.138	-0.515**	9.098
Nicaragua	---	0.837**	---	8.746	12.384
Paraguay	---	---	---	---	121.778
Peru	---	---	---	2.795	7.796
Uruguay	-0.588**	---	---	2100.690	1335.500
Venezuela	---	---	---	51.944	15.406

A circumflex, ^, indicates a percentage rate of change for the variable: P_{CPI} ≡ consumer price index; y ≡ real GDP; h ≡ money multiplier; DH ≡ domestic component of high powered money; θ ≡ ratio of foreign reserves to high powered money.

** NOT significantly different from hypothesized value.

--- NOT significantly different from zero.

and a double asterisk in Table 13. Column 6 in both Table 11 and Table 12 lists the coefficient for the domestic credit expansion variable for all countries. Nearly all of these are significantly different from zero, but--as columns 5 and 6 of Table 13 indicate--in nearly all cases they are also significantly different from minus unity.

The two countries which have coefficients for the domestic credit expansion variable which are consistent with our expectations, i.e., are significantly different from zero but not significantly different from -1, also have the first and second highest corrected R^2's for specification (5) [but not for specification (6)]. Indeed, Mexico, which has the highest corrected R^2 in specification (5), does not have a significant association between the explanatory variables and foreign-reserves-scaled balance of payments, specification (6).

Overall, the regression results both across countries and between specifications are not overwhelming in favor of the proposed model. That is, the summary statistics are not strongly supportive of the model--the regressions may be significant according to an F-test but the R^2's are, in general, small. Moreover, although the F-test indicates some relationship, the importance of most of the variables is not discernable in that the coefficients are insignificant.[14]

An attempt was made to separate the affects of domestic credit expansion on the balance of payments from the affects of the ratio of foreign reserves to high powered money, θ. That is, I ran regressions of the following form for each country:

$$\hat{F} = \alpha_0 + \alpha_1 \hat{P} + \alpha_2 \hat{y} + \alpha_3 \hat{h} + \alpha_4 \theta + \alpha_5 \hat{DH} + z \qquad (6')$$

I did not report the estimation since these regressions resulted in no net gain in terms of discerning the relative importance of θ vis-a-vis $\hat{DH}$ or in improving the performance of the other explanatory variables.

The generally poor results do not imply that the monetary model is not useful in explaining movements in official reserve assets for Latin American countries during this period. Rather, the paucity of good results does imply that the model as specified as a single equation estimated via OLS is not sufficiently efficient at untangling the underlying relationships that I expect to exist. Perhaps with better data and/or a more elaborate model the usefulness of the simple monetary model would be apparent.

With this in mind I would now like to focus on recent empirical work done by other researchers on the simple model. The work is summarized in Table 4. These results are, of course, not the complete scope[15] of the work done by these researchers, but it is fair to say that these results reflect the general tenor of their analysis in terms of the sample for which the research was conducted and their satisfaction with the performance of the simple model. I should mention at this point that while other researchers do include an interest rate variable in their analysis, none was included for the Latin American nations. This is due to the lack of reliable "market" interest rate data and/or a discount rate series of sufficient (time series) length. Moreover, in no case considered in Table 4 is the coefficient on the interest rate variable significantly

TABLE 14

RECENT EMPIRICAL WORK[1] ON THE MONETARY APPROACH TO THE BALANCE OF PAYMENTS

A. Bean on Japan, Quarterly data 1959 - 1970, OLS;

1. Table 14.1, column 2:

$$\theta\cdot\hat{F} = \underset{(5.38)}{1.19}\,\hat{P}_{CPI} + \underset{(6.36)}{0.52}\,\hat{y} - \underset{(-1.22)}{0.11}\,\hat{i} - \underset{(-5.29)}{0.82}\,\hat{h} - \underset{(-8.32)}{0.67}\,(1-\theta)\hat{D}H$$

$$R^2 = 0.65 \qquad DW = 1.99$$

2. Table 14.2, column 2:

$$\hat{F} = \underset{(4.87)}{0.89}\,\hat{P}_{CPI} + \underset{(4.71)}{0.37}\,\hat{y} - \underset{(-1.70)}{0.13}\,\hat{i} - \underset{(-4.88)}{0.82}\,\hat{h} - \underset{(-6.20)}{0.52}\,(1-\theta)/\theta)\hat{D}H$$

$$R^2 = 0.48 \qquad DW = 1.96$$

B. Genberg on Sweden, Quarterly data 1950 - 1968, 2SLS; Table 13.9, line 2:

$$(1-\theta)\cdot\hat{D}H = \underset{(0.004)}{0.011} - \underset{(0.27)}{0.53}\,\theta\cdot\hat{F} + \underset{(0.06)}{0.02}\,\hat{G}$$

$$\theta\cdot\hat{F} = \underset{(0.26)}{0.39} + \underset{(0.45)}{1.06}\,\hat{P}_{CPI} - \underset{(0.25)}{0.04}\,\hat{y} - \underset{(0.03)}{0.01}\,\hat{i} - \underset{(0.30)}{0.23}\,\hat{h}$$

$$- \underset{(0.63)}{1.23}\,[(1-\theta)\cdot\hat{D}H] - \underset{(0.02)}{0.04}\,\ln(M_{t-1})$$

C. Guitain on Spain, Annual data 1955 - 1971, OLS;

1. Table 15.6, equation 4:

$$\Delta F = 25.11 - \underset{(-1.851)}{0.507}\,P_{CPI}\;(\cdot)^2\;y - \underset{(-11.678)}{0.881}\,\Delta DH; \quad R^2 = 0.969 \quad DW = 3.144$$

2. Table 15.6, equation 10:

$$\Delta^2 F = -1.253\;(\cdot)^2\;\Delta P_{CPI} - \underset{(-1.366)}{0.056}\,\Delta y - \underset{(-9.644)}{0.853}\,\Delta^2 DH; \quad R^2 = 0.882 \quad DW = 3.064$$

D. Zecher[3] on Australia, Quarterly data 1951 - 1971, OLS;

$$\theta\cdot\hat{F} = \underset{(3.70)}{0.65}\,\hat{P}_{CPI} + \underset{(6.54)}{1.11}\,\hat{y}_p - \underset{(-0.75)}{0.035}\,\hat{i} - \underset{(-5.08)}{0.89}\,\hat{h} - \underset{(-7.97)}{1.06}\,(1-\theta)\hat{D}H$$

$$R^2 = 0.93 \qquad DW = 1.69$$

---

1. Figures in parenthesis are t-statistics, except for Genberg.
2. Coefficient not reported by Guitain.
3. Zecher uses a 16 quarter weighted average to measure permanent income, y_p.

different from zero. The countries studied by other researchers are, in general, more highly developed than those in the Latin American sample. Also, quarterly data for the variables in the model were available, allowing, if nothing else, greater degrees of freedom in the model. In addition, all work reported in Table 14 covers a period ending in 1971 or previously--before the so-called U.S. dollar crisis. That is, the sample period covered by their analysis is one during which the international money system could be considered as being a stable fixed exchange rate regime with the U.S. dollar acting as a reserve currency.

The above factors, all basically of a statistical nature, would tend to favor the performance of the simple model. In general, using the usual statistics to assess the performance of a single equation estimation, the results for the countries presented in Table 14 are good. However, upon closer examination this "goodness-of-fit" can be seriously questioned. Indeed, given the criticisms below, the results described in Table 14 are no better than those for the Latin American countries described in Tables 11 and 12. Moreover, I propose here that the results presented in tables 11, 12 and 14 are sufficiently poor as to contradict the claim that these results represent a test of the validity of the monetary approach to the balance of payments. Not that the monetary model cannot be validated; rather that it has yet to be validated.[16]

I begin the discussion of the empirical work with a general setting of the scene. Bean analyzes the Japanese economy using quarterly data for the period 1959-1970. She estimates equations of of the form of specifications (5) and (6) using the ordinary least squares technique. Genberg studies the Swedish economy using quarterly data for the period 1950-1968. He estimates a variant of specification (5) as the second stage of a two-stage least squares process with the high powered money-scaled domestic credit expansion variable being predicted in the first stage. Guitian's work concerns the Spanish economy using annual data for the period 1955-1971. He estimates a variant of specification (5) also using the OLS technique. Zecher analyzes the Australian economy using both quarterly and annual data for the period 1951-1971. He estimates an equation of the form of specification (5) using the OLS technique. On first blush the results seem to be consistent with the monetary approach in that the equations fit well and the coefficients have the expected signs and magnitudes. These are, however, first-order tests and can be questioned. Guitian presents results with the highest R^2; I analyze his work first.

A number of clarifying comments are in order. First, Guitian relates the first difference in foreign reserves, i.e., the official settlements balance of payments, to the level of prices and real gross domestic product and also the first difference in domestic credit. Guitian uses several measures of the latter in his research; the results presented in Table 14 refer to his fourth measure which conforms to the definition used for the Latin American countries and those other countries mentioned above. He also estimates an equation using the first difference of the balance of payments, i.e., the second difference in foreign reserves, and relates that to the rates of inflation and real GDP growth and the second difference in domestic credit. That is, in Guitian's first specification, the balance of payments--whether official settlements are in surplus or deficit--is, in part, determined by the average level of prices. Whereas in his second specification, changes in the balance of payments--whether a surplus/deficit worsens or improves--is, in part, determined by the rate of inflation. The theoretical justification for these two specifications is not at all clear. This in part might account for the poor performance of the price level and GDP variables despite the very large corrected R^2's.

Even pushing this aside, we should be cautious in attaching any meaning whatsoever to Guitian's results on a very simple level. Namely, as Granger and Newbold (1974) warn, low Durbin-Watson statistics even with very high R^2's can be a sign of a spurious regression. That is, whenever the DW test is applied to least squares residuals and the residuals fail the test, some specification error is indicated. Guitian reports DW statistics of 3.144 and 3.064 which pass the test of no autocorrelation in the residuals against the alternative hypothesis of positive autocorrelation but not against the alternative of negative autocorrelation where the DW statistics is $4 - d$. In this case the appropriate values to consider are 0.856 and 0.936. The critical value for 17 observations and three explanatory variables plus a constant term is 0.900. Thus in Guitian's first specification the presence of negative serial correlation is indicated, and in his second specification the test proves inconclusive--but just barely. In light of the above, it is not meaningful to interpret Guitian's results as either validating or discounting the monetary approach in that the appropriate statistical techniques to allow us to make such a decision based on hypothesis tests, e.g., simple t-tests on coefficients, have not been applied.

Bean and Zecher both use specifications very similar to those applied to the Latin American data and both researchers use the OLS technique of estimation. Genberg uses a two-stage technique; so I save his work for last. We can analyze the work done by Bean and Zecher simultaneously since nearly all of my comments apply to both.

The most obvious flaw in their work is that neither Bean nor Zecher explain why there is no constant term in their regression results. If the coefficient is not significant under normal t-tests why not mention this. (This by the way is not the appropriate test for the significance of the constant term (see Williams (1959)). The main point is: are these regressions in some sense indicative of a goodness of fit of the monetary model to the data for Japan and Australia, respectively? The problem in answering this question is that if the regression results were produced using standard statistical packages the R^2's were not calculated properly, and more importantly the Durbin-Watson statistics are meaningless.[17]

Since Bean and Zecher report DW statistics near a safe value, we should consider what an accurate representation of the existence of negative serial autocorrelation would mean. That is, if DW is underestimated sufficiently, such that upon reestimating we obtain a DW-statistic around 2.70 for Japan and 2.50 for Australia, then we could reject the null hypothesis of no serial correlation in favor of the alternative of negative serial correlation. This would invalidate the usual t-tests.

Beyond this, similar problems to those encountered for the Latin American countries vis-a-vis the imprecise estimation of coefficients remain, particularly for Japan. That is, while the coefficients are statistically different from zero they are also statistically different from their theoretical values. Again these criticisms should not be interpreted as being skeptical of the monetary approach but rather of the simplistic fashion in which it has been tested.

Genberg does try to account for the possibility of a more elaborate interaction between domestic credit component of high powered money and the foreign reserves component by postulating a central bank reaction function. That is, in the literature it has been claimed that a central bank can sterilize the inflationary influence of a balance of payments surplus, an increase of foreign reserves, by reducing the stock of government securities it holds--"destroy" domestic credit. Genberg attempts to test this hypothesis by performing a two-stage least squares regression of two equations.

The first stage consists of an estimation of the central bank reaction function:

$$(1-\theta)\cdot\hat{DH} = \alpha_0 + \alpha_1\ \theta\cdot\hat{F} + \alpha_2\cdot\hat{G} + z \qquad (7)$$

where $\hat{G}$ is the growth in government debt outstanding and z is a random error term serially uncorrelated with zero mean and constant variance. The predicted values from this regression were then used to obtain the results for a specification similar to (5):

$$\theta \cdot \hat{F} = \beta_0 + \beta_1 \hat{P} + \beta_2 \hat{y} + \beta_3 \hat{i} + \beta_4 \hat{h} + \beta_5((1-\theta)\cdot \hat{DH})^* + \beta_6 \log M_{t-1} \qquad (8)$$

where $((1-\theta)\cdot \hat{DH})^*$ is the expected high powered money-scaled domestic credit expansion variable from regression equation (7) above.

The usual tests for judging the significance of this relationship (8) do not hold since it was estimated via a two step procedure. Dhrymes (1971) does suggest some asymtotically efficient statistics. However, the procedure Genberg applies is incorrect. The purpose of the two step estimation is to purge the suspected endogenous variable, in this case $(1-\theta)\cdot \hat{DH}$ of any possible correlation with the error term in the second step of the procedure. By specifying the purging equation as in (7) Genberg inadvertently includes the error term associated with $\theta \cdot \hat{F}$. That is, the correct procedure calls for the first stage to predict values of $(1-\theta)\cdot \hat{DH}$ from a regression of itself on all the exogenous variables of a specification similar to (5) and other exogenous variables not included elsewhere in the system. This is clearly a major error on the part of Genberg in applying this technique since rather than purging the possible simultaneous equations bias he has reinforced it.

These claims of improper implementation of the monetary model have not been made elsewhere. As was alluded to earlier, Magee (1976) does criticize these researchers on a number of statistical points. But in no case is his criticism so strong as to suggest that that if this empirical work is an attempt at validating the monetary approach to the balance of payments in truth the approach has yet to be validated.

FOOTNOTES TO CHAPTER III

1. While I am in agreement with much of Magee's comments, some differences remain, e.g., although it is apparent that the estimation procedures do not allow us to discover whether M^d or M^s is influencing the balance of payments, it remains unclear whether the statistics are at all meaningful.

2. Some questions can be raised as to the appropriateness of empirical work aimed at testing the validity of viewing a balance of payments disequilibrium as a monetary phenomenon. These issues are of more than econometric importance although they can be expressed as such. That is, one can apply statistical analyses to econometric problems without first resolving difficulties in the interpretation of the theoretical constructs. Subsequently, criticisms can be levied against the analysis for failing to use an appropriate technique. In this way these queries can be viewed as econometric problems.

3. We can either assume that there are two markets: money and goods, or we can have three markets--the third being securities. Assuming gross substitutability in the latter case (it necessarily holds in the former), any deficit in the balance of the current and capital accounts implies a surplus in the money account, i.e., an excess supply of money.

4. See Cagan (1956) and Friedman and Schwartz (1963), as well as studies on Latin American countries: Deaver (1970), Diz (1970), Harberger (1963), and Vogel (1971).

5. See, for example, Bean, Genberg, Guitian, and Zecher in Frankel and Johnson (1976). Further and more explicit comments and criticisms of previous work will be described later.

6. The following identity can be used to derive the components of high powered money (see Zecher in Frenkel and Johnson (1976):

$$F + OA = H + OL$$

where F is the foreign reserve assets of the monetary authorities, gold and foreign currency holdings, and OA is all other assets. H is high powered money representing the liabilities of the authorities to the (domestic) public and defined in the usual way as currency in circulation plus legal bank reserves--required and excess, and OL is all other liabilities. Hence the domestic credit component of the monetary base can be obtained as a residual, i.e.,

$$DH = H - F = OA - OL.$$

7. The change in the official reserve holdings of the central bank has been recommended as the appropriate definition of the balance

of payments by Mundell (see his textbook, International Economics, 1968, p. 141).

8. See Swoboda (1977).

9. Except for the work of Genberg (1976), OLS has been applied to estimate the equation.

10. The change in real income was appropriately transformed to yield an elasticity. Since no data on market interest rates were available for Latin America, I deleted that variable. See Appendix A for sources and notes on all variables.

11. The growth rates for all variables were calculated as first logarithmic differences, except for domestic credit which in some cases obtained a negative value. $\hat{D}H$ was, in those cases, calculated as a standard percentage change.

12. Since most of the empirical work done in the past analyses developed, and in some cases highly industrialized, economies, the order of magnitude of some coefficients are not expected, in general, to be the same, e.g., as between Sweden and Costa Rica. That is, those countries with higher real income growth, *ceteris paribus*, will experience greater growth in official reserves--relative to the rest of the world. Specifically, the higher the growth in real income (per capita) the higher will be the growth in foreign reserves, depending on the real income elasticity of real cash balances. Less developed economies will exhibit higher real income elasticities of real cash balances than will more highly developed economies and thus the estimated coefficient, β_2, should be higher for a less developed economy which is growing faster than an industrialized nation.

13. There is no *a priori* justification for estimating equations (5) and (6) without a constant term. That the equations are specified without one is a result of specifying the demand for real cash balances as:

$$\frac{M^d}{P} = L(y,i).$$

If the demand for real cash balances were instead specified as

$$\frac{M^d}{P} = A \cdot Q(y,i),$$

where A varies over time, say, as a function of the level of the population, then the empirical specification would include the constant terms, β_0' and β_0', which would reflect autonomous growth in the demand for real cash balances. Leaving the constant term out of the regression will lead to some difficulty in interpreting the goodness of fit of an estimation.

14. We might not be able to draw clear distinctions regarding the applicability of the simple model to all countries because of the violation of a number of assumptions in the data for one country but not the other. Specifically, the existence of stronger trends and more similar movements among the variables in the analysis for one country may appear to reduce the importance of a particular variable for that country and not another, i.e., multicollinearity. Moreover, those countries which have experienced greater fluctuations in their balance of payments, for whatever reason, will require explanation for a phenomenon of greater variation and hence place a greater burden upon the same explanatory variables, e.g., domestic credit expansion, to account for the greater total variation.

15. Table 14 indicates the performance of the simple model described in equation 5 as reported by other researchers. An attempt has been made to present those results which are in some sense compatible with those I present in Tables 11 and 12 for the Latin American nations which are included in my sample. More complete results can be obtained for the other countries by consulting the original sources.

16. For empirical work, applied in a more sophisticated fashion, which tests the monetary approach, see Blejer (1977) and Girton and Roper (1977).

17. The appropriate DW statistic to use in the case of a regression without a constant is obtained by first regressing the same specification but including a constant term. The statistic usually produced by the standard package and that defined by Durbin and Watson is:

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

The calculation of the d statistic generally assumes the mean value of the least squares residual is zero--which is not, in general, the case when a regression is estimated without a constant term. The statistic should be:

$$d' = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} (e_t - \bar{e})^2}$$

We know that the second moment of a random variable about any point other than its mean will result in a larger sum of squares. Thus, for the same values of e_t the statistic d will underestimate d', since the denominator of d is larger than the denominator for d'.

CHAPTER IV

THE DEMAND FOR MONEY IN LATIN AMERICA

A. Introduction

An important ingredient of the monetary approach to balance of payments theory is the stability of the demand for money. The monetary approach postulates an equivalence between the rate, per unit time, of domestic hoarding/dishoarding and an official settlements balance of payments surplus/deficit, at a given price lemel.[1] Domestic hoarding is s.mply the adjustment of desired nominal cash balances to actual money supplied. In a closed economy, hoarding would determine the price level. In the context of a small open economy, the price level is determined by world conditions in the long run. In the short-run the price lemel of a small open economy can be affected by small country conditions as well.

The central character of the demand for money in balance of payments theory lies in the resolution of the balance of payments statement through movements of official reserves. That is, the monetary approach, in general, dispenses with analyzing the various accounts in the balance of payments statement and focuses on the overall or money account. In this respect the settlement of international accounts requires a monetary outflow for deficits and an inflow for surpluses.

Therefore, for reliable and meaningful predictions from a balance of payments theory which utilizes the monetary approach, tractable relationships between the desired quantity of money and other variables must be formulated and their validity tested.

In this chapter, I discuss the stability of money demand relationships in Latin American countries. In particular, I analyze the correspondence between the behavior of demanders and suppliers of money over different periods in time. In addition, I test various specifications of the demand for real cash balances with the aim of verifying several theoretical propositions established and verified for the cases of the United States and other industrialized countries as well as some Latin American countries.[2]

B. Theoretical Aspects of the Demand Demand for Money

The demand for real cash balances has been the subject of studies by many authors. However, much of the current stock of knowledge of empirical estimates of money demand functions has been derived from the theoretical framework established by Milton Friedman (1956a, 1959 and 1971). The theoretical aspects of the monetary analysis for Latin America I use here also draw heavily on the Friedman framework.

The essential features of monetary analysis are that the quantity theory of money is a demand theory relating the desired ratio of nominal stock of money to nominal income that individuals hold to a small number of variables; that money is an asset which individuals hold as some part of their wealth and as such money yields services which are demanded and for which standard demand theory tools are applicable for specifying the demand function; that this demand function can be derived, essentially, from utility maximization subject to a wealth constraint.

These assertions yield a model of the demand for money which relates the nominal stock of cash balances to the returns on money and other (non-human) assets and to wealth. The returns on assets are easily defined from the description of the asset. Thus, the real return on money corresponds to the volume of goods which one unit commands, i.e., the price level--assuming no interest is paid on demand deposits.[3] The price level helps to define the real return on all alternative assets as well. Other assets, the yields for which are included in the demand for money, are nominal assets such as bonds--the yield being the market (nominal) rate of interest on those bonds; real assets such as equities which appreciate with increases in the general level of prices--the yield being the market interest rate plus the expected rate of inflation; real goods whose returns are not in money such as physical goods--the implicit yield being the expected change in the money value of goods, i.e., the expected rate of inflation.

The principles of demand theory require that changes in nominal units of monetary variables will affect in an equiproportionate way the nominal demand for money. That is, if nominal money demand is[4]:

$$M = f(P,\ i_b,\ i_e,\ \hat{P}^E;\ Y)$$

where:

$M \equiv$ nominal stock of money;

$P \equiv$ the general price level;

$i_b \equiv$ the market rate of interest on bonds;

$i_e \equiv$ the market rate of interest on equities;

$\hat{P}^E \equiv$ the expected rate of change of the price level;

$Y \equiv$ nominal income;

then an increase in P and Y, by the same percentage amount, will increase M in the same way. In other words the demand for <u>real</u> cash balances, M/P, is homogeneous of degree <u>zero</u> in prices and money (nominal) income:

$$\frac{M}{P} = g(i_b, i_e, \hat{P}^E; y)$$

where y = real income = Y/P.

The rates of return on alternative assets are expected to reflect the gross substitutability of assets in portfolio holding (excluding explicit risk considerations). That is, the rates of return are measures of the opportunity cost of holding cash instead of other forms of wealth. Specifically, the higher are the returns to holding assets other than money, the lower will be the quantity of real cash balances.

On the other hand, increases in real income will be translated into a greater demand for real cash balances.[5] That is, an increase in real income represents an increment to wealth. This greater stock of wealth permits new combinations of portfolio choice previously unattainable. Depending on whether this increase in real income is (perceived as) permanent or transitory, individuals will generally hold a greater quantity of real cash balances at all opportunity costs,[6] i.e., demand will increase as for a normal good.

Several questions can be raised in regard to the specification of the money demand function. In the context of a small (non-reserve currency) open economy, operating under a fixed exchange rate regime the price level may be determined, at least in the long run, by world factors. The demand for money could then be expressed as:

$$M = f(i, \hat{P}^E; \bar{P}; Y)$$

where i is a weighted average of rates of return on all asset alternatives to money and $\bar{P}$ is the world-determined price level. If nominal income, Y, were to rise, say because of productivity increases, then the nominal stock of money would increase.[7] Unless the increase in nominal balances was validated by the monetary authorities, residents of the small country would begin hoarding thereby inducing a balance of payments surplus. This result is counter to income-determination models of international trade which would suggest that an increase in income will cause a current account deficit and since the interest rate, i, is being held constant then a balance of payments <u>deficit</u> should result.

One possible way around this difference would be if instead of facing a fixed price level in the short run (determined by world conditions), some flexibility was permitted. The increase in productivity, other things equal, would put downward pressure on domestic prices. In this way real cash balances would be increased. The (temporarily) lower small-country prices would induce inflows of international reserves as foreign consumers seek to take advantage of the difference in price levels (assuming the exchange rate is unchanged), and domestic residents reduce their (now too high) real cash balances. The increase in nominal money corresponding to the inflow of reserves temporarily increases actual real cash balances above desired inducing small-country residents to further dishoard while the average level of prices rises to the world level.

In this case the resultant outflow of reserves will not be equal to the full amount of the inflow of reserves which was induced by the initial lowering of prices. Rather only that part of the rest-of-the-world dishoarding which corresponds to the initial increase in nominal (and, at that instant, real) income will show up as a balance of payments deficit. Hence, by allowing adjustments to international accounts disequilibria to be resolved through cash balance adjustment (and in turn price level adjustments) rather than constraining adjustments to have not short-run effects on prices[8] (because of instantaneous price arbitrage), the monetary approach's predictions are the same as "traditional" theory. In this respect, I believe it is appropriate to analyze the demand for money in real terms and permit the data to demonstrate whether or not the specification is in error.

Another question with respect to specification of the demand for money function is the appropriate definition of money. Frequently opportunity cost measures and quality adjustment factors (see Klein, 1974) are not available. Hence, using a definition of money which includes various forms of deposits is likely to result in a misspecification of the money demand function. Lothian (1976) has proposed and demonstrated that, since a narrow definition of money is more closely related to transactions motives and less dependent on opportunity cost and quality differences, high powered money is in many instances a better measure of money than the standard M1 and M2 definitions.[9] In empirical analysis below, I consider the results of specifying the demand in terms of high-powered money.

Another problem frequently encountered in monetary analysis is the measurement of opportunity costs of holding money. Generally, any measure used should reflect market conditions in the sense that the rates chosen are feasible alternatives for the holders of money. In this respect central bank discount rates are not very useful in themselves. The typically highly regulated time and saving deposit rates are also poor reflections of market conditions for assets although the assets to which those rates apply are feasible alternatives to cash.

A second issue with respect to opportunity cost measures concerns the term structure of interest rates. In terms of inflationary expectations as the only determinant of term structure, the alternative cost aspect of a wide variety of interest bearing assets would be reflected in long-term interest rates. If liquidity enjoys a premium then from an initial specification of a short-term interest rate the remaining term structure can be developed by incorporating liquidity preferences and expectations of inflation.[10]

In the context of a small open economy, an integrated capital market is likely to result in domestic interest rates equalling those prevailing in the rest of the world. As interest rates generally incorporate information on expectations of inflation, rest-of-the-world rates of interest might also measure the opportunity cost of holding the currency of a small open economy if long-run inflationary expectations are similar--say because of long-run convergence of rates of inflation.

This issue and other questions concerning the specification of the demand for real cash balances will be taken up in a later section of this chapter. Suffice it to say that these empirical questions are of a rather general nature and apply to all cases of money demand estimation. I would like to describe the behavior of money holders in Latin America before proceeding to the estimation of demand functions.

B. The Stability of the Monetary Sector

A major factor in the stability of the monetary sector is the stability of the behavior of the actors in regard to their pattern of money holdings. I showed in Chapter II that, in general, the velocity of money--a demand characteristic--was generally less variable than the nominal stock of money--a supply characteristic. In this way, I expect the observations on money to trace out a demand relationship rather than a stable supply relation.

A simple way of demonstrating the stability of the monetary sector and more importantly the demand side is by comparing behavior for various sub-periods to determine the strength of relationships across time. In Table 15 I have listed the average annual ratio of three parameters: c, the ratio of currency holdings to demand deposits of the non-bank public; r, the ratio of commercial bank reserves to demand deposits; V, the ratio of nominal income to nominal money, i.e., velocity. I calculated the annual averages over several periods. The first period, 1947-1976, covers fully the available data. The second period, 1956-1971, approximately covers the period of a world-wide U.S. dollar exchange standard. The remaining two periods split the period of greater and more variable rates of inflation worldwide, 1966-1975.

The currency/deposit ratio, c, measures the behavior of the public as it affects the composition of the nominal stock of money.[11] The reserve/deposit ratio, r, reflects in part the preferences of banks and also restraints in the form of reserve requirements. Velocity, V, reflects money holders' behavior as it relates to transactions turnover of cash balances. That is, velocity shows the frequency with which individuals use each unit of currency and demand deposits for transactions in one time period (in this case, a year).

In looking at the figures in Table 15, I observe several striking features. First, in nearly all Latin American countries, the currency/deposit ratio is much greater than in the U.S. Only Brazil and Venezuela are similar to the U.S. Moreover, as we go

TABLE 15

SELECTED MONETARY PARAMETERS, AVERAGE FOR VARIOUS PERIODS

c ≡ currency/demand deposit ratio
r ≡ bank reserve/demand deposit ratio
V ≡ income velocity of money (M1)

	1947-1976(30)			1956-1971(16)			1966-1970(5)			1971-1975(5)		
	c	r	V	c	r	V	c	r	V	c	r	V
Argentina	0.97	0.87	4.57	1.10	0.45	5.33	0.92	0.32	5.57	0.65	0.38	5.21
Bolivia	3.18	0.62	10.87	4.08	0.57	9.10	3.52	0.64	7.69	2.40	0.73	7.88
Brazil	0.43	0.26	4.80	0.38	0.29	4.98	0.32	0.28	5.90	0.73	0.16	5.66
Chile	0.62	0.57	9.16	0.64	0.53	10.20	0.67	0.67	10.37	0.86	1.55	7.78
Colombia	0.68	0.27	6.58	0.62	0.24	6.26	0.55	0.30	6.05	0.50	0.38	6.32
Costa Rica	0.74	0.30	6.13	0.68	0.31	6.28	0.56	0.31	5.94	0.45	0.34	5.22
Ecuador	0.99	0.53	7.41	0.96	0.50	7.56	0.79	0.53	6.72	0.63	0.59	5.70
El Salvador	1.16	0.60	7.17	0.93	0.63	7.55	0.85	0.92	8.12	0.75	0.96	6.89
Guatemala	1.52	0.69	9.83	1.34	0.62	9.81	1.27	0.66	10.03	1.13	0.90	9.76
Honduras	1.13	0.38	9.35	1.22	0.34	9.72	1.01	0.36	9.39	0.86	0.36	7.76
Mexico	0.89	0.38	8.03	0.81	0.28	8.28	0.71	0.26	8.01	0.73	0.49	7.78
Nicaragua	0.84	0.38	8.56	0.81	0.40	8.59	0.67	0.55	8.59	0.55	0.44	7.53
Paraguay	1.33	0.90	10.42	1.42	0.91	11.33	1.37	1.28	10.63	1.18	1.49	10.56
Peru	0.99	0.50	7.12	0.99	0.55	7.77	1.05	0.50	7.71	1.15	0.53	5.06
Uruguay	2.08	0.67	6.41[1]	2.34	0.62	6.07	2.87	0.65	6.74	2.08	0.82	7.48
Venezuela	0.66	0.42	7.40	0.55	0.43	7.42	0.49	0.40	7.59	0.36	0.41	6.45
United States	0.28	0.19	3.57	0.26	0.18	3.74	0.28	0.18	4.28	0.30	0.17	4.68

1. Velocity figure for Uruguay covers 1955-1975.

across the table from the averages for the full period to the smaller periods, the c ratio declines for most Latin American countries whereas for the U.S. the currency/deposit ratio increases. Brazil, Chile and Peru are exceptions to this. The changes are not dramatic, however, except for the period 1971-1975.

Second, bank reserves relative to demand deposits are greater in Latin America than in the U.S. for all periods. Only Brazil's reserve/deposit ratio for 1971-1975 is similar to the U.S. ratio. Again when we look at the period 1971-1975 we see that most Latin American nations increased their reserves relative to demand deposits whereas the U.S. reduced its ratio, marginally. The reserve/deposit ratio is remarkably steady for most of these countries across periods. Argentina and Brazil have a significantly smaller ratio in 1971-1975 than any other period.

Third, the frequency of turnover of M1, velocity, was generally much greater for Latin American countries than for the U.S. However, in going from the longer periods to the subperiod 1971-1975, most Latin American countries exhibit a decreased velocity whereas the U.S. shows an increased velocity. This tendency, of converging velocity, is striking for several countries. In particular, Argentina (5.2), Brazil (5.7) and Peru (5.1) have a rate of turnover not much different than that for the U.S. (4.7).

In Table 16 I have listed the average annual growth rates of money (M1), the average level of prices (P) and velocity (V). Several features of the economic situation in Latin America are apparent in Table 16. First, as compared to the U.S., the mean

TABLE 16

SELECTED ANNUAL GROWTH RATES,[1] AVERAGE FOR VARIOUS PERIODS, %

M1 ≡ nominal narrow money stock
P ≡ price level, Consumer Price Index
V ≡ income velocity of money (M1)

	1947-1976(30)			1956-1971(16)			1966-1970(5)			1971-1975(5)		
	$\hat{M}1$	$\hat{P}$	$\hat{V}$	$\hat{M}1$	$\hat{P}$	$\hat{V}$	$\hat{M}1$	$\hat{P}$	$\hat{V}$	$\hat{M}1$	$\hat{P}$	$\hat{V}$
Argentina	31.64	30.72	1.10	22.85	23.99	4.38	25.65	17.69	-6.40	58.02	49.73	4.98
Bolivia	26.16	22.63	-0.07	21.57	16.80	-8.01	9.71	5.74	0.70	22.67	18.73	2.76
Brazil	29.18	23.97	1.06	34.60	30.79	1.95	26.90	24.19	4.16	33.26	19.11	-1.70
Chile	44.12	43.23	1.71	32.63	24.17	-2.25	33.21	23.42	-0.40	115.85	112.35	3.92
Colombia	16.38	11.02	0.44	16.09	9.97	-0.83	16.86	9.59	-1.61	19.34	17.44	4.01
Costa Rica	11.05	4.76	-0.95	8.94	2.11	-1.66	12.24	2.51	-2.10	19.93	12.81	-1.37
Ecuador	11.90	5.22	-1.78	10.80	3.09	-2.66	16.12	4.61	-5.29	22.97	12.63	-0.34
El Salvador	8.38	4.73	0.05	3.82	0.53	0.75	4.72	1.07	0.38	16.44	8.26	-4.96
Guatemala	7.81	3.22	1.29	4.79	0.43	0.80	5.97	1.49	1.19	14.32	8.12	-1.66
Honduras	7.84	2.96	-0.93	6.73	1.29	-0.38	9.22	1.71	-2.41	10.50	6.12	-2.70
Mexico	12.36	6.80	0.10	10.51	3.84	-0.05	11.54	3.61	-1.39	16.43	11.40	0.73
Nicaragua	10.60	4.23	-1.79	5.57	0.56	0.44	3.16	2.16	3.14	15.66	8.95	-1.40
Paraguay	19.72	16.58	-0.05	10.66	5.91	0.38	7.94	1.26	-2.08	17.84	10.94	0.82
Peru	15.68	11.08	0.88	15.71	8.50	-2.03	19.75	9.27	-4.63	22.23	11.88	-5.50
Uruguay	26.07	27.98	3.20[2]	31.99	30.51	-0.28	42.43	46.81	6.69	43.02	52.54	8.66
Venezuela	11.14	3.49	-1.90	7.58	1.54	-0.34	7.70	1.58	-1.40	24.80	5.55	-7.40
United States	3.56	3.61	3.42	3.47	2.58	2.65	4.97	4.17	2.20	5.86	6.53	2.94

1. A circumflex indicates a percentage growth rate of the variable.

2. Velocity growth figure for Uruguay covers 1956-1975.

growth rates of money and prices for all periods are generally higher, and significantly so. The cases for which the rates of growth in prices are lower in the 1956-1971 and 1966-1970 sub-periods than for the U.S. are cases when the differences are in excess of two percentage points. Second, the percentage change in velocity for most Latin American countries is intermittently negative and its absolute value is generally different than the growing velocity of the U.S.

Finally, as between periods, the pattern for Latin America in money and price level growth corresponds to that of the U.S. In nearly all cases monetary expansion and inflation have increased. However, the same correspondence between Latin America and the U.S. is not so clear in terms of the pattern over time of the percentage change in velocity. Indeed in going from the period 1966-1970 to the period 1971-1975 only 9 Latin American countries have increased the rate of change of the rate of turnover of their currency--as has been the pattern for the U.S. Moreover, nine Latin American countries have, on average, a declining velocity for 1971-1975 as opposed to the increasing velocity of the U.S.

In Table 17 I have listed the average annual growth rates of real per capita money (m) and income (y). The predictions of the quantity theory are that, holding velocity constant, a one-to-one correspondence exists between real money and income growth (per capita)[12] in the steady state. Since velocity was not constant for these countries for all periods, by adding the growth in velocity (Table 16) to the difference between the growth in real per capita

TABLE 17

REAL PER CAPITA ANNUAL GROWTH RATES OF MONEY AND INCOME,[1]
AVERAGE FOR VARIOUS PERIODS, %

m ≡ real per capita narrow money (M1)
y ≡ real per capita gross domestic product

	1947-1976(30)		1956-1971(16)		1966-1970(5)		1971-1975(5)	
	$\hat{m}$	$\hat{y}$	$\hat{m}$	$\hat{y}$	$\hat{m}$	$\hat{y}$	$\hat{m}$	$\hat{y}$
Argentina	-0.74	1.92	-2.78	2.57	6.60	2.83	6.97	2.00
Bolivia	1.20	1.85	2.18	0.54	1.37	3.55	1.28	3.04
Brazil	2.42	4.72	0.94	3.24	0.05	4.74	11.38	7.53
Chile	1.26	1.04	6.33	2.52	7.87	2.77	1.71	-3.07
Colombia	2.52	2.35	3.07	1.72	4.69	2.97	-0.84	3.32
Costa Rica	2.84	2.94	3.35	1.81	6.75	3.77	4.53	3.49
Ecuador	3.54	2.29	4.78	1.35	8.72	0.76	7.47	6.16
El Salvador	0.82	2.66	0.12	1.84	0.44	1.14	5.12	1.77
Guatemala	1.53	2.11	1.24	2.19	0.92	2.04	3.34	2.61
Honduras	1.91	1.04	2.59	1.37	4.69	1.40	0.54	-1.29
Mexico	2.27	2.23	3.30	2.94	4.50	3.25	1.61	2.10
Nicaragua	3.52	3.66	2.27	2.22	-1.44	1.29	3.40	2.00
Paraguay	0.62	0.99	2.18	1.42	4.19	1.62	4.06	3.11
Peru	2.02	2.75	4.37	2.14	7.61	1.49	7.37	2.36
Uruguay	-2.80	-0.46[2]	0.15	-0.44	-5.66	1.02	-10.66	-0.84
Venezuela	4.22	2.22	2.47	2.35	2.57	0.90	16.40	1.90
United States	-1.43	1.82	-0.50	1.88	-0.26	1.96	-1.49	1.36

1. A circumflex indicates a percentage growth rate of the variable.

2. Real per capita income growth figure for Uruguay covers 1956-1975.

money and income, a zero discrepancy should result on average, except for rounding. The statistical discrepancy was small (less than one percentage point) for most countries for the two longer periods. However, for the two periods since 1966, the number of countries for which the discrepancy was greater than one percentage point increased. Interpreting the quantity equation as a demand theory suggests that this discrepancy might be a reflection of a short-run disequilibrium.

Several other characteristics of Latin American countries are reflected in Table 17. Namely, for the most part, real per capita cash balances have been increasing for Latin America whereas in the U.S. m has been decreasing. The only consistent exception was Uruguay which exhibited large percentage decreases in real cash balances.

Also, across time periods, the growth in real per capita cash balances tends to alternate both in direction and magnitude. However, as between 1966-1970 and 1971-1975, the descriptive statistics in Table 17 suggest that as real per capita income growth increased (decreased) so did real cash balances per capita. Argentina, Colombia, Ecuador, Paraguay and Peru are exceptions to the correspondence of changes in $\hat{y}$ and $\hat{m}$ between the two short periods. Only six of the remaining Latin American countries had a pattern similar to the U.S.--a lower y and thus a lower $\hat{m}$ in 1971-1975 than in 1966-1970.

Thus overall the descriptive statistics of Tables 15-17 indicate that: broad patterns of behavior in Latin America were different than the U.S. in magnitude and direction of change; short-run disequilibria did exist; and a stable basic money demand relationship was broadly consistent with annual changes in the time series.

C. The Demand for Money in Latin America

In an earlier section, I discussed several theoretical aspects of the demand for money. I present below a summary of attempts to estimate a country specific demand function which addresses some of the questions raised earlier. Repeating for clarity, the demand for real cash balances is homogeneous of degree zero in money income and the price level and inversely related to the per unit cost of real cash balances. In the case of no explicit return on money the cost of holding money can be measured as the rate of return on alternative assets--the opportunity costs of money.

As mentioned earlier this simple specification is not so simple to implement. Permanent real income and permanent real cash balances should be used empirically. Difficulty in constructing such series led me to use measured real aggregates. Interest rate data of a consistent and useful variety is not available for the Latin American countries.

Several measurements were utilized to try to capture the affect of alternative costs on the demand for real cash balances per capita. First, the expected rate of inflation is a measure of the potential decline in the value of real balances. Adaptive price expectations--using the past history of the price level for one step ahead forecasts, or rational price expectation--using information of the model which generates the price level, would be helpful in describing the demand function. Difficulty in obtaining satisfactory price expectation series led me to choose a simpler course. Specifically, I used the first difference in the actual rate of inflation--a measure of the acceleration of the price level, i.e., how rapidly nominal cash balances deteriorated between last period and the current period. I expect a more rapid deterioration in the purchasing power of nominal balances to lead to a decline in real cash balances--part of an increasing tax on real balances.

A second measure I used to capture the opportunity cost of holding real cash balances was, in part, Klein's (1974) measure of the implicit competitive rate of return on money. Klein's measure is:

$$i_M = i_I(1 - \frac{H}{M})$$

where i_M = the rate of return on money, i_I = the marginal rate of return on commercial bank investments, H = nominal high powered money and M = nominal narrow money. If i_I is assumed constant then, since $\ln(i_M/i_I) = - \ln(H/M)$, the log of the ratio of high powered money to narrow money can be used as a measure of the opportunity cost of holding money relative to the rate of return on money, i.e., $\ln(H/M) = \ln(i_I/i_M)$.

A third measure of the opportunity cost of holding money is the world rate of interest on alternative assets. That is, if capital markets are integrated then interest rate arbitrage will assure, over time, that interest rates will equalize adjusting for risk. In this regard, I used, alternatively, the 3 month U.S. Treasury bill yield as a proxy for a short-term world interest rate and the yield on a 30 year U.S. government bond as a proxy for the long-term world interest rate.

Finally, I constructed short-term and long-term interest rates for each country based on a sequence of assumptions. First, I utilized the Fisher equation for each country and the U.S. as follows:

$$i_k = r_k + \hat{P}_k^E$$

and

$$i_{us} = r_{us} + \hat{P}_{us}^E$$

where i_k = the nominal interest rate in country k, r_k = the real rate of interest and $\hat{P}_k^E$ = the expected rate of change of the price level. Second, I used the rate of growth of real per capita income as a proxy for the real rate of return. Third, I assumed the expected rate of inflation equals the actual rate. Thus, for each country, k,

$$i_{Ek} = i_{us} + (r_k - r_{us}) + (\hat{P}_k - \hat{P}_{us})$$

is the estimated nominal interest rate. Alternatively, using the short-term and long-term rates of interest for the U.S. allowed me to derive two proxies for each country.

I estimated the demand function in the following general form:

$$\ln m_t = \beta_0 + \beta_1 \ln y_t + \beta_{2j} C_{jt} + \beta_3 i_t + u_t \qquad (9)$$

$$u_t = \rho u_{t-1} + \varepsilon_t$$

where

$m_t \equiv$ real cash balances per capita
$= M/(P N)$;

$y_t \equiv$ real measured income per capita
$= Y/(P \cdot N)$;

$c_1 \equiv$ change in the rate of inflation
$= \hat{P}_t - \hat{P}_{t-1}$;

$c_2 \equiv$ Klein's measure of return on money
$= \ln\ (H/M)_t$;

$i_t \equiv$ U.S. or derived interest rate.

In addition, I included a lagged dependent variable to capture the short-run demand behavior when that seemed appropriate. Indeed, as indicated in the previous section, some shift in behavior between periods suggests that some adjustment process might show itself in the estimation. An alternative way of accounting for possible shifts is by including a set of dummy variables in each regression. This latter method has two disadvantages. First, the eyeballing of the data necessary to come up with a set of, essentially, ad hoc dummy variables is time intensive. Secondly, the potential set of dummies might prove to be very expensive in terms of precious few degrees of freedom.

I have listed in Tables 18-20 estimates of the demand for real cash balances per capita for each country. Each table only lists one equation per country which represents the best fit as indicated by the summary statistics.[13] Table 18 lists the short-run demand function using the implicit measures of opportunity costs, C_1 and C_2. Table 19 lists the long-run demand function using the variety of explicit opportunity costs, i_{us} and i_{Ek}, as well as implicit costs. Finally, Table 20 lists the short-run regressions corresponding to Table 19. All specifications have been corrected for first order serial correlation and have been estimated for the period 1948-1976.[14]

Several general features of these regressions are apparent. First, the coefficient of determination, adjusted for degrees of freedom, is reasonably high. Notable exceptions are: Argentina, Chile, Honduras, Paraguay and Peru all for the long-run function only.

Secondly, the per capita income elasticity of demand for real cash balances per capita is positive, significant and, for the most part, not statistically different from unity. Moreover, the direct estimates of the income elasticity are generally less than one in numerical value (although not statistically so) for the short-run specifications but generally greater than one for the long-run specification (again not statistically so). This aspect of the data is capturing the dichotomy between permanent and transitory real income. Perhaps by appropriately estimating a permanent income series, an

TABLE 18

THE DEMAND FOR REAL CASH BALANCES PER CAPITA

$$\ln\left(\frac{M}{P.N}\right)_t = \beta_0+\beta_y \ln\left(\frac{Y}{P.N}\right)_t + \beta_{cj} C_{jt} + \beta_{-1} \ln\left(\frac{M}{P.N}\right)_{t-1} + u_t;\; u_t = \rho u_{t-1} + \varepsilon_t$$

Country	β_y	β_{c1}[1]	β_{c2}[2]	β_{-1}	long-run[3] income elasticity of demand	$\bar{R}^2$	SER	$\hat{\rho}$
Argentina	0.722*†	-0.276*		0.948*	13.885	0.796	0.112	0.001
	(0.188)	(0.102)		(0.113)				
Bolivia	0.045	-0.421*	-2.015*	0.846*	2.922	0.821	0.156	-0.130
	(0.347)	(0.106)	(0.950)	(0.117)				
Brazil	0.351*			0.424*	0.610	0.814	0.093	-0.187
	(0.110)			(0.153)				
Chile[4]	1.114*†		-0.329	0.834*	6.895	0.749	0.179	-0.171
	(0.505)		(0.246)	(0.123)				
Colombia	0.733*†		-0.211*	0.424*	1.274	0.909	0.062	-0.109
	(0.277)		(0.124)	(0.194)				
Costa Rica	1.376*†		-0.303	0.025	1.411	0.953	0.055	-0.116
	(0.272)		(0.318)	(0.182)				
Ecuador	0.877*†			0.597*	2.176	0.965	0.066	0.045
	(0.310)			(0.158)				
El Salvador	0.361*	-0.491*		0.739*	1.381	0.843	0.077	-0.141
	(0.174)	(0.234)		(0.187)				

(continued)

TABLE 18 (continued)

Country	β_y	β_{c1}[1]	β_{c2}[2]	β_{-1}	long-run income elasticity of demand[3]	$\bar{R}^2$	SER	$\hat{\rho}$
Guatemala	0.785*†			0.283*	1.095	0.768	0.054	-0.444
	(0.180)			(0.158)				
Honduras[4]	0.649*†	-0.734*		0.824*	3.691	0.875	0.082	0.104
	(0.266)	(0.380)		(0.113)				
Mexico	0.391*	-0.158		0.602*	0.982	0.941	0.056	-0.045
	(0.181)	(0.239)		(0.182)				
Nicaragua	0.976*		-0.758*	0.117	1.105	0.918	0.075	-0.414
	(0.216)		(0.280)	(0.172)				
Paraguay[4]	0.383*	-0.409*		0.891*	3.504	0.754	0.123	0.403
	(0.191)	(0.161)		(0.123)				
Peru[4]	0.548*	-0.266		0.731*	2.039	0.927	0.087	-0.178
	(0.130)	(0.349)		(0.088)				
Uruguay[4]	0.797†		-1.802*	0.151	0.939	0.651	0.122	0.144
	(0.881)		(0.468)	(0.249)				
Venezuela	0.568	-0.597		0.508*	1.154	0.903	0.049	-0.473
	(0.148)	(0.064)		(0.116)				

NOTES TO TABLE 18

Standard errors in parenthesis, Constant not shown.

1. The first measure of opportunity costs is the first difference in the rate of inflation.

2. The second measure of opportunity costs is the log of the ratio of high powered money to M1.

3. The long-run income elasticity of demand is $\beta_y/(1-\beta_{-1})$, where $1-\beta_{-1}$ is the speed of adjustment of desired to actual real cash balances.

4. Nominal M1 was deflated by the CPI for: Chile, Honduras, Paraguay, Peru and Uruguay. All other countries had M1 deflated by the implicit GDP price deflator.

* = significantly different from zero at $\alpha = 0.05$ one-tailed test.

† = not significantly different from unity at $\alpha = 0.05$ two-tailed test.

TABLE 19

THE DEMAND FOR REAL CASH BALANCES PER CAPITA

$$\ln\left(\frac{M}{P.N}\right)_t = \beta_o + \beta_y \ln\left(\frac{Y}{P.N}\right)_t + \beta_{c2} C_{zt} + \beta_i . i_t + u_t;\ u_t = \rho u_{t-1} + \varepsilon_t$$

Country	β_y	β_{c2}[1]	β_{is}[2]	β_{i1}[2]	interest rate elasticity at mean β_i[3]	$\bar{R}^2$	SER	$\hat{\rho}$
Argentina	0.486		-1.716		-0.060	-0.019	0.146	-0.701
	(0.398)		(2.830)					
Bolivia[4]	1.575*†	-1.191*	-1.352		-0.052	0.632	0.102	-0.383
	(0.299)	(0.611)	(1.967)					
Brazil	0.745*†	-0.777*		-7.477*	-0.322	0.771	0.082	-0.451
	(0.185)	(0.343)		(4.119)				
Chile	1.805*†		-9.982*		-0.350	0.256	0.183	-0.663
	(0.585)		(3.628)					
Colombia	1.124*†	-0.309*	1.315		0.046	0.838	0.060	-0.402
	(0.167)	(0.133)	(1.309)					
Costa Rica	1.484*	-0.629*	-2.082*		-0.082	0.953	0.052	-0.189
	(0.113)	(0.351)	(1.204)					
Ecuador	1.273*†		8.901*		0.349	0.951	0.057	-0.273
	(0.230)		(2.651)					
El Salvador	1.094*†		-0.196		-0.007	0.678	0.082	-0.144
	(0.168)		(1.436)					

(continued)

TABLE 19 (continued)

$$\ln\left(\frac{M}{P.N}\right)_t = \beta_o + \beta_y \ln\left(\frac{Y}{P.N}\right)_t + \beta_{c2} C_{zt} + \beta_i . i_t + u_t ; \; u_t = \rho u_{t-1} + \epsilon_t$$

Country	β_y	β_{c2}[1]	β^2_{is}	β_{i1}[2]	interest rate elasticity at mean[3] β_i'	$\bar{R}^2$	SER	$\hat{\rho}$
Guatemala[2]	1.098*†		-0.128		-0.008	0.694	0.055	-0.548
	(0.149)		(0.166)					
Honduras[2,4]	1.968*†		-0.505		-0.020	0.335	0.100	-0.596
	(0.522)		(0.661)					
Mexico[2]	0.941*†		-0.130		-0.012	0.813	0.054	-0.560
	(0.087)		(0.084)					
Nicaragua	1.217*†			-0.626	-0.027	0.878	0.091	-0.421
	(0.148)			(3.130)				
Paraguay	1.365*†			-6.069	-0.261	0.158	0.126	-0.673
	(0.538)			(5.186)				
Peru[4]	1.007*†			3.387*	0.120	0.571	0.101	-0.707
	(0.222)			(1.981)				
Uruguay	0.563†	-1.607*		-4.356*	-0.215	0.791	0.101	0.347
	(0.699)	(0.358)		(2.032)				
Venezuela	0.811*†	-1.075*	-1.783		-0.063	0.744	0.093	-0.278
	(0.287)	(0.405)	(2.091)					

NOTES TO TABLE 19

Standard error in parenthesis. Constant not shown.

1. This measure of opportunity costs is the log of the ratio of high powered money to M1.

2. The interest rate used for Guatemala, Honduras and Mexico was derived using purchasing-power parity and a Fisher equation, see text. All other countries used either the short-term (S) or long-term (L) U.S. interest rate.

3. The elasticity was calculated by multiplying coefficient β_1 by the appropriate mean interest rate.

4. The CPI was used to deflate M1 for: Bolivia, Honduras and Peru.

* = significantly different from zero at $\alpha = 0.05$, one-tailed test.

† = not significantly different from unity at $\alpha = 0.05$, two-tailed test.

TABLE 20

THE DEMAND FOR REAL CASH BALANCES PER CAPITA

$$\ln\left(\frac{M}{P.N}\right)_t = \beta_o + \beta_y \ln\left(\frac{Y}{P.N}\right)_t + \beta_{c2}{}^{1} C_{zt} + \beta_i i_t + \beta_{-1} \ln\left(\frac{M}{P.N}\right)_{t-1} + u_t;\ u_t = \rho u_{t-1} + \varepsilon_t$$

Country	β_y	β_{is} [2]	β_{-iL} [2]	β_{-1}	interest rate elasticity at mean [3] β''_i	long-run interest elasticity of demand [4]	long-run income elasticity of demand [4]	$\bar{R}^2$	SER ($\hat{\rho}$)
Argentina	0.712†		-6.789	0.945*	-0.238	-4.327	12.981	0.654	0.140
	(0.476)		(6.024)	(0.132)					(-0.045)
Bolivia[1,5]	1.127*†		-0.436	0.254	-0.020	-0.027	1.512	0.563	0.124
	(0.401)		(3.161)	(0.198)					(-0.244)
Brazil	0.732*†		-8.116*	0.311*	-0.349	-0.507	1.063	0.823	0.089
	(0.219)		(4.230)	(0.155)					(-0.219)
Chile	1.641*†	-12.204*		0.657*	-0.427	-1.245	4.789	0.643	0.163
	(0.404)	(3.276)		(0.134)					(-0.157)
Colombia[1]	0.722*†	0.934		0.361	0.033	0.052	1.129	0.905	0.063
	(0.282)	(1.504)		(0.218)					(-0.115)
Costa Rica[1]	1.344*†	-2.218*		0.108	-0.087	-0.098	1.508	0.958	0.053
	(0.260)	(1.263)		(0.180)					(-0.106)
Ecuador	0.695*†	2.130		0.588*	0.084	0.204	1.685	0.972	0.062
	(0.290)	(1.215)		(0.149)					(0.121)
El Salvador	0.582*†	-1.076		0.553*	-0.038	-0.085	1.302	0.818	0.082
	(0.209)	(1.593)		(0.176)					(-0.144)

(continued)

TABLE 20 (continued)

Country	β_y	β_{is}[2]	β_{iL}[2]	β_{-1}	interest rate elasticity at mean β''_i[3]	long-run interest elasticity of demand[4]	long-run income elasticity of demand[4]	$\bar{R}^2$	SER ($\hat{\rho}$)
Guatemala	0.827*†		-0.562	0.291*	-0.024	-0.028	1.167	0.758	0.055
	(0.267)		(2.593)	(0.166)					(-0.445)
Honduras[5]	0.842*†	-1.075		0.831*	-0.038	-0.227	4.992	0.858	0.087
	(0.389)	(1.789)		(0.133)					(0.105)
Mexico[2]	0.407*†	-0.048		0.576*	-0.004	-0.011	0.960	0.941	0.056
	(0.178)	(0.098)		(0.175)					(-0.041)
Nicaragua	0.761*†		-1.192	0.378*	-0.051	-0.082	1.223	0.913	0.085
	(0.245)		(2.724)	(0.169)					(-0.328)
Paraguay	1.636*†		-11.829*	0.706*	-0.509	-1.728	5.561	0.663	0.117
	(0.486)		(4.147)	(0.118)					(0.005)
Peru[2,5]	0.496*		-0.068	0.752*	-0.009	-0.036	2.002	0.934	0.088
	(0.143)		(0.145)	(0.098)					(-0.120)
Uruguay	0.758†		-9.711*	.092	-0.479	-0.528	0.835	0.412	0.150
	(1.138)		(4.059)	(0.318)					(0.030)
Venezuela	0.702*†	-1.117		0.497*	-0.039	-0.078	1.397	0.819	0.099
	(0.254)	(2.198)		(0.201)					(0.043)

NOTES TO TABLE 20

Standard error in parenthesis. Constant not shown.

1. In only three cases was the implicit opportunity cost measure, In(H/M1), in the chosen specification: Bolivia = -0.845; Colombia = -0.232*; Costa Rica = -0.643*.

2. The interest rate used for Mexico and Peru was derived using purchasing power parity and a Fisher equation; see text. All other countries used either the short-term (S) or long-term (L) U.S. interest rate.

3. The elasticity was calculated by multiplying coefficient β_i by the appropriate mean interest rate.

4. The long-run elasticities were calculated by dividing coefficients β_i'' and β_y by $(1-\beta_{-1})$.

5. The CPI was used to deflate M1 for: Bolivia, Honduras and Peru.

* = significantly different from zero at $\alpha = 0.05$, one-tailed test.

† = not significantly different from unity at $\alpha = 0.05$, two-tailed test.

estimate of the permanent income elasticity could be obtained which would be consistent between short-run and long-run demand specifications. The estimates of income elasticities, listed in Tables 18 through 20, do reflect, however, the general predictions of the theoretical demand model. Namely, despite the variety of monetary experiences represented by the sample of Latin American countries studied, increases in real income per capita show up in (nearly) equivalent increases in real per capita cash balances.

By way of comparison, the estimates of income elasticities for several countries made in previous studies can be analyzed. Diz (1970) estimates the long-run income elasticity for Argentina as 1.17 (see his Table 7, p. 98); Silveira's (1973) estimate for Brazil is 0.75 (p. 120, equation 4); Deaver's (1970) estimate for Chile is 0.63 (see his Table 3, p. 35); Adekunle's (1968) estimate for Costa Rica is 0.94 and for Mexico is 0.61 (see his Table 5, p. 263). These estimates should be compared to my Table 19, since the other authors do not include a lagged dependent variable in their regressions. Except for Argentina and Brazil, my estimates are much higher than those taken from those other studies. The difference might be reconciled by noting that my estimates refer to 1948-1976, whereas for the other studies their analyses ended by 1962 and generally involved fewer observations. That is, over a longer period, velocity is more likely to tend to its steady-state value, zero. This suggests that the income elasticity will be closer to unity. In the case of Argentina other forces have reversed this tendency. Specifically, velocity has increased over time in Argentina thereby diminishing the impact of changes in real income on real money holdings.

Third, the implicit and explicit opportunity costs measures generally exhibit an inverse relationship with real cash balances. Unfortunately, the U.S. rates of interest (short and long-term) and the derived country rates are not generally statistically different from zero. I note that the two measures I have labelled implicit opportunity costs are almost always significantly and negatively related to real cash balances per capita (Table 18). Chile, Costa Rica, Mexico, Peru and Venezuela do not exhibit significant coefficients on these implicit measures.

Regarding the measures I have labelled explicit opportunity costs, only Colombia, Ecuador and Peru exhibit a positive interest rate coefficient for the long-run demand function (Table 19). A positive interest rate coefficient for the short-run demand only shows up for Colombia and Ecuador.

Although the coefficient estimates for the interest rate variables are less than satisfactory, I believe the generally negative values are indicative of a rational responsiveness of Latin American residents to the opportunity costs of holding money. It is noteworthy to point out that, except for Costa Rica, those countries which have negative <u>and</u> significant interest rate coefficients are generally the countries which experienced higher and more variable inflations[15]: Brazil, Chile, Paraguay and Uruguay.

Finally, in estimating the demand for real cash balances in stock adjustment form (short-run specification), I was able to compare speeds of adjustment of actual real cash balances to desired--the difference in long-run equilibrium being zero. That is, suppose[16]

$$\ln (m_t/m_{t-1}) = \lambda\{\ln (m_t^d/m_{t-1})\} \qquad (10)$$

where $m_t \equiv$ real cash balances per capita, a superscript "d" indicates a desired level, and λ is the speed of adjustment. Then,

$$\ln m_t = \lambda \ln m_t^d + (1-\lambda) \ln m_{t-1} \qquad (11)$$

If the previously specified demand function represents the desired level of real cash balances demanded then the estimated demand function function should be:

$$\ln m_t = \lambda\, \beta_0 + \lambda\, \beta_1 \ln y_t + \lambda\, \beta_{2j}\, C_{jt} + \lambda\, \beta_3 i_t + (1-\lambda) \ln m_{t-1} \qquad (12)$$

In the long-run $\lambda = 1$, hence the original specification is the long-run functional form. The closer is λ to one, the more rapidly do individuals adjust their actual real money holdings to their desired level.

In terms of the regression coefficient for the lagged dependent variable, m_{t-1}, the closer is the coefficient to zero the more rapid will be the adjustment. Moreover, by dividing the estimated coefficients for the independent variables by the coefficient of the lagged dependent variable, the "long-run" elasticity (or coefficient for interest rates) can be obtained. In Tables 18 and 20 I have listed the regression estimates, $\beta_{-1} = (1 - \lambda)$, as well as the estimates for the long-run real per capita income and interest rate elasticities of demand for real cash balances.

If β_{-1} is close to zero (and therefore λ is close to one), the hoarding function is operating rapidly. This suggests that those countries which adjust their real cash holdings more rapidly than others are also likely to adjust more rapidly to monetary impulses through the balance of payments. I arbitrarily classify those countries whose speed of adjustment is at least 70% per annum as exhibiting fast adjustment; those with at least 40% but less than 70% per annum exhibit a moderate speed; those with λ less than 40% per annum are classified as exhibiting slow adjustment.

As indicated in Tables 18 and 20, most countries in this sample adjust their real cash holdings with moderate to slow speeds. Only Costa Rica, Guatemala and Uruguay operate quickly in both specifications (without and with an interest rate as an explanatory variable). The most surprising results are the extremely slow adjustments of Argentina (5.2%), Chile (16.6%) and Paraguay (10.9%). Each of these countries has experienced high rates of inflation and, except Paraguay, each has devalued frequently over the period studied. This is, however, consistent with the descriptive statistics presented in Tables 15-17. Specifically, a stable demand relationship holds with some short-run disequilibria as reflected in the generally slow speed of adjustment.

I have also specified a short-run money demand function using high powered money (deflated by the price level and population). The basic justification, as described more fully by Lothian (1976), is that using a monetary aggregate which is more sensitive to data not readily available, e.g., using M1 or M2 when appropriate interest rate data do not exist, involves a specification error which is not conducive to estimating a stable demand relationship.

In Table 21 I have estimated the following equation:

$$\ln h_t \equiv \lambda\beta_0 + \lambda\ \beta_1 \ln y_t + \lambda\ \beta_2 i_t + (1-\lambda)h_{t-1} + u_t \qquad (13)$$

$$u_t = \rho u_{t-1} + \varepsilon_t$$

where $h_t \equiv H/(P \cdot N)$ is real high powered money (H) per capita in time t. The results for high powered money are similar to those for M1 in several respects.

First, the short-run income elasticity is generally significant and not different from unity. Second, the interest rate variable, although negative, is significant in only a few cases. Third, the corrected R^2's are generally high with only Uruguay (0.107) being insignificant and Bolivia (0.575) being relatively low.

Finally, with regard to the speed of adjustment, Costa Rica, Guatemala and Uruguay each have rapid adjustment processes. However, nearly every other country (except Bolivia, Brazil and Colombia) have very slow speeds of adjustment, λ less than 40% per annum.

D. Conclusion

The purpose of this chapter was to demonstrate the stability of the money demand relationship. In this connection both the descriptive statistics of Table 15-17 and the regression analyses

TABLE 21

THE DEMAND FOR REAL HIGH POWERED MONEY PER CAPITA

$$\ln\left(\frac{H}{P.N}\right)_t = \beta_o + \beta_y \ln\left(\frac{Y}{P.N}\right)_t + \beta_i\, i_t + \beta_{-1} \ln\left(\frac{H}{P.N}\right)_{t-1} + u_t;\ u_t = \rho u_{t-1} + \varepsilon_t$$

Country	β_y	β_{is}	β_{iL}	β_{-1}	interest rate elasticity at mean β_i[3]	long-run interest elasticity of demand[3]	long-run income elasticity of demand[3]	R^2	SER ($\hat{\rho}$)
Argentina	0.580†	-2.430		0.991*	-0.085	-8.957	61.053	0.746	0.198
	(0.449)	(4.242)		(0.014)					(0.031)
Bolivia[4]	1.162*†		-0.477	0.241	-0.022	-0.029	1.530	0.575	0.122
	(0.384)		(2.958)	(0.190)					(-0.227)
Brazil	0.789*†		-0.494	0.542*	-0.021	-0.046	1.724	0.987	0.073
	(0.195)		(3.002)	(0.108)					(-0.010)
Chile	2.623*	13.259*		0.785*	-0.464	-2.158	12.191	0.956	0.208
	(0.523)	(4.277)		(0.100)					(0.126)
Colombia[1,4]	0.764*†		0.035	0.528*	0.006	0.012	1.620	0.885	0.090
	(0.302)		(0.094)	(0.182)					(-0.066)
Costa Rica[4]	1.568*†		-6.771*	0.111	-0.312	-0.351	1.764	0.895	0.064
	(0.298)		(2.780)	(0.187)					(-0.200)
Ecuador	0.268	2.148		0.923*	0.084	1.096	3.478	0.992	0.085
	(0.329)	(1.707)		(0.082)					(0.260)
El Salvador	0.352*	-1.790		0.991*	-0.064	-6.795	37.596	0.994	0.076
	(0.178)	(1.700)		(0.105)					(0.187)

(continued)

TABLE 21 (continued)

Country	β_y	β_{is}	β_{iL}	β_{-1}	interest rate elasticity at mean β_i"[3]	long-run interest elasticity of demand[3]	long-run income elasticity of demand[3]	$\bar{R}^2$	SER ($\hat{\rho}$)
Guatemala[1,4]	0.866*†	-0.172		0.277	-0.010	-0.014	1.197	0.777	0.067
	(0.225)	(0.217)		(0.186)					(-0.285)
Honduras[4]	0.903*†	-2.397		0.866*	-0.085	-0.634	6.726	0.796	0.096
	(0.414)	(1.895)		(0.122)					(0.153)
Mexico[4]	0.490*	-5.078*		1.076*	-0.178	-2.334	6.433	0.942	0.097
	(0.201)	(2.530)		(0.094)					(0.135)
Nicaragua	0.344		5.648	0.746*	0.243	0.958	1.356	0.983	0.093
	(0.278)		(4.261)	(0.151)					(-0.150)
Paraguay	1.984*†		-4.028	0.730*	-0.173	-0.637	7.295	0.937	0.124
	(0.550)		(5.563)	(0.190)					(-0.143)
Peru[1,4]	0.713*†		0.031	0.689*	0.004	0.013	2.293	0.940	0.111
	(0.203)		(0.182)	(0.109)					(-0.071)
Uruguay[1,4]	1.772*†	0.129		0.306	0.047	0.068	2.556	0.107	0.135
	(1.005)	(0.100)		(0.257)					
Venezuela	0.675*†	-0.351		0.837*	-0.012	-0.075	4.130	0.987	0.097
	(0.304)	(2.071)		(0.087)					

NOTES TO TABLE 21

Standard error in parenthesis. Constant not shown.

1. In only one case, Brazil, was the implicit opportunity cost, $\hat{P}_t - \hat{P}_{t-1}$, in the chosen specification: Brazil = -0.237*.
2. The elasticity was calculated by multiplying coefficient β_i by the appropriate mean interest rate.
3. The long-run elasticities were calculated by dividing coefficients, β_i and β_y, by $(1-\beta_{-1})$.
4. The CPI was used to deflate H for: Bolivia, Colombia, Costa Rica, Guatemala, Honduras, Mexico, Peru and Uruguay.

* = significantly different from zero at $\alpha = 0.05$, one-tailed test.

† = not significantly different from unity at $\alpha = 0.05$, two-tailed test.

of Tables 18-21 indicate that the standard framework for monetary analysis is useful in the context of these Latin American countries.

Several important reservations must be expressed here. First, more elaborate and fruitful attempts at modeling "permanent" series should be made. That is, permanent income and price level series should be generated and utilized in the regression analysis. Second, incorporating expectations of inflation which are closer to rational behavior (in the Muthian sense) than the simple myopia utilized here would also be informative. Finally, better interest rate data would be helpful. As this last caveat may be very difficult to remedy other possible opportunity cost measures should be explored.

FOOTNOTES TO CHAPTER IV

1. See Dornbusch (1973) as an exponent of the monetary approach who uses this framework.

2. See Friedman (1959) for empirical estimates of the demand for money in the U.S.; see Friedman and Schwartz (forthcoming) for such estimates for the U.S. and U.K.: see Adelkunle (1968), Clark (1973), Gandolfi and Lothian (1978), Macesich (1970), and Melitz (1976), for such estimates for industrialized countries; see Deaver (1970), Diz (1970), and Silveira (1973) for such estimates for some Latin American countries.

3. The nominal rate of return on money would be the interest paid on demand deposits. Klein (1974) discusses ways this is accomplished and he incorporates these in a money demand specification for the U.S.

4. This formulation is taken from Friedman (1956a), p. 10.

5. This ignores the permanent/transitory dichotomy of income measurement propounded by Friedman and used to rationalize the cyclical rise in velocity with the secular decline in velocity in the U.S. See Friedman (1959), pp. 330-35.

6. Some adjustments <u>might</u> be made to transitory movements in real income; see Friedman (1959), p. 336.

7. Since the price level is fixed, real income has increased and so, therefore, have real cash balances demanded with i and $\hat{P}^E$ constant.

8. Just how short is the short-run is an empirical issue. However, even the most die-hard believer of rapid price arbitrage would have to concede that realistically not <u>all</u> prices will be arbitraged immediately. This raises the corollary question of the appropriate measure of the average level of prices which should be incorporated in the nominal money demand equation. My guess is that a more general index such as the GNP deflator or the CPI is better than a traded-goods price index for money demand analysis. The latter index is, however, more likely to demonstrate the effects of rapid arbitrage since the commodities analyzed are likely to be more nearly homogeneous.

9. Chetty (1969) has demonstrated the high degree of substitutability of time deposits (and hence M2) with the basic definition of money M1.

10. I do not plan to analyze term structure as it affects the demand for money in Latin America. Rather, I simply compare money demand estimates using alternatively short and long-term interest rates.

11. This ratio would be all the more important if the comparison were between currency and demand plus time deposits at commercial banks, as in Cagan (1965) and Friedman and Schwartz (1963). In that way, the substitution between currency and interest and non-interest bearing near moneys could be accounted for. In the cases I study here no such distinction is made. The ratio as it stands nevertheless reflects preferences to some degree.

12. The quantity theory is not always expressed in per capita terms but doing so does not affect the predictions.

13. Two points should be raised here. First, the usefulness of summary statistics as we normally use them depend crucially upon meeting the assumptions regarding the error term. Second, to avoid being fooled into accepting a spurious regression, I occasionally accepted one specification over another because the estimates were more in line with intuition than in the case of the "better" fitting regression.

14. Bolivia, Costa Rica and Ecuador cover 1952-1976, and Uruguay covers 1956-1975.

15. See Chapter II.

16. This form presumes that last periods desired real holdings are equal to the actual real holdings of that period.

CHAPTER V

THE DYNAMICS OF INFLATION: PART I--LATIN AMERICAN AND WORLD INFLATION

The purpose of this chapter is to analyze within a theoretical and empirical framework the relationship between the rate of inflation experienced by sixteen Latin American countries and rates of inflation external to those countries. In the first part of the analysis, I discuss the proposition regarding convergence of rates of inflation, and apply statistical tests to determine whether the proposition is valid. The second part of the analysis essentially deals with the purchasing-power-parity principle, and I apply ordinary least squares regression analysis to shed light on the issue of the influence of measures of world inflation on the domestic rate of inflation.

A. Introduction

One general implication of the monetary approach to balance of payments theory is that a small open economy maintaining a fixed exchange rate, in terms of an international asset, cannot operate a monetary policy independent of the rest of the world.[1] Ignoring the possibility of sterilization, the monetary authorities of a small country, when faced with a balance of payments surplus--an increase in official international reserve assets, can incur a quantity of additional liabilities equivalent to the increase in assets thereby expanding the nominal stock of high-powered money. This increase of course leads to an expansion of the nominal stock of money through the money-multiplier supply process.[2] The increase in the quantity of money will lead to a corresponding (one-shot) rise in the price level at full employment.

In the context of a growing world economy, a small country will continue to receive impulses to its nominal stock of money through the foreign component of its high powered money stock if the rest of the world continues to increase its supply of money relative to demand.

The argument is symmetric with respect to greater growth in the demand for money, by the rest of the world, relative to supply, inducing small country balance of payments deficits and reductions in its nominal stock of money. Given the evidence[3] regarding the relationship between money supply growth and inflation, the influence of rest-of-the-world money growth on small-country money growth implies that the rate of inflation a small open economy faces is an exogenous variable determined by the world rates of money growth and real income growth neither of which is affected by the behavior and/or policy actions of a small country. These latter growth rates (for the rest of the world) affect changes in the distribution of international reserve assets and hence high-powered money growth of a small open economy. Therefore a corollary of the monetary approach to a balance of payments theory for small open economies maintaining fixed exchange rates is that rates of inflation will tend to converge to a "world" rate of inflation which is determined by "world" money supply growth.[4]

In this chapter, I present results of statistical tests aimed at verifying two interrelated assumptions of the monetary approach to balance of payments theory using data on Latin America. Firstly, I show that the convergence of rates of inflation obtains for reasonably long periods, say fifteen to twenty years. However, for shorter periods during which policy considerations are of greatest importance, say three to five years, I provide evidence of considerable diversity in average rates of inflation across Latin American countries and the United States.

Secondly, I provide evidence below which indicates that variation in a "world" rate of inflation generally does not explain much of the variation in the domestic rate of inflation experienced by the Latin American countries. Moreover, I show that the transmission of percentage point increases in rates of inflation does not occur contemporaneously--within the current period. Together with the notion alluded to in the previous paragraph, that convergence of rates of inflation does take considerable time for the countries in this sample, these pieces of evidence imply that at any point in time (other than the long run) the rate of inflation may not be a completely rest-of-the-world determined characteristic for a small open economy.

B. On the Convergence of Rates of Inflation

In a world of completely integrated markets, price arbitrage will prevent prices for the same commodity from differing greatly, holding other things constant. If prices and price levels are equated across national boundaries and over time then rates of inflation would also not differ significantly. Completely integrated markets exist when tradeable commodities represent an important part of the production of a nation and therefore affect all markets through the demand for all commodities. The fact that Brazil is the largest supplier of coffee in the world is not, however, sufficient evidence that its markets are completely integrated.

As described in the previous section, the proposition that rates of inflation will converge to a "world" rate is consistent with the monetary approach to balance of payments theory. The integrated markets hypothesis (see Genberg, 1976 and Swoboda, 1977) also agrees with the convergence of rates of inflation. The inflation convergence proposition implies that, in an analysis of average rates of inflation, observed variation across countries should not be significantly different than observed variation in inflation (over time) within countries. One way of testing for the convergence of inflation rates is by comparing the dispersion across countries of average yearly rates of inflation, averaged over some period of time, relative to the average of within country dispersion of yearly rates of inflation, over the same period.[5] This is simply an analysis of variance but a statistical technique which makes use of several assumptions.

1. Some Theoretical Considerations

The following develops a representation of the world which would permit inflationary processes of a type which could validly be compared in an analysis of variance. Consider a world on a particular monetary standard, say a U.S. dollar standard, such as prevailed from the time of the Bretton Woods Agreement [1944] to approximately the third quarter of 1971 when the dollar could not longer be exchanged for gold by foreign central banks. During this time most countries did not deviate greatly from a fixed parity of their currency with the dollar. Occasionally, a number of countries devalued their currency with the acceptance of the other parties in the agreement. The Bretton Woods Agreement, along with the General Agreement on Tariffs and Trade (GATT) in 1947, promoted a situation of free trade and reasonably stable exchange rates.

Under a system such as this, markets for goods could become well integrated worldwide. In effect, under these circumstances, the law of one price could be expected to prevail. That is, any tendency for one price in one part of the world to differ (in efficiency units[6]) from that price in the rest of the world would be eliminated by arbitrage. Given little barriers to free trade, any arbitrage required to reduce price differences could be carried out. If prices are equated both across countries and every time period, then rates of inflation would not differ. But as Whitman (1975) points out, the law of one price is an assumption about an empirical issue. The law implies a quick and direct elimination of price differences and differences in rates of inflation, as well as a high degree of substitutability of traded commodities.

The world economy described above would have a single average level of prices and rate of inflation. Data on any one country could be considered as a single sample from a population (represented by the world). The analysis of variance (F-test) described earlier could then be applied[7] to test the validity of the assumption. The F-test compares the extent to which country (sample) average rates of inflation differ from the world (population) average rate of inflation relative[8] to the extent to which a country's observations differ from that country's average rate of inflation, for all countries (samples). The test also presumes that the variance of the rate of inflation of one country does not significantly differ from the variance for other countries.

Of course, a violation of the conditions of this system would show up as greater variation across countries than within countries. The most obvious violation would be any one of many forms of trade restrictions. By imposing tariffs, quotas or exchange controls, a country can, in effect, partially close its economy to the rest of the world. The price level of the country closed by trade barriers would then deviate from the world average. Moreover, if the imposition of these barriers varies from period to period as to their level and/or market placement, then the domestic rate of inflation would also deviate from the world rate of inflation. The relationship of the domestic price level of a small country and the price level of the rest of the world can be depicted algebraically using the following expression of purchasing-power-parity[9]:

$$P_d = e'_d \, P_w(1-\tau) \tag{14}$$

where P_d is the domestic price level of a particular country, e'_d is an index[10] of the rate of exchange of the domestic currency unit for a unit of world currency, P_w is the rest-of-the-world price level, and τ is a measure of trade impediments as a proportion of the world price level. If $e'_d = 1$, a constant exchange rate through time, and $\tau = 0$, then $P_e = P_w$, even in the short run.

Taking expected values[11] of equation (14) and assuming e'_d and τ are constant[12] over time, I obtain

$$E(P_d) = e'_d(1 - \tau) \; E(P_w) \tag{15}$$

where "E" is the mathematical expectations operator. If $e'_d = 1$ and $\tau = 0$, then the average domestic price level will equal the average world price level. Under these same conditions, the variances of the price levels will be equal, i.e.,

$$\mathrm{VAR}(P_d) = (e'_d)^2 \; (1 - \tau)^2 \; \mathrm{VAR}(P_w) \tag{16}$$

with $e'_d = 1$ and $\tau = 0$, $\mathrm{VAR}(P_d) = \mathrm{VAR}(P_w)$. However, if $\tau \neq 0$ then the average price levels can differ even if $e'_d = 1$, and so will their respective variances. That is, the existence of (constant) tariffs, for example, will drive a wedge between the domestic price level and that prevailing in the rest of the world.

I obtain a similar relationship for rates of inflation by computing the rate of change of equation (14):

$$\hat{P}_d = \hat{e}_d' + \hat{P}_w - \hat{\tau} \qquad (14')$$

where a circumflex, ^, represents a percentage change.

The relationship between mean rates of inflation and the variance of these rates is:

$$E(\hat{P}_d) = E(\hat{e}_d') + E(\hat{P}_w) - E(\hat{\tau}) \qquad (15')$$

$$VAR(\hat{P}_d) = VAR(\hat{e}_d') + VAR(\hat{P}_w) + VAR(\hat{\tau}) \qquad (16')$$

If e_d' and τ are constants (τ not necessarily zero), then the average rates of inflation, over time, will be equal and so will their variances, $E(\hat{P}_d) = E(\hat{P}_w)$ and $VAR(\hat{P}_d) = VAR(\hat{P}_w)$.[13] But from a period of transition from one level of trade impediments, say τ_1--not necessarily zero--to another, say τ_2, the domestic rate of inflation, $\hat{P}_d$, would differ from that prevailing in the rest of the world, $\hat{P}_d - \hat{P}_w = \hat{\tau}$. Nevertheless, this difference would be washed out over longer periods assuming that the average change in trade restrictions nets to zero (and $\hat{e}_d' = 0$), $E(\hat{P}_w) - E(\hat{P}_d) = E(\hat{\tau}) = 0$.

Another source of potential divergence of price levels and rates of inflation is non-fixity of exchange rates. If intercountry trade is free of restriction, then purchasing-power-parity suggests that

$$P_d = e_d' \, P_w \qquad (17)$$

If e_d' is constant, then by taking expected values and variances, I obtain:

$$E(P_d) = e_d' \, E(P_w) \qquad (18)$$

and

$$VAR(P_d) = (e_d')^2 \, VAR(P_w) \qquad (19)$$

With the exchange rate index set to unity, the average domestic price level and its variance are equal to the average world price level and its variance, respectively. This also holds instantaneously not merely for longer than one time period.

Furthermore, I derive a similar relationship for rates of inflation by taking percentage changes of equation (17):

$$\hat{P}_d = \hat{e}_d' + \hat{P}_w \qquad (17')$$

By taking expected values and, for mathematical simplicity, assuming $\hat{e}_d'$ and $\hat{P}_w$ are uncorrelated,[14] I obtain:

$$E(\hat{P}_d) = E(\hat{e}_d') + E(\hat{P}_w) \qquad (18')$$

and

$$VAR(\hat{P}_d) = VAR(\hat{e}_d') + VAR(\hat{P}_w) \qquad (19')$$

If $\hat{e}_d'$ is constant--the exchange rate appreciates/depreciates at the same rate each period, then the average exchange-rate-adjusted domestic rate of inflation will equal the average world rate of inflation and similarly for the respective variances, $E(\hat{P}_d) - \varepsilon =$

$E(\hat{P}_w)$ and $VAR(\hat{P}_d) = VAR(\hat{P}_d - \varepsilon) = VAR(\hat{P}_w)$ where $\varepsilon = E(\hat{e}_d')$ is the constant rate of exchange rate adjustment.

Even if $\hat{e}_d'$ is not constant but on average the rate of appreciation/depreciation is zero, then average rates of inflation will not differ.[15] Thus, adjusting for exchange rates and assuming no trade impediments, domestic and rest-of-the-world rates of inflation should converge, equalize on average over some time period. However, at any point in time (or during the short run) if purchasing power parity does not hold, say because an (series of) exchange rate adjustment(s) is not one of equilibrium then the average adjusted domestic rate of inflation will differ from the average rate of inflation in the rest of the world.

2. Empirical Results

As alluded to earlier, an analysis of variance is a useful way of testing the validity of the convergence proposition. Over the sample period, 1947-1976, the exchange rate of most of these countries increased, that is, these currencies devalued. Only three currencies remained constant: El Salvador 2.5 colones/$; Guatemala 1.0 quetzal/$; Honduras 2.0 lempiras/$. Other countries adjusted their exchange rate repeatedly: Argentina, Brazil, Chile, Colombia, and Uruguay. Still others adjusted their exchange rate only intermittently with long periods between adjustments: Costa Rica, Ecuador, Mexico, and Nicaragua. Mexico, for example, kept its exchange rate at 12.5 pesos per dollar for the period 1955 to 1975. Thus, in this regard, differences in inflation rates should be significant across Latin America.

The analysis of variance was performed in a number of ways. First, the average rate of inflation was calculated as the (uncorrected) first logarithmic difference of the Consumer Price Index for each country, with 1970 = 1.00. The test was applied for several periods: 1947-1976, 1956-1975, and 1956-1971. The first period covers the entire availability of data on country CPI's. The second period refers to a period over which sufficient data was available to generate a world price index (see Appendix B). The last period refers to a time frame approximately covering the dollar standard throughout the world. The test was applied to the entire sample of countries, including the United States. In addition, the test was applied to the subgroup of countries which had an average rate of inflation of 7% per annum or less for the corresponding periods. The F-statistics are listed in Table 22.

The results are interesting in a number of respects. First, we indicated in the second column 2 of Table 22, the average rates of inflation do differ across this broad sample of countries. This, in itself, is not surprising since during these periods most of these countries did not maintain a constant exchange rate.

Second, and perhaps more interestingly, for the subgroup of low-inflation countries--Costa Rica, Ecuador, El Salvador, Guatemala Honduras, Mexico, Nicaragua, Venezuela, and the U.S.--there was no significant difference in average rates of inflation for the periods 1947-1976 and 1956-1975. These countries were on a fixed exchange rate system, although Costa Rica, Ecuador, and Mexico did have

TABLE 22

F-TEST FOR CONVERGENCE OF RATES OF INFLATION

$\hat{P}_{it} \equiv \ln CPI_{it} - \ln CPI_{it-1}$

H_0: $\bar{\hat{P}}_i = \bar{\hat{P}}_j = \bar{\hat{P}}$, that average unadjusted rates of are equal.

Time Period	Across Countries including U.S. $F(16,n^2)$	Across Low-Inflation[1] Countries including U.S. $F(8,m^3)$
1947 - 1976	134.24*	1.49
1956 - 1975	127.50*	1.38
1956 - 1971	161.42*	4.53*

* reject null hypothesis at $\alpha = 0.05$.

1. Low-Inflation countries: Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Venezuela and the United States, had less than 7% inflation as measured by the growth in their unadjusted consumer price index.

2. Degrees of freedom of denominator: for 1947-1976 = 261, for 1956-1975 = 323, for 1956-1971 = 255.

3. Degrees of freedom of denominator: for 1947-1976 = 261, for 1956-1975 = 171, for 1956-1971 = 133.

several devaluations each in the early part of the longer period. The latter part of each of these periods was marked by higher rates of inflation worldwide and higher variability of inflation rates.[16]

However, for the period 1956-1971, the group of low-inflation countries does exhibit significantly different rates of inflation. During this period only four of the countries had an exchange rate adjustment: Costa Rica devalued its colon by 18% in 1961, Ecuador devalued its sucre by 20% in 1961 and again by 39% in 1970, Nicaragua devalued its cordoba by 3% in 1958, and Venezuela devalued its bolivar by 38% in 1964 but revalued by 2% in 1971. All of these adjustments were accounted for in the periods 1947-1976 and 1956-1975 plus several other exchange rate adjustments.

The degree to which these adjustments were responsible for the apparent difference in average rates of inflation, for this subgroup, is not clear. One possible reason could be that the exchange rates and their adjustments do not reflect a complete nor equilibrium adjustment. Another explanation could be that the variation within countries for the longer periods, inclusive of the period 1972-1976, was relatively greater than that for 1956-1971. Hence, with the same variation across low-inflation countries in 1956-1971 and the longer periods, the F-ratio would be insignificant for the longer periods but not 1956-1971. The variation across low-inflation countries for 1956-1975 (and 1947-1976) is smaller than the respective variation for 1956-1971. However, the variation within these countries for the longer periods is larger than the respective variation for the period 1956-1971.[17] Hence the decrease, over time, in the dispersion of average inflation rates across these low-inflation countries could explain the appearance of significant inter-country dispersion for the period 1956-1971.

I attempted to correct for changes in the exchange rate of all currencies by applying a similar F-test to average rates of inflation adjusted for devaluations (and/or revaluations). I first converted the domestic CPI for each country to dollar equivalents by dividing the domestic CPI by the ratio of the contemporaneous exchange rate to the exchange rate that prevailed in the base year, 1970. This procedure left the price index with a base 1970 = 1.00. I then computed the first logarithmic difference and therefore the adjusted rate of inflation was simply the difference between the rate of growth of the domestic CPI and the rate of exchange rate adjustment. The F-statistics for the analysis of variance of these data are listed in Table 23.

These statistics indicate that differences in the average adjusted rates of inflation across all countries are not significant. This, of course, is the expected result for a world monetary system in the long run which the averages over sixteen and twenty years represent. Also of interest is the observation that the F-ratios rise as the analysis covers less of the most recent and volatile price period, 1972-1976. As alluded to earlier, in moving from the longest period, 1947-1976, to the shortest period, 1957-1971, the variation across countries rose while the variation within countries fell (see footnote 17).

TABLE 23

F-TEST FOR CONVERGENCE OF RATES OF INFLATION ADJUSTED FOR EXCHANGE RATE CHANGES

$$P'_{it} \equiv XR_{i1970}\, CPI_{it}/XR_{it}$$

$$\hat{P}'_{it} \equiv \ln P'_{it} - \ln P'_{it-1}$$

H_0: $\bar{\hat{P}}'_i = \bar{\hat{P}}'_j = \bar{\hat{P}}'$, that average exchange-rate-adjusted rates of inflation are equal.

Time Period	Across Countries including U.S. $F(16,n^2)$	Across Low-Inflation[1] Countries including U.S. $F(8,m^3)$
1947 - 1976	0.08	0.29
1956 - 1975	0.24	0.66
1956 - 1971	0.36	1.24

1. Low-Inflation countries: Costa Rica Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Venezuela and the United States, had less than 7% inflation as measured by the growth in their unadjusted consumer price index.

2. Degrees of freedom of denominator: for 1947-1976 = 493, for 1956-1975 = 323, for 1956 - 1971 = 255.

3. Degrees of freedom of denominator: for 1947-1976 = 261, for 1956-1975 = 171, for 1956-1971 = 133.

An additional F-test, for the convergence of inflation rates, was applied to screen out the effects of exchange rate adjustments. For this test I computed the average rate of inflation for all countries for only those years during which they maintained a fixed exchange rate, using the domestic CPI and excluding the rate of inflation for the year in which the new exchange rate prevailed. The mean and variance of the rate of inflation for each country is listed in Table 23, along with the number of years for which these statistics apply. As indicated at the bottom of Table 24, the difference in average rates of inflation across countries is significant at the 5% level. The calculation of this last F-statistic was dominated by the long periods for which several countries maintained a fixed exchange rate: Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Venezuela, and of course the U.S. This is clearly not consistent with the convergence proposition. Since the country averages do not refer to precisely the same periods, the inference is that the convergence proposition is not a stable relationship across time periods <u>and</u> across countries. That is, the previous tests (Tables 22 and 23) compare average rates of inflation across countries over the same time periods. This latest test, however, compares averages across countries over time bounds which overlap but are not completely subsets.

For the most part the results presented in Tables 22 and 23 represent evidence that for long periods of time of sixteen to twenty years, average rates of inflation in Latin America and the U.S. as a whole do not differ greatly. Table 24, however, does

TABLE 24

AVERAGE RATE OF INFLATION AND VARIANCE
FOR PERIODS OF FIXED EXCHANGE RATES

$$\hat{P}_{it} \equiv \ln CPI_{it} - \ln CPI_{it-1}; \quad CPI_{i1970} \equiv 1.00.$$

H_0: $\bar{\hat{P}}_i = \bar{\hat{P}}_j = \bar{\hat{P}}$, that average unadjusted rates of inflation are equal.

Country	Mean (%)	Variance ($\%^2$)	Number of Observations (T_i)
Argentina	20.30	246.	9
Bolivia	5.67	12.	12
Brazil	10.56	72.	7
Chile	18.37	37.	9
Colombia	10.79	83.	6
Costa Rica	2.56	3.	11
Ecuador	2.87	10.	18
El Salvador	4.73	42.	30
Guatemala	3.22	23.	30
Honduras	2.97	11.	30
Mexico	5.64	26.	20
Nicaragua	3.76	34.	18
Paraguay	5.68	38.	16
Peru	9.57	18.	11
Uruguay	12.63	18.	5
Venezuela	2.94	24.	23
United States	3.61	12.	30

$\bar{\hat{P}} \equiv \Sigma T_i \hat{P}_i / T = 5.54; \qquad T \equiv \Sigma T_i = 285.$

$F(16,285) = 10.11$, significant at $\alpha = 0.05$.

suggest that care should be taken when considering different time periods for each country as a methods of comparison.

Additional F-tests were performed to determine if convergence held over shorter periods of time. These tests were performed in several different ways. First, the average dispersion within countries for several sub-periods was compared to the average dispersion within countries over the full periods 1956-1971 and 1956-1975. These periods were disaggregated into three year and five year sub-periods. The test results are presented in Table 25. These results indicate in nearly every case that the dispersion of inflation rates over time within countries was generally constant. That is, the average dispersion of inflation within countries for a sub-period, say 1966-1970, was not greater than the dispersion within countries for the full period 1956-1975. Thus, in the shorter run (3 and 5 years) within country variation is equal to its longer run counterpart (16 to 20 years).

However, when comparing the variation across countries for a sub-period with the variation across countries for the full period, a significant difference generally exists. That is, the dispersion in average rates of inflation from the group average for a sub-period, say 1966-1970, was greater than that for the full period 1956-1975. Thus even after adjusting for exchange rate changes, short run (3 to 5 years) differences in rates of inflation still exist across this group of countries.

The F-statistics listed in Table 26, when combined with the statistics in Tables 23 and 25, yield some implications for rational

TABLE 25

F-TEST COMPARING VARIATION IN AVERAGE RATES OF INFLATION WITHIN COUNTRIES, ADJUSTED FOR EXCHANGE RATE CHANGES

Time Period	Mean Variation WITHIN Countries ($\%^2$)	Compared to Variation WITHIN Countries for 1956 - 1971[1] F(48,256)[3]	Compared to Variation WITHIN Countries for 1956 - 1975[2] F(48,320)[3]
1956 - 1958	2254.74	4.11*	3.68*
1959 - 1961	88.01	0.16	0.14
1962 - 1964	319.54	0.58	0.52
1965 - 1967	292.21	0.53	0.48
1968 - 1970	81.81	0.15	0.13
		F(80,256)[3]	F(80,320)[3]
1956 - 1960	141.63	0.26	0.23
1961 - 1965	299.00	0.54	0.49
1966 - 1970	147.73	0.27	0.24
1971 - 1975	737.38	1.34*	1.20

* statistically significant at $\alpha = 0.05$.

1. Variation within countries for 1956-1971 = 549.00($\%^2$).

2. Variation within countries for 1956-1975 = 611.81($\%^2$).

3. Degrees of freedom.

TABLE 26

F-TEST COMPARING VARIATION IN AVERAGE RATES OF INFLATION ACROSS COUNTRIES, ADJUSTED FOR EXCHANGE RATE CHANGES

Time Period	Mean Variation ACROSS Countries ($\%^2$)	Compared to Variation ACROSS Countries for 1956 - 1971[1] F(16,16)[3]	Compared to Variation ACROSS Countries for 1956 - 1975[2] F(16,16)[3]
1956 - 1958	381.75	30.64*	52.38*
1959 - 1961	107.55	8.63*	14.76*
1962 - 1964	21.53	1.73	2.95*
1965 - 1967	83.00	6.66*	11.39*
1968 - 1970	57.31	4.60*	7.86*
1956 - 1960	142.29	11.42*	19.52*
1961 - 1965	16.66	1.34	2.28†
1966 - 1970	19.22	1.54	2.64*
1971 - 1975	54.41	4.37*	7.47*

†statistically significant at $\alpha = 0.10$.
* statistically significant at $\alpha = 0.05$.

1. Variation across countries for 1956-1971 = 12.46($\%^2$).

2. Variation across countries for 1956-1975 = 7.29($\%^2$).

3. Degrees of freedom.

expectations models of expected price formation. I infer from the results of Table 23 that residents of countries in this sample will do well in forecasting the long-term average domestic rate of inflation by using a weighted average of the rates that prevail in other Latin American countries and the U.S.--adjusting for any future exchange rate changes. I infer from Table 25 that residents will do well in forecasting short-term intra-country variability of inflation by using the long-run counterpart. However, I infer from Table 26 that long-term dispersion of rates of inflation across countries is not a good predictor of short-term intercountry dispersion. That is, short-term forecasts of domestic rates of inflation based on some weighted short-term average of inflation in other Latin American countries and the U.S. will be less precise (greater variation) than the long-term forecasts based on a long-term average. Therefore, rational agents should base their short-term forecasts on neither long-term convergence nor short-term dispersion that only accounts for exchange rate adjustments but ignores other differences, say in real per capita income growth. The inflation convergence proposition therefore can be accepted as a long-run phenomenon but one which does not necessarily hold for short periods of time.

C. The Relationship between Small-Country and World Inflation

According to the purchasing-power-parity principle and the integrated markets hypothesis, no difference should exist between rates of inflation experienced by a small country and that prevailing in the rest of the world (see Section B of this chapter). Moreover, the adjustment of the rate of inflation in a small country to an external rate impulse should be rapid under these conditions. That is, within the current period, percentage point increases in the rate of inflation for the rest of the world should be (nearly) completely reflected in the inflation rate of a small country.

The relationship between the rate of inflation external to a small country and its own domestic rate can be represented as a derivative of a variant of the purchasing-power-parity relationship. Suppose the price level of a small country can be represented as:

$$P_{dt} = A_t \, e'_{dt} \, P_{wt} \tag{20}$$

where A_t is a shift parameter which could drive a wedge between the domestic, P_{dt}, and world, P_{wt}, price levels, e.g., trade impediments, and e'_{dt} is an index of the exchange rate. By taking the first logarithmic derivative of equation (20), I obtain

$$\hat{P}^{\bullet}_{dt} = \hat{A}_t + \hat{e}'_{dt} + \hat{P}_{wt} \tag{20'}$$

where a circumflex represents a percentage change.

The validity of this relationship can be tested via regression analysis in several forms, e.g.,

$$\hat{P}_{dt} = a + b\,\hat{e}_{dt} + c\,\hat{P}_{wt} + u_t \tag{21}$$

or

$$\hat{P}'_{dt} = a + c\,\hat{P}_{wt} + v_t \tag{22}$$

where $\hat{P}'_{dt}$ is the domestic rate of inflation adjusted by the rate of exchange rate change, and u_t and v_t are serially uncorrelated random normal variates with zero means and constant variances. In effect, equation (22) estimates a similar relationship to equation (21) except that (22) restricts the coefficient b in (21) to be unity. If there are no exchange rate changes during the sample period, then equations (21) and (22) are formally equivalent, once we drop $\hat{e}'_{dt}$ from equation (21). Under this condition ($\hat{e}'_{dt} = 0$, for all t) the relationship to be estimated is

$$\hat{P}_{dt} = a + c\,\hat{P}_{wt} + u_t \qquad (21')$$

Before proceeding with the discussion of the values I expect the coefficients of regressions of the form of equation (21') to obtain, indeed before presenting the empirical results, one important disclaimer should be made here. Namely, the rather naive nature of the purchasing power relationship as presented above is one which is implicit in much of the literature on the monetary approach to the balance of payments. Its simplicity lies in the fact that no allowance for adjustment over time is permitted. That is, as postulated above, price levels and rates of inflation are equated instantaneously. On a theoretical level, that no lags in adjustment exist is a heavy burden for most macroeconomic relationships to bear. Nevertheless, researchers have been content to make the empirical assumption that no lags exist. It is partly my aim to demonstrate that the naive representation of PPP is made on shaky empirical grounds, at least for Latin America.

1. The Intercept

The ordinary least squares regression intercept estimate $\tilde{a} = E(\hat{P}_{dt}) - \tilde{c}\, E(\hat{P}_{wt})$, where E( ) indicates a mean value and a tilda, ~, represents a point estimate. Over long periods of time we expect the average rate of inflation throughout the world to be equalized, say for 16 to 20 year periods (see Section B.2 above). If, on average, $\tilde{c}$ is not different from unity, the regression intercept should be zero, i.e.,

$$E(\tilde{a}) = E(\hat{P}_{dt}) - E(\tilde{c})\, E(\hat{P}_{wt}) \tag{23}$$

That is, with $E(\tilde{c}) = 1$ and $E(\hat{P}_{dt}) = E(\hat{P}_{wt})$ the intercept term will equal zero, $E(\tilde{a}) = 0$.

Several factors might cause differences between rates of inflation to prevail resulting in the intercept being different than zero. First, any one of a number of impediments to free trade will generally allow a small country to experience a rate of inflation different than the rest of the world. As alluded to in the previous section, (B.1), if the imposition of trade restrictions changes from time to time and the changes themselves change, i.e., are not a constant change, then the expected domestic rate of inflation will differ from that for the rest of the world, even if the exchange rate remains fixed.

Second, if the exchange rate changes in a non-constant fashion, then differences in rates of inflation will be observed. This effect is all the more likely when exchange rate changes are a matter of policy rather than the result of free market determination. For example, in the face of persistent balance of payments deficits under a fixed exchange rate regime a devaluation may be in order. If the extent of the adjustment is geared toward rectifying the current problem, can we expect the adjustment to prevent future (say, the next five years) disequalibria or even merely soften them? If the adjustment is made with the future clearly in mind, the currency might be undervalued in the short-run by over-depreciating the currency. This might have short-run advantages (some of which are strictly political), but no gain may be obtained in the future vis-a-vis balanced international payments or moderation of inflation. However, this policy will temporarily cause the domestic rate of inflation to diverge from the rate of inflation prevailing in the rest of the world.

Finally, the constant term in the regression (21') could be different from zero, even in the long run, if the coefficient of adjustment, c, were not unity. In the short-run the two factors mentioned above, trade impediments and exchange rate adjustments, would prevent quick and complete arbitrage from equalizing rates of inflation throughout the world. For example, by imposing heavy tariffs on imports and imposing exchange controls, a small country can, in effect, close itself to the rest of the world. Over time, as individuals compete for an artificially limited supply of goods, upward pressure would be exerted on domestic prices causing residents to seek less expensive substitutes. Unless these barriers are continually rivised, a leakage of expenditure will occur. Until this occurs, a divergence in rates of inflation will exist. The leakage will reduce the difference in rates of inflation. The question is how long will the process of convergence take--that is, reflected in the regression coefficient c.

2. The Slope--the Inflation Convergence Coefficient

That c is different than unity implies that goods markets between a small country and the rest of the world are not highly integrated. That is, when c is different than unity, arbitrage has not quickly and directly eliminated differences in prices and rates of inflation--the "law" of one price is violated. An obvious way of viewing this is by comparing the markets less developed nations are likely to deal in relative to those of the industrialized nations that dominate world trade--e.g., Germany, Japan, and the United States. If the respective goods markets are integrated, then the less developed nations might provide the industrialized nations with the necessary raw materials for manufactured goods, for example. These goods would then be exported to the less developed nations. However, if demand for these manufactured goods is small, then the scope for arbitrage to operate to eliminate differences in rates of inflation is limited. Minimally, some time would be required for the small sphere of influence to exert itself sufficiently to cause inflation rates to converge. Only fortuitiously would rates of inflation be equalized. Thus, even though markets are integrated in the sense that one party is supplying the raw materials and demanding the finished products of the other party which is demanding the raw materials, the transmission of increases in the rate of inflation may not be complete unless the respective markets are highly integrated, at least in the short-run. That is, these markets must be significant enough in magnitude to quickly influence the general level of prices.

Another factor which could cause the adjustment to be incomplete, i.e., c different than unity, would be differences in the rate of technological innovation. A small country receiving impulses to its price level and domestic rate of inflation through a balance of payments surplus might be able to sustain the increased aggregate demand because of higher productivity--real per capita income growth. Indeed, the monetary approach to balance of payments theory predicts a surplus on the international accounts of those countries which grow, in real terms, faster than the rest of the world (see, e.g., Swoboda, 1977, p. 22).

Tests of the expected relationship between the rate of inflation experienced by a small country and that prevailing in the rest of the world were made. Regressions of the form of equations (21) and (22), repeated here for convenience, were performed for the 16 Latin American countries:

$$\hat{P}_{dt} = a + b\,\hat{e}'_{dt} + c\,\hat{P}_{wt} + u_t \qquad (21)$$

$$\hat{P}'_{dt} = a + c\,\hat{P}_{wt} + v_t \qquad (22)$$

The rate of inflation for the small country, in equation (21), was simply the first logarithmic difference of the domestic Consumer

Price Index. For specification (22) the rate of growth of the domestic CPI was adjusted for exchange rate changes. Two measures of the rate of inflation in the rest of the world were used. The first was simply the first logarithmic difference in the Consumer Price Index for the United States. The second measure was the first logarithmic difference of a weighted average of the CPI, converted to dollar equivalent, for the countries in the sample, excluding the country being studied, plus the United States.[18] The regressions were performed for the periods 1956-1975 and 1956-1971. The former period refers to the period over which sufficient data was available for the construction of the rest of the world indices. The latter period refers to that period of time during which the world was on the dollar standard. During these two periods, only four countries did not adjust their currency in relation to the dollar: El Salvador, Guatemala, Honduras, and Mexico.

In Tables 27.A and 27.B I present results for specification (21), with the uncorrected domestic rate of inflation as the dependent variable, covering the periods 1956-1975 and 1956-1971, respectively. In general the corrected R^2's for the regressions with the rest of the world inflation rate as the independent variable are greater than those for the regressions with the U.S. rate of inflation. Also the regressions for the longer period have higher corrected R^2's.[19]

In general, the performance of this specification is poor. In only eight of the sixteen cases does the set of explanatory variables account for a majority of the variation in the uncorrected

TABLE 27.A

SUMMARY OF REGRESSION RESULTS[1] FOR INTEGRATED MARKETS HYPOTHESIS, 1956-1975

$$\hat{P}_{dt} = a + b\,\hat{e}'_{dt} + c\,\hat{P}_{wt}$$

Country	Constant	$\hat{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\bar{R}^2$	SER	DW
Argentina	0.022'	0.304*	0.049†		0.491	0.164	1.73
	(0.062)	(0.073)	(1.536)				
	0.218'	0.278*		0.191†	0.494	0.193	2.24
	(0.044)	(0.114)		(0.652)			
Bolivia	0.040	0.251*	2.330†		0.581	0.106	2.18
	(0.075)	(0.053)	(1.670)				
	0.087	0.243*		0.557†	0.495	0.110	2.24
	(0.058)	(0.054)		(0.533)			
Brazil	0.246'	0.348*	-1.321		0.451	0.106	1.00
	(0.053)	(0.103)	(0.968)				
	0.208'	0.377*		-0.255	0.415	0.110	1.00
	(0.043)	(0.103)		(0.307)			
Chile	-0.012	0.460*	7.409*		0.830	0.212	1.63
	(0.081)	(0.096)	(2.517)				
	0.044	0.410*		4.821*†	0.789	0.235	1.57
	(0.086)	(0.149)		(2.506)			
Colombia	0.079'	-0.031	1.263*†		0.118	0.069	1.77
	(0.027)	(0.076)	(0.597)				
	0.093	-0.030		0.458*	0.196	0.066	2.08
	(0.020)	(0.072)		(0.179)			
Costa Rica	-0.024	0.316*	1.861*		0.831	0.027	1.77
	(0.010)	(0.104)	(0.258)				
	0.002	0.346*		0.598*	0.875	0.023	1.67
	(0.007)	(0.087)		(0.068)			
Ecuador	-0.009	-0.064	1.800*		0.701	0.030	0.64
	(0.012)	(0.085)	(0.264)				
	0.017	0.018		0.548*	0.644	0.033	1.21
	(0.010)	(0.092)		(0.091)			
El Salvador[2]	-0.032'		1.634*		0.597	0.041	1.62
	(0.013)		(0.290)				
	-0.013			0.590*	0.820	0.022	2.76
	(0.006)			(0.061)			

(continued)

TABLE 27.A (cont'd)

Country	Constant	$\hat{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\bar{R}^2$	SER	DW
Guatemala[2]	-0.032'		1.596*		0.703	0.029	1.20
	(0.010)		(0.227)				
	-0.010			0.524*	0.772	0.022	1.82
	(0.007)			(0.062)			
Honduras[2]	-0.007		0.894*		0.430	0.033	1.41
	(0.009)		(0.215)				
	0.006			0.283*	0.434	0.037	1.67
	(0.007)			(0.067)			
Mexico[2]	0.0003		1.609*		0.671	0.030	0.97
	(0.011)		(0.245)				
	0.024'			0.518*	0.707	0.027	1.79
	(0.008)			(0.073)			
Nicaragua	-0.033	1.217†	1.634*†		0.419	0.048	1.06
	(0.018)	(1.700)	(0.415)				
	-0.004	1.141†		0.447*	0.288	0.053	1.35
	(0.015)	(1.881)		(0.145)			
Paraguay	0.033	0.301*	0.866†		0.208	0.060	1.46
	(0.024)	(0.125)	(0.535)				
	0.045'	0.287*		0.282	0.221	0.060	1.68
	(0.018)	(0.121)		(0.165)			
Peru	0.062'	0.080	0.840*†		0.194	0.040	1.66
	(0.016)	(0.090)					
	0.070'	0.048		0.342*†	0.372	0.036	1.77
	(0.010)	(0.080)		(0.098)			
Uruguay	0.176'	0.241	3.124*†		0.226	0.198	1.54
	(0.082)	(0.133)	(1.729)				
	0.226'	0.222		1.021*†	0.230	0.197	1.41
	(0.067)	(0.135)		(0.555)			
Venezuela	-0.004	0.042	0.789*†		0.414	0.023	1.57
	(0.009)	(0.073)	(0.201)	0.274*			
	0.007	0.016		(0.054)	0.550	0.020	1.72
	(0.006)	(0.063)					

$\hat{P}_{dt}$ ≡ the domestic rate of inflation; $\hat{P}_{us}$ ≡ the U.S. rate of inflation;
$\hat{P}_w$ ≡ the rest-of-the-world rate of inflation; $\hat{e}'_d$ ≡ the rate of exchange rate adjustment.

' - significantly different from zero at a=0.05, two-tailed test.
* " " " " " " , one-tailed test.
† not " " " " " " , two-tailed test.
1. Standard error of coefficient in parenthesis. 2. No exchange rate changes during this period.

TABLE 27.B

SUMMARY OF REGRESSION RESULTS[1] FOR INTEGRATED MARKETS HYPOTHESIS, 1956-1971

$$\hat{P}_{dt} = a + b\,\hat{e}'_{dt} + c\,\hat{P}_{wt}$$

Country	Constant	$\hat{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\bar{R}^2$	SER	DW
Argentina	0.293'	0.200	-3.338†		0.008	0.144	1.96
	(0.080)	(0.194)	(2.380)				
	0.290'	0.278		-3.273	0.134	0.140	2.04
	(0.068)	(0.190)		(1.903)			
Bolivia	0.098	0.250	0.208†		0.567	0.192	2.36
	(0.099)	(0.054)	(3.207)				
	0.099	0.250*		0.130†	0.567	0.192	2.36
	(0.095)	(0.054)		(2.550)			
Brazil	0.318'	0.292*	-3.529*		0.456	0.110	0.89
	(0.072)	(0.113)	(1.912)				
	0.311'	0.346*		-3.507*	0.515	0.104	0.84
	(0.058)	(0.101)		(1.628)			
Chile	0.267'	-0.078	-0.374†		-0.113	0.098	1.18
	(0.053)	(0.126)	(1.628)				
	0.260'	-0.080		-0.049	-0.118	0.099	1.20
	(0.049)	(0.136)		(1.430)			
Columbia	0.108'	-0.014	-0.255†		-0.146	0.071	2.24
	(0.036)	(0.079)	(1.175)				
	0.117'	-0.006		-0.524†	0.084	0.070	2.22
	(0.034)	(0.080)		(0.943)			
Costa Rica	0.006	0.076	0.543†		0.205	0.013	1.46
	(0.007)	(0.087)	(0.225)				
	0.006	0.083		0.450*	0.222	0.013	1.38
	(0.007)	(0.086)		(0.180)			
Ecuador	0.009	0.011	0.850†		0.010	0.028	0.74
	(0.014)	(0.084)	(0.489)				
	0.018	0.031		0.556†	0.036	0.023	0.89
	(0.014)	(0.085)		(0.394)			
El Salvador[2]	-0.0008		0.239†		-0.044	0.024	2.96
	(0.012)		(0.391)				
	-0.004			0.288	-0.087	0.023	2.97
	(0.011)						

(continued)

TABLE 27.B (cont'd)

Country	Constant	$\overset{*}{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\bar{R}^2$	SER	DW
Guatemala[2]	-0.006		0.389*		0.153	0.011	2.08
	(0.006)		(0.173)				
	-0.006			0.320*	0.168	0.010	1.88
	(0.005)			(0.137)			
Honduras[2]	0.008		0.188		-0.131	0.022	1.08
	(0.011)		(0.353)				
	0.006			0.228	-0.101	0.021	1.06
	(0.010)			(0.280)			
Mexico[2]	0.024		0.555†		-0.017	0.025	1.51
	(0.012)		(0.404)				
	0.023			0.496†	0.019	0.024	1.48
	(0.011)			(0.315)			
Nicaragua	-0.013	1.501†	0.603†		0.065	0.032	0.68
	(0.016)	(1.158)	(0.531)				
	-0.014	0.552		0.552†	0.090	0.032	0.67
	(0.015)	(0.424)		(0.424)			
Paraguay	0.076'	0.259*	-1.025		0.328	0.051	1.74
	(0.027)	(0.107)	(0.865)				
	0.077'	0.261*		-0.890	0.342	0.050	1.69
	(0.026)	(0.106)		(0.681)			
Peru	0.878'	0.030	-0.159†		0.138	0.038	1.82
	(0.019)	(0.088)	(0.621)				
	0.864'	0.032		-0.090	-0.140	0.038	1.83
	(0.018)	(0.089)		(0.501)			
Uruguay	0.201	0.224	1.522†		0.028	0.208	1.33
	(0.113)	(0.148)	(3.416)				
	0.221	0.218		0.687†	0.018	0.209	1.30
	(0.107)	(0.148)		(2.772)			
Venezuela	0.008	0.025	0.245†		-0.113	0.022	1.71
	(0.012)	(0.073)	(0.377)				
	0.010	0.015		0.156	-0.126	0.022	1.68
	(0.011)	(0.071)		(0.297)			

$\hat{P}_{dt}$ ≡ the domestic rate of inflation; $\hat{P}_{us}$ ≡ the U.S. rate of inflation;
$\hat{P}_w$ ≡ the rest-of-the-world rate of inflation; $\hat{e}'_d$ ≡ the rate of exchange rate adjustment

' significantly different from zero at a=0.05, two-tailed test.
* " " " " " " , one-tailed test.
† not " " " unity " " , two-tailed test.

1. Standard error of coefficient in parenthesis. 2. No exchange rate during this period.

domestic rate of inflation, i.e., $\bar{R}^2 \geq 0.510$: Bolivia, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Mexico, and Venezuela.

In terms of the expected values of the coefficients, the results are equally poor. The coefficient for the rate of exchange rate adjustment is expected to be unity. Yet in only one case of the twelve for which this is a relevant variable, Nicaragua, is the coefficient not significantly different from unity in a statistical sense. Moreover, in that one case the coefficient is not significantly different from zero. In the seven cases for which a statistically significant coefficient was obtained, the coefficient for the exchange rate adjustment variable was less than 0.500.

The constant term should prove insignificant if markets are sufficiently well integrated. Considering the four variants presented in Tables 27.A and 27.B, we see that for eleven of the sixteen cases the constant term is statistically different from zero using a two-tailed test at a level of significance of 5%. Only Bolivia, Ecuador, Honduras, Nicaragua, and Venezuela do not have a significant constant term. The most interesting aspect of this result is the variety of countries for which we obtain this result. These include countries with: no exchange rate adjustment--El Salvador and Guatemala; infrequent exchange rate adjustment--Costa Rica and Paraguay; and frequent exchange rate adjustment--Brazil and Chile.

The results for the coefficient of adjustment of the domestic rate of inflation to the world rate, c, are very different for the two periods, implying a lack of stability in the relationship between the rates of inflation. For the longer period, 1956-1975, seven cases have an adjustment coefficient which is statistically significant and which is not significantly different from unity: Chile (4.8); Colombia (1.3); Honduras (0.9); Nicaragua (1.6); Peru (0.8); Uruguay (1.0); and Venezuela (0.8). However, in only one case of these seven is the corrected R^2 greater than 0.5: Costa Rica (0.789). Moreover, these results pertain to regressions with the U.S. rate of inflation as the independent variable--the specification with the lower corrected R^2.

While the adjustment coefficient for the regressions over the longer period are generally statistically significant--even in those cases when c is different from unity, the coefficient for the shorter period, 1956-1971, is generally not significantly different from zero. Indeed, in only one case is the coefficient both different from zero and not different from unity: Costa Rica (0.5). In this lone case the corrected R^2 dropped to 0.205 (from 0.789 for the longer period).

The results for regressions of specification (22), Tables 27.C and 27.D, using the domestic rate of inflation adjusted for exchange rate changes as the dependent variable, are worse than those for specification (21). For the period 1956-1975, only two cases of the twelve which had exchange rate adjustments had a corrected R^2 greater than 0.4: Argentina (0.48) and Nicaragua (0.415). For the period 1956-1971, only two cases have a positive corrected R^2. Even though this specification does not explain much of the variation in the adjusted domestic rate of inflation, in only

TABLE 27.C

SUMMARY OF REGRESSION RESULTS[1] FOR INTEGRATED MARKETS HYPOTHESIS, 1956-1975[2]

$$\hat{P}'_{dt} = a + c\,\hat{P}_{wt}$$

Country	Constant	$\hat{P}_{us}$	$\hat{P}_{w}$	$\bar{R}^2$	SER	DW
Argentina	0.234	-5.425†		0.014	0.403	1.69
	(0.152)	(3.502)				
	0.237'		-3.148*	0.481	0.293	1.80
	(0.078)					
Bolivia	-0.292	6.842†		-0.034	0.653	1.60
	(0.246)	(5.666)				
	-0.149		1.484†	-0.079	0.667	1.66
	(0.190)		(1.824)			
Brazil	0.022	0.512†		-0.112	0.189	2.45
	(0.071)	(1.642)				
	0.037		0.037†	-0.114	0.190	2.44
	(0.053)		(0.523)			
Chile	0.065	-2.221†		-0.085	0.347	2.56
	(0.071)	(3.014)				
	0.157		-3.619*	0.090	0.318	2.69
	(0.110)		(1.782)			
Colombia	-0.035	0.726†		-0.110	0.230	2.44
	(0.086)	(1.995)				
	-0.031		0.324†	-0.101	-0.230	2.46
	(0.065)		(0.625)			
Costa Rica	-0.014	1.165*		0.204	0.050	2.59
	(0.019)	(0.432)				
	-0.0002		0.413*	0.289	0.047	2.50
	(0.013)		(0.129)			
Ecuador	-0.028	1.577*		0.073	0.089	2.59
	(0.035)	(0.818)				
	-0.013		0.621*	0.181	0.089	2.30
	(0.025)		(0.242)			
Nicaragua	-0.032	1.631*		0.415	0.046	1.08
	(0.017)	(0.403)				
	-0.004		0.446*	0.285	0.051	1.36
	(0.015)		(0.140)			

(continued)

TABLE 27.C (cont'd)

Country	Constant	$\hat{P}_{us}$	$\hat{P}_{w}$	$\bar{R}^2$	SER	DW
Paraguay	-0.013	1.565*		0.058	0.098	1.63
	(0.037)	(0.855)				
	0.013		0.436†	0.020	0.100	1.77
	(0.029)		(0.274)			
Peru	0.023	0.799†		-0.072	0.105	2.33
	(0.039)	(0.909)				
	0.038		0.200	-0.089	0.106	2.37
	(0.030)		(0.288)			
Uruguay	-0.029	1.810†		-0.093	0.327	2.62
	(0.123)	(2.838)				
	0.012		0.350†	-0.109	0.329	2.37
	(0.094)		(0.908)			
Venezuela	-0.036	1.319*†		0.096	0.074	2.24
	(0.028)	(0.640)				
	-0.013		0.357	0.040	0.076	2.15
	(0.022)		(0.207)			

$\hat{P}'_{dt}$ ≡ domestic rate of inflation adjusted for exchange rate changes; $\hat{P}_{us}$ ≡ U.S. rate of inflation; $\hat{P}_{w}$ ≡ the rest-of-the-world rate of inflation.

' significantly different from zero at α = 0.05, two-tailed test.
* significantly different from zero at α = 0.05, one-tailed test.
† not significantly different from unity at α = 0.05, two-tailed test.

1. Standard error of coefficient in parenthesis.

2. No exchange rate changes were made for El Salvador, Guatemala, Honduras and Mexico during this period.

TABLE 27.D

SUMMARY OF REGRESSION RESULTS[1] FOR INTEGRATED MARKETS HYPOTHESIS, 1956-1971[2]

$$\hat{P}'_{dt} = a + c\,\hat{P}_{wt}$$

Country	Constant	$\hat{P}_{us}$	$\hat{P}_{w}$	$\bar{R}^2$	SER	DW
Argentina	0.145	-2.685†		-0.111	0.212	2.75
	(0.104)	(3.480)				
	0.211'		-4.600†	0.006	0.196	2.59
	(0.091)		(2.616)			
Bolivia	-0.310	8.509†		-0.113	0.729	1.55
	(0.358)	(11.955)				
	-0.217		4.073†	-0.140	0.737	1.59
	(0.355)		(9.732)			
Brazil	0.024	0.261†		-0.153	0.214	2.47
	(0.105)	(3.507)				
	0.116		-3.015†	-0.075	0.206	2.22
	(0.099)		(2.983)			
Chile	0.087	-1.971†		-0.134	0.244	2.45
	(0.120)	(4.008)				
	0.172		-4.430†	-0.004	0.230	2.18
	(0.110)		(3.070)			
Colombia	0.022	-2.128†		-0.133	0.253	2.47
	(0.124)	(4.128)				
	0.073		-3.414†	-0.066	0.246	2.41
	(0.116)		(3.192)			
Costa Rica	-0.021	1.222*†		0.079	0.040	2.24
	(0.019)	(0.649)				
	-0.022		1.040*†	0.108	0.039	2.28
	(0.019)		(0.514)			
Ecuador	0.028	-1.122†		-0.110	0.092	2.53
	(0.045)	(1.505)				
	0.018		-0.621†	-0.133	0.093	2.53
	(0.044)		(1.220)			
Nicaragua	-0.012	0.609†		-0.049	0.031	0.83
	(0.015)	(0.516)				
	-0.014		0.568†	-0.012	0.031	0.76
	(0.015)		(0.407)			

(continued)

TABLE 27.D (cont'd)

Country	Constant	$\hat{P}_{us}$	$\hat{P}_w$	$\bar{R}^2$	SER	DW
Paraguay	0.007	0.515†		-0.147	0.106	1.77
	(0.052)	(1.737)				
	0.014		0.202†	-0.152	0.106	1.80
	(0.051)		(1.396)			
Peru	0.039	0.072†		-0.154	0.117	2.40
	(0.058)	(1.918)				
	0.062		-0.684†	-0.138	0.116	2.41
	(0.055)		(1.527)			
Uruguay	-0.052	2.693†		-0.137	0.354	2.56
	(0.174)	(5.804)				
	0.021		-0.114†	0.000	0.356	2.57
	(0.171)		(4.724)			
Venezuela	-0.038	1.358†		-0.078	0.083	2.25
	(0.041)	(1.362)				
	-0.009		1.191†	-0.152	0.086	2.11
	(0.042)		(1.132)			

$\hat{P}'_{dt}$ ≡ domestic rate of inflation adjusted for exchange rate changes; $\hat{P}_{us}$ ≡ the U.S. rate of inflation; $\hat{P}_w$ ≡ the rest-of-the-world rate of inflation.

' significantly different from zero at $\alpha = 0.05$, two-tailed test.
* significantly different from zero at $\alpha = 0.05$, one-tailed test.
† not significantly different from unity at $\alpha = 0.05$, one-tailed test.

1. Standard error of coefficient in parenthesis.

2. No exchange rate changes were made for El Salvador, Guatemala, Honduras and Mexico during this period.

one instance is the constant term significantly different from zero: Argentina.

In terms of our expectations for the adjustment coefficient, c, the results are generally poor, for both periods, using specification (22). The coefficient is statistically significantly different from zero and not significantly different from unity in five cases for the period 1956-1975: Costa Rica (1.2); Ecuador (1.6); Nicaragua (1.6); Paraguay (1.6); and Venezuela (1.3). For the period 1956-1971, only Costa Rica (1.2) has a significant coefficient which is not different from unity. Moreover, only for the case of Nicaragua is the corrected R^2 greater than 0.4.

On the basis of these results, the integrated markets hypothesis for Latin American countries as a whole can be rejected. In an attempt to shed some light on possible other avenues through which differences in rates of inflation might show themselves, in the short run, regressions were performed using the same basic specifications as in (21) and (22) but augmented with a proxy for growth in aggregate demand not the result of higher prices. The measures used were the growth in real per capita gross domestic product and the difference between that growth rate and the growth in U.S. real per capita as well as the differential per capita growth rate of the small country and the rest of the world. That is, I ran regressions of the following form:

$$\hat{P}_{dt} = a + b\,\hat{e}'_{dt} + c\,\hat{P}_{wt} + f\,\hat{y}_{dt} + u_{dt} \qquad (24)$$

and

$$\hat{P}_{dt} = a + b\,\hat{e}'_{dt} + c\,\hat{P}_{wt} + g(\hat{y}_{dt} - \hat{y}_{wt}) + u_{zt} \quad (25)$$

where y_{jt} is real per capita income growth in the small country ($j = d$) and the rest of the world ($j = w$).

I use the real per capita income variables to proxy growth in the supply of the produce of a country and the differential with respect to the rest of the world. These growth rates will affect the growth in the respective demand for real cash balances. Holding world real income growth and all nominal money supply growth constant, the higher is the real per capita income growth of a small country the lower will be the domestic rate of inflation.

I also ran regressions (24) and (25) using the growth in the level of real GDP as well as four additional regressions with the exchange-rate-adjusted rate of inflation as the dependent variable and no exchange rate term on the right-hand side.

In Tables 28.A and 28.B I present results for the specification with the unadjusted domestic rate of inflation as the dependent variable, Table 28.A for the longer period. The regression equations listed represent the best equation for each country as indicated by the corrected R^2. As can be seen in these two tables, the constant is significant in seven of the sixteen cases, the exchange rate change coefficient is significant in only six of the twelve cases, and the adjustment coefficient is statistically different from zero and not different from unity for only Colombia (1.6), Costa Rica (0.6), Ecuador (1.0), and Nicaragua (1.3); of these only Costa Rica has a corrected R^2 smaller than 0.60.

TABLE 28.A

SUMMARY OF REGRESSION RESULTS[1] FOR ALTERNATIVE TESTS OF THE INTEGRATED MARKETS HYPOTHESIS, 1956-1975

$$\hat{P}_{dt} = a + b\,\hat{e}'_{dt} + c\,\hat{P}_{wt} + d\,\hat{y}_t$$

Country	Constant	$\hat{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\hat{y}_d$	$\hat{y}_d-\hat{y}_w$	$\bar{R}^2$	SER	DW
Argentina	0.193'	0.259*		1.288†		-1.270	0.596	0.142	1.23
	(0.043)	(0.063)		(0.995)		(0.514)			
Bolivia	0.008	0.130*		3.000*		-1.008*	0.908	0.080	1.03
	(0.028)	(0.025)		(0.555)		(0.112)			
Brazil	0.213'	0.322*	1.363†			-2.455*	0.719	0.076	2.17
	(0.039)	(0.074)	(0.948)			(0.592)			
Chile	0.030	0.403*	7.321*		-1.326		0.834	0.209	1.76
	(0.088)	(0.106)	(2.488)		(1.120)				
Colombia	0.074'			1.692*†		-1.398*	0.571	0.470	1.35
	(0.014)			(0.337)		(0.287)			
Costa Rica	-0.005	0.403*		0.568*	0.344*		0.891	0.022	1.55
	(0.007)	(0.087)		(0.066)	(0.184)				
Ecuador	-0.011		1.640*		0.244		0.781	0.029	0.75
	(0.011)		(0.280)		(0.190)				
El Salvador[2]	-0.009			0.586*	-0.242		0.827	0.022	2.60
	(0.008)			(0.062)	(0.284)				

(continued)

TABLE 28.A (cont'd)

Country	Constant	$\hat{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\hat{y}_d$	$\hat{y}_d-\hat{y}_w$	$\bar{R}^2$	SER	DW
Guatemala[2]	-0.016 (0.009)			0.535* (0.063)	0.257 (0.221)		0.789	0.023	1.95
Honduras[2]	0.005 (0.006)			0.567* (0.077)		-0.347* (0.159)	0.511	0.023	1.91
Mexico[2]	0.025 (0.014)			0.515* (0.077)	-0.050 (0.352)		0.707	0.027	1.81
Nicaragua	-0.014 (0.018)	1.272 (1.197)		1.262*† (0.202)		0.111 (0.176)	0.708	0.033	1.17
Paraguay	0.034 (0.020)	0.327* (0.127)		0.219 (0.175)	0.733 (0.694)		0.226	0.059	1.65
Peru	0.083' (0.012)			0.338* (0.092)		-0.464 (0.287)	0.444	0.034	1.55
Uruguay	0.080 (0.091)		6.179 (1.849)			-3.110* (1.156)	0.352	0.181	1.27
Venezuela	0.013 (0.007)			0.271* (0.051)	-0.257 (0.168)		0.603	0.019	1.62

$\hat{P}_d$ ≡ domestic rate of inflation; $\hat{P}_{us}$ ≡ the U.S. rate of inflation; $\hat{P}_w$ ≡ the rest-of-the-world rate of inflation; $\hat{e}'_d$ ≡ the rate of exchange rate adjustment; $\hat{y}_d$ ≡ the domestic rate of real per capita income growth; $\hat{y}_w$ ≡ the rest-of-the-world rate of real per capita income growth;

' significantly different from zero at $\alpha = 0.05$, two-tailed test; * one-tailed test; † not significantly different from unity at $\alpha = 0.05$, two-tailed test.

1. Standard error of coefficient in parenthesis. 2. No exchange rate changes during this period.

TABLE 28.B

SUMMARY OF REGRESSION RESULTS[1] FOR ALTERNATIVE TESTS OF THE INTEGRATED MARKETS HYPOTHESIS, 1956 - 1971

$$\hat{P}_{dt} = a + b\,\hat{e}'_{dt} + c\,\hat{P}_{wt} + d\,\hat{y}_t$$

Country	Constant	$\hat{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\hat{y}_d$	$\hat{y}_d-\hat{y}_w$	$\bar{R}^2$	SER	DW
Argentina	0.342' (0.070)	0.205 (0.181)		-3.533* (1.771)	-1.226* (0.695)		0.255	0.130	1.46
Bolivia	0.058' (0.014)	0.145* (0.009)		0.039 (0.446)		-0.942* (0.039)	0.991	0.027	1.64
Brazil	0.234' (0.061)	0.302* (0.086)	0.863† (1.999)			-2.366*	0.684	0.084	1.93
Chile	0.278 (0.024)			-2.403* (0.875)		0.512 (0.369)	0.222	0.080	1.65
Colombia	0.069' (0.013)			1.566*† (0.433)		-1.370* (0.262)	0.610	0.040	2.07
Costa Rica	0.008 (0.006)		0.582*† (0.239)		-0.115 (0.127)		0.208	0.013	1.50
Ecuador	0.012 (0.006)			0.976*† (0.188)		-0.118 (0.131)	0.648	0.017	1.08
El Salvador[2]	0.006 (0.014)			0.200 (0.312)	-0.369 (0.301)		0.026	0.023	2.89

(continued)

TABLE 28.B (cont'd)

Country	Constant	$\hat{e}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\hat{y}_d$	$\hat{y}_d - \hat{y}_w$	$\bar{R}^2$	SER	DW
Guatemala[2]	-0.007 (0.006)			0.328* (0.145)	0.030 (0.115)		0.172	0.011	1.92
Honduras[2]	0.005 (0.006)			0.399* (0.184)		-0.167 (0.169)	0.106	0.019	1.65
Mexico[2]	0.024 (0.012)		0.430† (0.411)			0.279 (0.023)	0.087	0.024	1.39
Nicaragua	-0.013 (0.008)	1.552 (0.927)		0.783*† (0.234)		0.080 (0.127)	0.404	0.025	1.35
Paraguay	0.089' (0.028)	0.261* (0.104)	-1.448 (0.897)			0.525 (0.392)	0.367	0.049	2.07
Peru	0.089' (0.015)		-0.108 (0.490)			-0.604* (0.213)	0.291	0.030	2.09
Uruguay	0.109 (0.133)		4.871† (3.848)			-3.006* (1.625)	0.094	0.200	1.10
Venezuela	0.010 (0.005)	0.079 (0.055)		0.196 (0.151)	-0.264* (0.079)		0.365	0.016	1.07

$\hat{P}_d$ ≡ domestic rate of inflation; $\hat{P}_{us}$ ≡ the U.S. rate of inflation; $\hat{P}_w$ ≡ the rest-of-the-world rate of inflation; e'_d ≡the rate of exchange rate adjustment; $\hat{y}_d$ ≡ the domestic rate of real per capita income growth; $\hat{y}_w$ ≡ the rest-of-the-world rate of real per capita income growth.

' significantly different from zero at $\alpha = 0.05$, two-tailed test; * one-tailed test. † not significantly different from unity at $\alpha = 0.05$, two-tailed test.

1. Standard error of coefficient in parenthesis. 2. No exchange rate changes during this period.

The coefficient on the variants of the real income growth variables was significantly different from zero in none of the cases. The expected value for the coefficient is less than zero, i.e., we expect the coefficient to have a negative value. The countries for which the coefficient for real per capita GDP growth was significant are: Costa Rica (0.3) and Venezuela (-0.3). The countries for which the coefficient on the difference in real per capita GDP growth was significant are: Argentina (-1.3); Bolivia (-1.0); Brazil (-2.5); Colombia (-1.4); Honduras (-0.3); Peru (-0.6); and Uruguay (-3.1). Even though the results are not exceptional, they do represent an improvement over the simple approach to the relationship between rates of inflation.

However, when we compare the results of the regressions using the exchange-rate-change-adjusted domestic rate of inflation as the dependent variable to those for the unadjusted rate of inflation, the former results are generally worse in a number of respects. First, in only three cases is the adjustment coefficient, c, both significantly different from zero <u>and</u> not different from one: Nicaragua (1.3); Paraguay (1.4); and Venezuela (1.2). Second, in only five of the twelve cases is the coefficient on the income growth variable significant. Moreover, in none of these five cases is the coefficient negative.

Overall, the results imply that the integrated markets hypothesis does not hold strongly for the sixteen Latin American countries. That is, in the short run the degree to which increases in the rate of inflation external to these small countries was

TABLE 28.C

SUMMARY OF REGRESSION RESULTS[1] FOR ALTERNATIVE TESTS OF THE INTEGRATED MARKETS HYPOTHESIS, 1956-1975[2]

$$\hat{P}'_{dt} = a + c\,\hat{P}_{wt} + d\,\hat{y}_t$$

Country	Constant	$\hat{P}_{us}$	$\hat{P}_w$	$\hat{y}_d$	$\hat{y}_d - \hat{y}_w$	$\bar{R}^2$	SER	DW
Argentina	0.212'		-3.062*	0.814		0.490	0.299	1.85
	(0.091)		(0.728)	(1.462)				
Bolivia	-0.214	1.647†		9.111*		0.186	0.596	2.28
	(0.227)	(5.713)		(4.251)				
Brazil	-0.012	2.755†			-1.996	0.003	0.184	2.56
	(0.073)	(2.266)			(1.428)			
Chile	0.134		-3.273	0.693		0.101	0.325	2.55
	(0.123)		(1.979)	(1.538)				
Colombia	-0.116	-0.650†		6.228*		0.119	0.211	2.72
	(0.088)	(1.943)		(2.966)				
Costa Rica	-0.015		0.382*	0.783*		0.464	0.042	2.39
	(0.014)		(0.016)	(0.333)				
Ecuador	-0.030		0.373	1.320*		0.426	0.076	2.37
	(0.023)		(0.228)	(0.489)				

(continued)

TABLE 28.C (cont'd)

Country	Constant	$\hat{P}_{us}$	$\hat{P}_w$	$\hat{y}_d$	$\hat{y}_d-\hat{y}_w$	$\bar{R}^2$	SER	DW
Nicaragua	-0.014 (0.009)		1.264*† (0.196)		0.104 (0.167)	0.722	0.032	1.22
Paraguay	-0.006 (0.023)		1.441*† (0.561)		0.325 (0.445)	0.369	0.081	1.91
Peru	0.008 (0.046)	0.850† (0.926)		0.614 (0.910)		-0.044	0.106	2.44
Uruguay	0.063 (0.123)	-0.140^{f} (2.818)		5.027* (2.563)		0.109	0.304	2.50
Venezuela	-0.006 (0.032)	1.197*† (0.614)		-1.071 (0.638)		0.224	0.070	2.26

$\hat{P}'_d$ ≡ domestic rate of inflation adjusted for exchange rate changes; $\hat{P}_{us}$ ≡ the U.S. rate of inflation; $\hat{P}_w$ ≡ the rest-of-the-world rate of inflation; $\hat{y}_d$ ≡ the domestic rate of real per capita income growth; $\hat{y}_w$ ≡ the rest-of-the-world rate of real per capita income growth.

' significantly different from zero at $\alpha = 0.05$, two-tailed test.
* significantly different from zero at $\alpha = 0.05$, one-tailed test.
† not significantly different from unity at $\alpha = 0.05$, two-tailed test.

1. Standard error of coefficient in parenthesis.

2. No exchange rate changes were made for El Salvador, Guatemala, Honduras and Mexico during this period.

TABLE 28.D

SUMMARY OF REGRESSION RESULTS[1] FOR ALTERNATIVE TESTS OF THE INTEGRATED MARKETS HYPOTHESIS, 1956-1971[2]

$$\hat{P}'_{dt} = a + c\,\hat{P}_{wt} + d\,\hat{y}_t$$

Country	Constant	$\hat{P}_{us}$	$\hat{P}_{w}$	$\hat{y}_{d}$	$\hat{y}_d - \hat{y}_w$	$\bar{R}^2$	SER	DW
Argentina	0.229' (0.101)		-4.769 (2.710)	-0.527 (1.048)		0.073	0.201	2.53
Bolivia	-0.180 (0.332)	1.452† (11.417)		9.576* (4.800)		0.147	0.661	2.30
Brazil	0.014 (0.101)	5.085† (4.584)		-3.530 (2.291)		0.025	0.204	2.42
Chile	0.154 (0.127)		-4.340† (3.185)	0.614 (1.893)		0.004	0.238	2.09
Colombia	-0.005 (0.103)		-5.714* (2.843)	8.636* (3.362)		0.292	0.208	3.00
Costa Rica	-0.021 (0.017)		0.644† (0.507)	0.667* (0.335)		0.316	0.035	1.72
Ecuador	-0.026 (0.044)	-0.244† (1.325)		2.287* (0.905)		0.256	0.078	2.24

(continued)

TABLE 28.D (cont'd)

Country	Constant	$\hat{P}_{us}$	$\hat{P}_w$	$\hat{y}_d$	$\hat{y}_d - \hat{y}_w$	$\bar{R}^2$	SER	DW
Nicaragua	-0.012 (0.008)		0.792*† (0.228)		0.054 (0.157)	0.373	0.024	1.55
Paraguay	-0.018 (0.027)		1.929*† (0.884)		0.383 (0.496)	0.245	0.086	1.82
Peru	0.051 (0.066)		-0.567† (1.618)	0.355 (1.073)		-0.128	0.120	2.46
Uruguay	0.102 (0.163)		-1.918† (4.431)	5.627* (2.937)		0.100	0.326	2.60
Venezuela	0.004 (0.048)	0.751† (1.360)		-1.153 (0.752)		0.088	0.079	2.26

$\hat{P}'_d$ ≡ domestic rate of inflation adjusted for exchange rate changes; $\hat{P}_{us}$ ≡ the U.S. rate of inflation; $\hat{P}_w$ ≡ the rest-of-the-world rate of inflation; $\hat{y}_d$ ≡ the domestic rate of real per capita income growth; $\hat{y}_w$ ≡ the rest-of-the-world rate of real per capita income growth.

' significantly different from zero at $\alpha = 0.05$, two-tailed test.
* significantly different from zero at $\alpha = 0.05$, one-tailed test.
† not significantly different from unity at $\alpha = 0.05$, two-tailed test.

1. Standard error of coefficient in parenthesis.

2. No exchange rate changes were made for El Salvador, Guatemala, Honduras and Mexico during this period.

transmitted is not great. Thus, although rates of inflation do converge in the long run because this convergence may not be completed within one period and the strength of the relationship of world and small country inflation rates may not be great, we should be careful when using the domestic rate of inflation as an exogenous determinant of the balance of payments--implicitly (or explicitly) assuming *a priori* that the domestic rate of inflation is not influenced by the same factors which affect the flow of international reserve assets.

FOOTNOTES TO CHAPTER V

1. For a more detailed discussion of the monetary approach, see Chapter III. Of course, the original theoretical arguments are expounded by Johnson(1958) and Mundell (1968,1971).

2. See Burger (1971) and Cagan (1965).

3. See Cagan (1956) and Friedman, and Schwartz (1963), as well as other studies on Latin American countries: Deaver (1970), Diz (1970), Harberger (1963), and Vogel (1974).

4. See Swoboda (1974) for a discussion of the distribution of reserves under a fixed exchange rate regime. Also, see Genberg and Swoboda (1977) and Heller (1976) for a discussion of worldwide inflation as determined by world money growth.

5. See Gandolfi and Lothian (1977) for a different approach to testing for convergence. See also Stigler and Kindahl (1971) for still another approach as applied to industrial prices with the U.S.

6. Although difficult to measure, the quality of products should not be different when comparing their prices. Therefore, I am assuming either that the products, the average price level of which I am comparing, are equivalent in quality terms or that the prices used to construct price levels have been adjusted for quality differences.

7. One additional necessary assumption is that the price level and the rate of inflation are generated as normal random processes. This allows the cross-country variation be represented as the sum of squared normal variates, i.e., as a χ^2 distribution--similarly for the average dispersion within countries--thus yielding an F-statistic as the ratio of two χ^2 variables.

8. The hypothesis, tested by the F-ratio suggested in the text, is that average rates of inflation do not differ, significantly, across Latin American countries and the U.S. That price levels and their rates of change are not the same at every point in time for a single country is well-known. That is, the rates of inflation experienced by a country exhibits some variability. The historical movements of inflation in one country may or may not run counter to the movements of inflation in another country. Therefore, if we hold the average (across country) variation (within country) of the rate of the inflation fixed, then any additional variation in average rates of inflation across countries will not represent the historical variability of inflation. In this regard, the analysis of variance suggested in the text tests for divergence across countries taking the historical movement in inflation as a datum.

9. See Swoboda (1977), p. 17.

10. Care must be taken in measuring and interpreting e_d'. If we are comparing prices measured in currency values then the appropriate exchange rate is simply the spot exchange rate measured in domestic currency units (per world currency unit). If however, we are comparing price levels measured as indices with some base, say 1970 = 1.00, then P_d is the ratio of current cost of some basket of goods in domestic currency units relative to base year costs in comestic currency units. Similarly, P_w is the ratio of current cost in world currency units to base year cost in world currency units. Therefore, e_d' should be the ratio of the current spot exchange rate to the spot exchange rate prevailing in the base year. Thus, for the base year: $e_d' = 1.00$.

11. The term "expected" value refers to the mathematical expectation, mean of a series, not the value which individuals anticipate will occur.

12. If e_d' and τ are not constant, but are uncorrelated with P_w, then the $E(P_d) = E(e_d') - E(\tau) + E(P_w)$. If their expected values are zero, i.e., depreciations are later offset by appreciations and import restrictions are later offset by import subsidies (generally unlikely), then $E(P_e) = E(P_w)$. This will not necessarily be true of the variances of the respective price levels.

13. Note that if $\hat{\tau} \neq 0$ and $\hat{\tau}$ and $\hat{P}$ are uncorrelated, then: $VAR(\hat{P}_d) = VAR(\hat{P}_w) + VAR(\hat{\tau})$. Thus, even if $E(\hat{\tau}) = 0$ if $VAR(\hat{\tau}) \neq 0$, the domestic variance of inflation will be greater than the world variance of inflation.

14. That $\hat{e}_d'$ and $\hat{P}_w$ are uncorrelated is an assumption which might be questioned. However, the relationship between rest-of-the-world and the rate of exchange rate adjustment would imply either a flexible exchange rate regime or that the monetary authorities react to domestic inflation relative to world inflation in setting the price of their currency not balance of payments disequilibrium. The second alternative would present a serious problem if balance of payments disequilibrium simultaneously represented an equivalent difference in price levels. The relationship between differences in

rates of inflation and balance of payments is an issue to which I speak in the next chapter.

15. This is not necessarily true for the variances. For example, suppose a country depreciates by x% half the time and appreciates by x% the other half. Then $E(\hat{e}_d') = 1/2x - 1/2x = 0$, but $VAR(\hat{e}_d') = 1/2(x)^2 + 1/2(-x)^2 = x^2 \neq 0$.

16. For the periods 1947-1976, 1956-1975, and 1956-1971, the average rate of inflation and the variance of inflation, both averaged across countries, were (after exchange rate adjustments):

	All Countries		Low-Inflation Countries	
	$E(\hat{P})$(%)	$VAR(\hat{P})(\%^2)$	$E(\hat{P})$(%)	$VAR(\hat{P})(\%^2)$
1947-1976	2.73	548.0	2.80	538.9
1956-1975	2.29	576.0	2.80	441.1
1956-1971	1.15	517.0	1.61	218.9

whereas, for the subperiods 1966-1970, 1971-1975, and 1973-1975:

	All Countries		Low-Inflation Countries	
	$E(\hat{P})$(%)	$VAR(\hat{P})(\%^2)$	$E(\hat{P})$(%)	$VAR(\hat{P})(\%^2)$
1966-1970	3.44	139.0	1.82	251.9
1971-1975	5.81	694.0	8.45	384.4
1973-1975	7.94	1033.7	11.72	287.8

The low-inflation countries were chosen on the basis of their respective nominal (uncorrected for exchange rate adjustment) domestic rate of inflation.

17. The variation across countries in average inflation rates for 1947-1976, 1956-1975, and 1956-1971 are 0.717($\%^2$), 1.527($\%^2$), and 2.133($\%^2$), respectively for low-inflation countries. The variation within countries in the average rate of inflation for the same periods are 60.63($\%^2$), 49.62($\%^2$), and 24.63($\%^2$), respectively. This is consistent with the results on dispersion presented by Salant (1977) for 21 OECD countries (see pp. 169-72).

18. See Appendix B for a discussion of the method of construction of the world price index and the validity of such an index.

19. This is the case because the variation in the rate of inflation within countries was generally greater for the longer periods. Hence, more "real" points of movement could be fitted. For the shorter period, it was harder to fit a relationship with the relatively little variation in the dependent variable. See footnote 17.

CHAPTER VI

THE DYNAMICS OF INFLATION: PART II--IS THE DOMESTIC RATE OF INFLATION EXOGENOUS?

In the last chapter, I tested the proposition that a strong relationship exists between the rate of inflation experienced by a small open economy and the rate of inflation external to it through a variant of the purchasing power parity principle. I showed that the variation in average rates of inflation across Latin America and the United States was not significantly different from the average variation of inflation within these countries. In effect, the domestic rate of inflation tended to converge to the average rate prevailing in the rest of the world--on average, over periods of sixteen and twenty years--once I accounted for the underlying variability in each country's rate of inflation.

However, I also showed that the correspondence between internal (domestic) and external rates of inflation was weak as a short run proposition. That is, generally only a minority of the variation in domestic rates of inflation was explained by measures of external inflation, whether using the U.S. rate of consumer price inflation or using a nominal-income-weighted average of U.S. and other Latin American countries' rates of consumer price inflation.

In light of that evidence for the sample of Latin American countries, it seems valid to ask: to what extent is it appropriate to treat the domestic rate of inflation as an exogenously determined variable and as an exogenous determinant of the balance of payments? In order to answer this question fully, the analytical framework must be explicit. The model should include a discussion of the concepts of causality and exogeneity as well as the overall point of references from which to view the behavior to be explained. That is, are we analyzing the relationships among economic aggregates of a single country per se or only as a small part of a larger world system? I now turn to these points.

A. The Framework

The basic issue I seek to analyze is the treatment of the rate of inflation experienced by a small country as an exogenous variable in a monetary model of the balance of payments. In developing the analysis, it is important to distinguish several characteristics of the model.

1. Causality

The discussion of causality, within an economic context, has its roots in the works of Koopmans (1950) and Simon (1953).[1] These ideas have been generalized by Sims (1972b, 1975, 1977) to incorporate the definition propounded by Granger (1969). The concept of causality or causal ordering may imply something about the meaning of relationships in a model; for example, are they (relationships) behavioral or structural? But the term causality itself merely reflects a property of the logical organization of a model in terms of the interaction of variables.

Specifically, consider[2] a space of possible outcomes, S_n, which represents the set of n-tuples of economic events which are of interest; for example: the domestic rate of inflation; the world rate of inflation; monetary conditions domestically and abroad; exchange rate regimes; the balance of payments; etc. Suppose further that a number of restrictions can be placed upon set S_n. For simplicity, suppose restrictions R_1 and R_2 yield meaningful economic outcomes. For example, restriction R_1 might refer to events occurring under a fixed exchange rate regime. R_1 could be expressed algebraically as the subset of S_n for which the rate of change of the domestic currency price of a reserve currency is zero, or the subset occurring when exchange rate adjustments result from autonomous domestic government policy action.[3] Restriction R_2 could, for example, refer to economic events occurring for countries which have highly integrated markets for commodities with the rest of the world. R_2 could be expressed simply as the assumption that purchasing power parity holds or that the parity principle holds for certain commodities, e.g., tradeables or factors or securities or monies.

The combination of these two restrictions results in a set of events which is a subset of all relevant outcomes, S_n, i.e., $R_1 \cap R_2 \subset S_n$. Furthermore, consider two functions, T_X and T_Y, which map S_n into spaces X and Y, respectively. Spaces X and Y represent the realizations of two characteristics of the economic system such as, for example, the domestic rate of inflation and the balance of payments. That is, $T_X(S_n) = X$ and $T_Y(S_n) = Y$.

Given a model characterized by R_1, R_2, and Y, a causal ordering from X to Y is defined[4] if and only if realizations Y are generated from only one subset of outcomes, say R_1, and realizations X can be generated from the subset of outcomes R_1 or $R_1 \cap R_2$. That is, X is causally prior to Y if and only if

$$T_Y(R_1) = Y$$

and

$$T_X(R_1) = T_X(R_1 \cap R_2)$$

For example, if the fixity of exchange rates (R_1) is sufficient to generate balance of payments positions (Y) and the integrated markets hypothesis (R_2) does not affect such positions, nor does R_2 affect the domestic rate of inflation (X) but variations in the domestic rate of inflation are not necessarily determined by the fixity of exchange rates, then the domestic rate of inflation causes the balance of payments. In other words, the conditions for causality are restrictions on a set of dynamic relations which help to identify that model.

Thus, continuing the example, in a small country monetary model of the balance of payments under a fixed exchange rate regime, where demanders and suppliers of money treat the price level (and rate of inflation) as given in determining the quantity of money, both demand and supply relationships should exhibit a causal ordering from inflation to money and therefore to the balance of payments via the hoarding function. Clearly, a crucial assumption is that both the residents of a small country and the monetary authorities behave as if the rate of inflation is out of their control or, more strictly, that they do not try to affect the time path of the rate of inflation by adjusting their holdings of cash. I will return to this point later on. Suffice it to say, any attempt by the monetary authorities to control inflation through, for example, changes in the growth rate of the money supply--whether successful or otherwise, would generally invalidate the causal ordering from inflation to money under the assumptions given. This point is implicit in the traditional assumption that no attempt at sterilizing monetary inflows is made by the central bank.

2. Exogeneity

The concept of exogeneity is a statistical one. The definition of causality used here implies that some variables in a model are exogenous. Suppose we have the following model:

$$a_1^* y + a_2^* x = u \qquad \text{(i)}$$

$$b_1^* y + b_2^* x = v \qquad \text{(ii)}$$

where "*" denotes the convolution operation defined as

$$c{*}Z = \sum_{s=-\infty}^{\infty} c(s)\ z(t-s)$$

To avoid the existence of unstable operators, c's, which in the presence of causality requirements implies explosive z's, assume

$c(s) = 0$ for $s < 0$ and normalize by setting[5] $a_1(0) = b_2(0) = 1$.

The definition of causality given above results if $b_1(s) = 0$, for all s, with $u(r)$ and $v(s)$ mutually uncorrelated, for all r and s. x is exogenous in the first relationship (i), if $x(r)$ and $u(s)$ are are uncorrelated for all r and s. Exogeneity is implied by the definition of causality inasmuch as the second relationship (ii) is between x and v only and no relationship exists between v and u. Thus, x is determined outside relationship (i).

However, exogeneity does not necessarily imply causality. That is, that x is exogenous in a realtionship such as (i) does not imply that x causes y since relation (ii) need not exist--in which case we would have to pretend to have some *a priori* theory to tell us whether x or y was the dependent variable, or u and v could be correlated. In other words, causality and exogeneity are not equivalent. However, by placing additional restrictions on the set of outcomes, $R_1 \cap R_2$, equivalence can be obtained, e.g., if $y(r)$ and $v(s)$ are uncorrelated for all r and s.

Perhaps an example will clarify these ideas. First, I let $\hat{F}$ equal the rate of change of official reserve assets holdings, i.e., a proportion of the official settlements balance of payments. Second, I let $\hat{P}$ be the domestic rate of inflation measured as the rate of change of the domestic consumer price index. Further, I postulate the following relationships:

$$a*\hat{F} + b*\hat{P} = u \qquad \text{(iii)}$$

$$c*\hat{P} = v \qquad \text{(iv)}$$

where "*" denotes convolution and u and v are (vectors of) random variables. By working with only one-sided distributed lags, no future values, and normalizing a and c to be equal to unity at time t, I rearrange terms to obtain:

$$\hat{F}(t) = - \sum_{s=1}^{\infty} a(s)\, \hat{F}(t-s) - \sum_{r=0}^{\infty} b(r)\, \hat{P}(t-r) + u \qquad \text{(v)}$$

$$\hat{P}(t) = - \sum_{s=1}^{\infty} c(s)\, \hat{P}(t-s) + v \qquad \text{(vi)}$$

For $\hat{P}$ to be exogenous in this model, I restrict $\hat{P}(r)$ and u(s) to be uncorrelated for all r and s. But if v and u are correlated, then $\hat{P}$ cannot be said to cause $\hat{F}$; indeed, the problem of simultaneity exists. That is, without the restriction of zero correlation between u and v, the "unknown" determinants of $\hat{P}$ influence $\hat{F}$ in two ways--through $\hat{P}$ and through v--thereby confounding the issue of causality.

On the other hand, if I begin by restricting u and v to be a covariance-stationary process,[6] then $\hat{P}$ will be a causal-exogenous determinant of $\hat{F}$. In this case the unspecified factors which influence $\hat{P}$ will influence $\hat{F}$ only through the determination of $\hat{P}$, whereas no feedback exists from $\hat{F}$ to $\hat{P}$.

The assumptions made to this point are all testable hypotheses.[7] Hypothesis tests of this nature were applied in the context of different models, most notably by Sargent (1973, 1976a) and Sims (1977b).[8] The direction of causality in the aggregate money-income relationship was first tested by Sims. His results suggest, for post-World War II

U.S. data, money causes income. Using data for the U.K., Williams et al. (1976) found evidence of bi-directional causality. This points out the model revision necessary when the basic assumptions are violated. That is, Williams et al. postulate essentially the same model as Sims. But if policy differences exist between these bodies of data then the structure of the model should also change. This is the principle propounded by Lucas (1970, 1976) which Wallace (1976) calls a non-invariance argument. The policy differences in the Sims vs. Williams et al. example might be the difference between the reserve currency status of the U.S. and the small-country status of the U.K.

In any case, the example I drew earlier would be susceptible to tests of hypotheses regarding correlations among u, v and $\hat{\dot{P}}$. Moreover, the effects of policy changes would also be discernible when comparing countries with different policy regimes, specifically different exchange rate regimes.

3. A Monetary Model

The perspective of the econometric model I propose to analyze is of a small open economy. I want to test the validity of the assumption that the rate of inflation experienced by such a nation is independent of the factors which determine the balance of payments. That is, from the point of view of the small country, is the rate of inflation an exogenous determinant of other variables? The analysis is confined to models of a single country although it is applied to sixteen Latin American countries. The model therefore treats each country as a single observable entity. The focus of the simple model described in Chapter III has been on the balance of payments and treats the rate of inflation as given at every point in time. My focus is to explore the possibility of treating the rate of inflation of a small country as endogenous--as it would be in a world model.

The discussion of the existence of a causal ordering and the conditions for exogeneity indicates that a model by definition incorporates, explicitly or implicitly, statements regarding these characteristics. Hence, a test for causality (and exogeneity) is really a test for possible specification error in the proposed model. In the inflation/balance-of-payments example described above, the specification that a small country has a rate of inflation which is determined in the rest of the world is questionable for the Latin American countries studied here. A weak link was found to exist between small country and rest-of-the-world inflation. Thus, calling into question the specification of the small-country rate of inflation as exogenously determined and therefore so also questioning the treatment of the domestic rate of inflation as an exogenous determinant of the balance of payments.

I would like to formulate a general model which begins with a specification of the demand for real cash balances as a stable[9] function of real income and an opportunity cost measure of holding cash. A money supply is also specified as having a proportional relationship to high powered money. An equilibrium condition equates nominal money supply to demand. In addition, I postulate several relationships regarding the formation of inflationary expectations.

The model can be expressed in general dynamic terms, from which a special case is shown to conform to the simple model analyzed in an earlier chapter.

$$a_1^* \hat{M}^d + a_2^* \hat{y} + a_3^* \hat{i} + a_4^* \hat{P} + a_5^* \hat{N} = u_1 \tag{26}$$

$$b_1^* \hat{M}^s + b_2^* \hat{h} + b_3^*(\theta(\hat{e}+\hat{R}) + (1-\theta)\hat{DH}) = u_2 \tag{27}$$

$$c_1^* \hat{P}_W^E + c_2^* \hat{P}^E + c_3^* \hat{e} = u_3 \tag{28}$$

$$f_1^* \hat{P}_W^E + f_2^* \hat{M}_W = u_4 \tag{29}$$

$$g_1^* \hat{P} + g_2^* \hat{P}^E = u_5 \tag{30}$$

$$k_1^* \hat{M}^d + k_2^* \hat{M}^s = u_6 \tag{31}$$

The variables are defined as follows:

M ≡ nominal narrow money stock; d = demanded; s = supplied;

y ≡ real gross domestic product;

i ≡ nominal interest rate;

P ≡ price level;

h ≡ money multiplier = M/H;

H ≡ nominal high powered money = $F + DH = eR + DH$;

R ≡ foreign reserves in reserve currency units = F/e;

DH ≡ domestic component of high powered money;

e ≡ exchange rate of domestic currency units for reserve currency;

N ≡ population;[10]

θ ≡ ratio of foreign reserves to high powered money--

where a circumflex indicates a percentage growth rate, the "W" subscript indicates a rest-of-the-world aggregate, an "E" superscript indicates an expectational variable, "*" indicates convolution, and the u_j's are random variates.

Equation (26) is a representation of the demand for real cash balances allowing for distributed lags in the relationship. Equation (27) represents the supply of money as a proportion of high powered money which has been decomposed into its foreign and domestic components. The relationship between the expected domestic rate of inflation and its determinants is described in (28). Equation (29) postulates a rational inflation-expectations formation relationship for the rest of the world. Equation (30) postulates the adjustment of expected domestic inflation to actual domestic inflation. Finally, equation (31) represents equilibrium in the money market which is usually simplified[11] with setting $u_6 = 0$, $k_1(0) = k_2(0) = 1$, and $k_1(r) = k_2(r) = 0$ for $r \neq 0$: simply, $\hat{M}^d = \hat{M}^s$.

These equations can be greatly simplified to conform to what I have called the "simple" model. First, let the operators $a_i(r)$ and $b_j(r)$ be zero for $r \neq 0$ and all i, j. Next, let $\hat{e} = 0$. Also, let $\hat{P} = \hat{P}^E = \hat{P}^E_W = \hat{P}_W$. Assuming $a_1 = b_1 = 1$, the model then reduces to

$$\hat{M}^d = - a_2 \hat{y} - a_3 \hat{i} - a_4 \hat{P} - a_5 \hat{N} + u_1$$

$$\hat{M}^w = - b_2 \hat{h} - b_3 \theta\hat{F} - b_3(1-\theta)\hat{DH} + u_2$$

With $k_1 = k_2 = 1$ and $u_6 = 0$, $\hat{M}^d = \hat{M}^s$, then:

$$\theta\hat{F} = \beta_0 + \beta_1 \hat{y} + \beta_2 \hat{i} + \beta_3 \hat{P} + \beta_4 \hat{h} + \beta_5(1-\theta)\hat{DH} + u$$

where $\beta_0 = n\ a_t/b_3$ assuming $\hat{N} = n$ is a constant; $\beta_1 = a_2/b_3$; $\beta_2 = a_3/b_3$; $\beta_3 = a_4/b_3$; $\beta_4 = -b_2/b_3$; $\beta_5 = -1$; and $u = (u_2 - u_1)/b_3$.

Ordinary least squares cannot be performed on this equation if $\hat{y}$ or $\hat{i}$ or $\hat{P}$ are correlated with u_2 (even assuming they are uncorrelated with u_1) because such a correlation would yield the problem of simultaneity. In economic terms, a correlation between, for example, $\hat{P}$ and u_2 is a correlation between unexplained money supply growth and inflation. Barro (1977) provides evidence for the U.S. that a negative correlation holds for unanticipated money growth and the price level and hence the rate of inflation. That is, unanticipated money growth is associated with a lower price level, yielding a lower rate of inflation than would exist if monetary growth were fully anticipated. Thus, OLS is likely to be an inappropriate method of estimation, unless other assumptions can be employed. More importantly for my concern, the existence of a statistically significant correlation between the rate of inflation and a random variable, e.g., unanticipated money growth, would invalidate the treatment of the rate of inflation as an exogenous variable.[12]

This criticism of the simple model is equally valid in open- and closed-economy models because the main ingredient of this criticism is the relationship between unanticipated (and anticipated) money growth and inflation whatever the source. In the framework of a model for a small open economy, the simple model postulates immediate equalization of domestic inflation to rest-of-the-world inflation. The world rate is related to unanticipated and anticipated world money growth, incorporated in equation (29) above as: $f_1 \hat{P}_W^E + f_2 \hat{M}_W = u_4$. Clearly, both components of world money growth will influence the distribution of reserves throughout the world. The official reserve position of a non-reserve currency country must therefore be affected in that way. Hence, the factors which affect the balance of payments of a small open economy, e.g., unanticipated and anticipated world money growth, will also affect the rate of inflation experienced by that country. Therefore, on these grounds, the domestic rate of inflation should not be treated as an exogenous variable even if we believe the domestic rate of inflation is equivalent to the rate of inflation prevailing in the rest of the world.

B. Empirical Analysis

I am not concerned with estimating the model presented in the previous section. Rather, I wish only to demonstrate the use of a recently developed statistical technique in testing the hypothesis that the rate of inflation is an exogenous determinant of the balance of payments of a small open economy. In addition, I also present tests, using the same technique, which are directed at other hypotheses.

1. The Technique

The technique applied here to test for exogeneity is based on the incremental prediction criterion suggested by Granger and Newbold (1977) as a useful statistical test for causality. As Granger defines causality,[13] we can say a series X causes another series Y if we can better predict current Y by using the information contained in past Y and past X than by only using past Y to predict current Y. This, Granger suggests, can be judged by the relative efficiency of prediction errors conditional upon the information sets.[14] That is, suppose we perform two regressions of the following form:

$$Y_t = \delta_0 + \delta_1 t + \sum_{i=1}^{n} \beta_i Y_{t-i} + u_t \tag{32}$$

and

$$Y_t = \delta_0 + \delta_1 t + \sum_{i=1}^{n} \beta_i Y_{t-i} + \sum_{j=1}^{m} \gamma_j X_{t-j} + v_t \tag{33}$$

The first equation describes how past Y is used to predict current Y with the help of a linear trend. Whereas the second regression equation demonstrates the prediction of current Y from the information sets of past Y and past X. If the explained sum of squares from regression (33) is relatively greater than the explained sum of squares from regression (32), then X is said to cause Y. This is a simple F-test of the hypothesis that all the γ_j coefficients are not significantly different from zero, as a group.[15]

Granger's definition of causality is not universally accepted as valid. Zellner (1978) believes the definition is overly restrictive in two general respects. The two conditions set out in Granger and Newbold (1977)--that only stochastic processes can be studied in discussions of causality and that causality implies temporal ordering--are restrictions which Zellner suggests are not incorporated in definitions of causality used in the philosophical, statistical and earlier econometric literatures. In addition, Zellner is critical of the statistical requirements of the test. For example, Granger's suggested criterion for testing causality is based on the existence of an unbiased least squares predictor from finite sets of data. Both Granger and Zellner point out that such predictors may not exist in some cases. The critical discussion of Zellner lacks only one important ingredient: an alternative test procedure for causality. Moreover, Pierce and Haugh (1977) and Schwert (1978) point out that the Granger technique is still very useful as a statistical tool in shedding light on empirical associations and specifically on the question of exogeneity.

Another critical feature of the Granger test is that the results depend on the existence of disturbance terms which are free of serial correlation. This can easily be tested in large samples by using the "h" statistic developed by Durbin (1970) which has a "normal" asymtotic distribution. An alternative method, to insure serially uncorrelated disturbance terms, would be to reduce series Y and X in equation (33) to white noise: identically and independently distributed serially uncorrelated normal variates with zero means and unit variances.

Pierce and Haugh (1977) demonstrate that such prewhitened series will yield the same causality results as for the measured variables[16]--if in fact causality exists between the variables. The prewhitened series can be obtained as the residuals from the estimation of autoregressive-integrated moving average processes (ARIMA), using Box-Jenkins (1976) techniques, for the two series separately. The residual series can then be analyzed using the Granger technique as Pierce (1977) has done. The whitened series can also be cross-correlated, at different lags, and analyzed using the "S" statistic developed by Haugh (1976) to check for interdependence between the two series.

Schwert (1978), in his Appendix B, has shown that the Pierce method--using the Granger technique to analyze two whitened series--and the Haugh method differ in the power of the tests: the regression method is more powerful for tests on individual coefficients, whereas the cross-correlation method is more powerful for tests on groups of coefficients. In effect, the regression F-test is more likely to reject the hypothesis that no relationship exists than Haugh's test. However, the cross-correlation procedure has low (vis-a-vis other procedures) power against specific alternative hypotheses,[17] i.e., when the alternative hypothesis has some theoretical content such as the direction of causality is from X to Y rather than simply having the alternative hypothesis that causality exists.

I have chosen to stick with the Granger technique primarily because of its ease of application. In addition, since I have very specific economically meaningful alternative hypotheses, the Granger technique retains its usefulness. Moreover, the tests I will undertake involve the first difference of natural-log-transformed data which, in part, is a minor attempt at whitening the series.[18] With these caveats in mind, I will proceed to the empirical analyses.

2. Is the Domestic Rate of Inflation Exogenous?

Recalling the earlier discussion, a model such as the following will yield an exogenous rate of inflation and show causality from the domestic rate of inflation to the balance of payments:

$$a^{*}\hat{F} + b^{*}\hat{P} = u \tag{34}$$

$$c^{*}\hat{P} = v \tag{35}$$

if u(r) and v(s) are mutually uncorrelated (for all r and s) random variates, where $\hat{F}$ is the rate of growth of foreign reserves, and $\hat{P}$ is the domestic rate of inflation.

Thus, by performing the two corresponding regressions suggested by the Granger technique:

$$\hat{F}_t = \delta_0 + \delta_1 t + \sum_{i=1}^{n} \beta_1 \hat{F}_{t-1} + u_t \tag{36}$$

$$\hat{F}_t = \delta_0 + \delta_1 t + \sum_{i=1}^{n} \beta_1 \hat{F}_{t-i} + \sum_{j=1}^{m} \gamma_j \hat{P}_{t-j} + v_t \tag{37}$$

I can test the null hypothesis that no relationship exists between $\hat{F}$ and $\hat{P}$ against the alternative that $\hat{P}$ causes $\hat{F}$. That is, if I reject the hypothesis that the γ_j's are, as a group, not different from zero, then the test results imply causality from $\hat{P}$ to $\hat{F}$ and, from model (34) and (35), $\hat{P}$ is said to be exogenous.

I have applied the Granger test for this set of hypotheses in several ways. First, I used two measures for the official settlements balance of payments. Both measures have been used in previous tests of the monetary approach to the balance of payments. The first measure is $\theta_t \hat{F}_t$, where $\theta_t = F_t/H_t$ is the ratio of foreign reserves to high powered money and $\hat{F}_t$ is the logarithmic first difference of foreign reserves. The second measure of the balance of payments is simply $\hat{F}_t$.

Secondly, I also tested for the existence of reverse causality, i.e., from the balance of payments to the rate of inflation. The existence of such causality would not only invalidate the treatment of the domestic rate of inflation as an exogenous variable, it would also suggest that price arbitrage was not operating effectively for the particular country and period of analysis. In the reverse causation tests, I also used both measures of the balance of payments described above.

Third, I assumed that the lag structures, denoted by n and m, of the two series had a finite length of at least three years. I used a three year lag structure because I expect the monetary adjustments implicit in the model to be made within the course of a cycle. For my purposes, I treated the events of each phase of the cycle as being broadly similar in the movements of the underlying economic data. Thus, rational adjustments might well be expected to be completed within each phase of a cycle. I made the empirical assumption that such phases were, on average, three years in length. I also allowed the lag on the variable tested for exogeneity to be six years. Unfortunately, because of data limitations, using very long lags to make an empirical statement regarding lag structure was not possible.

The Granger causality test results for the null hypothesis that the domestic rate of inflation ($\hat{P}$) does not cause the balance of payments versus the alternative that $\hat{P}$ causes the balance of payments are reported in Table 29.A for the $\theta_t \hat{F}_t$ measure and in Table 29.B for the $\hat{F}_t$ measure of the balance of payments. Test results for the reverse direction of causation are reported in Tables 29.C and 29.D.

The results of the causality tests, presented in Tables 29.A through 29.D, may be summarized as follows:

a) A significant uni-directional causal influence from the domestic rate of inflation to the respective balance of payments exists for Argentina, Guatemala and Paraguay at the 5% level of significance; Nicaragua also exhibits a similar causal relationship but only at the 10% level of significance.

b) A significant uni-directional causal influence from the balance of payments to the respective domestic rate of inflation exists for Ecuador, Uruguay and Venezuela at the 5% level of significance. Colombia also exhibits a similar causal relationship, but only at the 10% level of significance.

c) A significant bi-directional causal relationship between the domestic rate of inflation and the respective balance of payments exists for Bolivia, Chile and Mexico at the 5% or 10% levels of significance.

d) Generally, the incremental explanation for current Y due to past X is offset after three years for both directions of causation.

TABLE 29.A

TEST OF CAUSALITY FROM INFLATION TO BALANCE OF PAYMENTS $(\theta_t \hat{F}_t)$

$$Y_t = \delta_o + \delta_1 t + \sum_{i=1}^{n} \beta_i Y_{t-i} + \sum_{j=1}^{m} \gamma_j X_{t-j}$$

Annual data $t = 1953,\ldots,1976$

H_o: $\gamma_j = 0$, $j = 1, \ldots, m$: X does not cause Y.

$Y_t = \theta_t . \hat{F}_t$ = the balance of payments scaled by high-powered money.

$X_t = \hat{P}_t$ = the domestic rate of inflation.

n=3=maximum lag on dependent variable.

Country	m=6 F(6,13)	m=3 F(3,16)
Argentina	1.45	6.69**
Bolivia	0.38	0.46
Brazil[1]	1.77	1.29
Chile	0.54	1.23
Colombia	0.18	0.30
Costa Rica	0.91	0.95
Ecuador	0.27	0.65
El Salvador	0.43	0.63
Guatemala	2.44†	3.63*
Honduras[1]	0.88	1.88
Mexico	2.69†	3.25†
Nicaragua	0.93	1.56
Paraguay	6.35**	1.85
Peru	0.74	1.39
Uruguay[1]	0.39	0.40
Venezuela	0.42	0.07

† Reject null hypothesis at α = 0.10;

* " " " " α = 0.05;

** " " " " α = 0.01.

1. One less residual degree of freedom.

TABLE 29.B

TEST OF CAUSALITY FROM INFLATION TO BALANCE OF PAYMENTS ($\hat{F}_t$)

$$Y_t = \delta_o + \delta_1 t + \sum_{i=1}^{n} \beta_i Y_{t-1} + \sum_{j=1}^{m} \gamma_j X_{t-j}$$

Annual data $t = 1953,\ldots,1976.$

H_o: $\gamma_j = 0$, $j = 1,\ldots, m$: X does not cause Y.

$Y_t = \hat{F}_t$ = the rate of growth of foreign reserves.

$X_t = \hat{P}_t$ = the domestic rate of inflation.

n=3=maxium lag on dependent variable

Country	m=6 F(6,13)	m=3 F(3,16)
Argentina	1.74	3.75*
Bolivia	1.39	2.63†
Brazil[1]	0.40	0.29
Chile	2.94†	6.74**
Colombia	0.26	0.10
Costa Rica	0.95	0.98
Ecuador	0.11	0.23
El Salvador	0.56	0.88
Guatemala	1.91	2.34
Honduras[1]	0.95	1.60
Mexico	1.27	1.48
Nicaragua	1.58	2.81†
Paraguay	0.68	0.52
Peru	0.56	1.27
Uruguay[1]	0.53	0.42
Venezuela	0.91	0.28

† Reject null hypothesis at $\alpha = 0.10$.

* " " " " $\alpha = 0.05$.

** " " " " $\alpha = 0.01$.

1 One less residual degree of freedom.

TABLE 29.C

TEST OF CAUSALITY FROM BALANCE OF PAYMENTS ($\theta_t \hat{F}_t$) TO INFLATION

$$Y_t = \delta_o + \delta_1 t + \sum_{i=1}^{n} \beta_i Y_{t-1} + \sum_{j=1}^{m} \gamma_j X_{t-j}$$

Annual data $t = 1953,\ldots,1976$.

H_o: $\gamma_j = 0$, $j = 1,\ldots, m$: X does not cause Y.

$Y_t = \hat{P}_t$ = the domestic rate of inflation.

$X_t = \theta_t \hat{F}_t$ = the balance of payments scaled by high-powered money.

n = 3 = maximum lag on dependent variable.

Country	m=6 F(6,13)	m=3 F(3,16)
Argentina	0.28	0.58
Bolivia	1.10	1.31
Brazil[1]	0.24	0.37
Chile[1]	0.87	1.13
Colombia	2.39†	0.86
Costa Rica	1.06	1.12
Ecuador	10.49**	12.82**
El Salvador	0.09	0.38
Guatemala	0.40	0.85
Honduras[1]	1.14	1.01
Mexico[1]	2.07	1.60
Nicaragua	0.70	1.62
Paraguay	0.33	0.12
Peru	0.64	0.56
Uruguay[1]	2.34†	3.41*
Venezuela	2.95*	5.81**

† Reject null hypothesis at $\alpha = 0.10$;

* " " " " $\alpha = 0.05$;

** " " " " $\alpha = 0.01$.

1. One less residual degree of freedom.

TABLE 29.D

TEST OF CAUSALITY FROM BALANCE OF PAYMENTS ($\hat{F}_t$) TO INFLATION

$$Y_t = \delta_o + \delta_1 t + \sum_{i=1}^{n} \beta_i Y_{t-i} + \sum_{j=1}^{m} \gamma_j X_{t-j}$$

Annual data $t = 1953,\ldots,1976$.

$H_o: \gamma_j = 0,\ j = 1,\ldots,m$: X does not cause Y.

$Y_t = \hat{P}_t$ = the domestic rate of inflation.

$X_t = \hat{F}_t$ = the rate of growth of foreign reserves.

n = 3 = maximum lag on dependent variable

Country	m=6 F(6,13)	m=3 F(3,16)
Argentina	0.24	0.49
Bolivia	3.38*	3.54*
Brazil[1]	0.58	1.12
Chile[1]	1.32	2.54†
Colombia	2.40†	1.30
Costa Rica	1.34	1.41
Ecuador	8.57**	8.20**
El Salvador	0.16	0.16
Guatemala	0.48	0.48
Honduras	0.91	1.18
Mexico[1]	4.14*	1.69
Nicaragua	0.64	1.40
Paraguay	0.11	0.17
Peru	0.96	1.09
Uruguay[1]	4.36*	5.81**
Venezuela	2.53†	3.06†

† Reject null hypothesis at $\alpha = 0.10$.

* " " " " $\alpha = 0.05$.

** " " " " $\alpha = 0.01$.

1. One less residual degree of freedom.

Paraguay is the only exception for which significant causation, from inflation to the balance of payments, appears over six years but not over three years. Mexico is the only exception for which significant causation, from the balance of payments to inflation, appears over six years but not over three years.

If we put our faith in the instantaneous price arbitrage version of the monetary approach to the balance of payments, the results of Tables 29.A through 29.D are striking pieces of counter-evidence. Indeed, that version of the monetary approach suggests that price levels and rates of inflation equalize so rapidly that non-reserve currency country residents must passively adjust their nominal stocks of money and thereby the official stock of international reserves to world conditions, i.e., the domestic rate of inflation causes the balance of payments.

The evidence from these tests is at variance with the simple model's prediction in several respects. First, only three countries exhibit clear indications of causality in the direction predicted. Second, the lag structure reflected in the significance of the F-statistics varies across the three countries--the model predicts quick and continued influence. Third, the simple model is best suited for countries operating under a fixed exchange rate regime--yet, of the three countries which have an exogenous rate of inflation, only Guatemala maintained an unchanged fixed exchange rate. Finally, evidence that a mechanism similar to specie-flow, wherein reserves move first when international monetary disequilibrium occurs and then price levels adjust, exists in seven cases--including those countries where bi-directional causality exists.

An interesting feature of these test results is the cross-country comparisons they afford. Indeed, the policy regimes of these countries differ in several respects, as discussed in earlier chapters. For clarity let's compare the three cases for which uni-directional causality from inflation to the balance of payments exists: Argentina, Guatemala, and Paraguay. As mentioned earlier, only Guatemala had not changed its exchange rate during the period. Paraguay had devalued frequently prior to 1960, but from that time to 1976 it maintained a fixed rate of 126 guaranies per U.S. dollar. Argentina, at the other extreme, has devalued often and has even changed its currency unit.[19] Whereas the real per capita income growth rates of these three countries are not statistically significantly different, the nominal monetary and price level growth rates differ significantly: Guatemala had lower and less variable inflation and monetary expansion than did Paraguay, which had lower and less variable inflation and monetary expansion than did Argentina, over the same time period (see Chapter II). Guatemala had a fast speed of money demand adjustment--indicative of an open economy--whereas Paraguay had a moderate speed and Argentina's was very slow (see Chapter IV). For each of these countries, the simple monetary model performed poorly--low $\bar{R}^2$'s, insignificant coefficients, many with the incorrect sign (see Chapter III).

The lack of other similar characteristics among countries which exhibit common causality patterns is indicative of a need to specify a balance of payments model for these countries as distinct models. The one common underlying result for all 16 countries is the lack of rapid convergence of the domestic rate to an external rate (see Chapter V). Another disappointing aspect of the test results is the lack of any statistically significant relationship, in either direction, between the domestic rate of inflation and the balance of payments measures for Brazil, Costa Rica, El Salvador, Honduras and Peru. Again, few similarities among these five countries exist that would permit me to draw a conclusion from this particular result[20]—or lack thereof.

2. Direct Tests of the Influence of the United States on Inflation in Latin American Countries

I attempted to test, more directly than by the simple purchasing power regressions of Chapter V, the hypothesis that the rates of inflation experienced by Latin American countries were not influenced by the U.S. I applied the Granger technique to test hypotheses regarding U.S. influence in two ways. First, I tested the null hypothesis that the U.S. rate of inflation did not cause the inflation rate in each Latin American country. This was, in effect, an extension of the naive tests of the purchasing power parity principle. It may be recalled that those test results indicated a weak relationship existed between U.S. and Latin American rates of inflation on a year-to-year basis, and that those tests did not allow for lags in the adjustment of small-country to rest-of-the-world inflation. The test of causality conducted here allows, in effect, for lags in adjustment for the purchasing power relationship.

I performed the test using the following regressions:

$$\hat{P}'_t = \delta_0 + \delta_1 t \sum_{i=1}^{m} \beta_i \hat{P}'_{t-i} + u_t \qquad (38)$$

and

$$\hat{P}'_t = \delta_0 + \delta_1 t + \sum_{i=1}^{m} \beta_i \hat{P}'_{t-i} + \sum_{j=1}^{m} \gamma_j \hat{P}_{us,t-j} + v_t \qquad (39)$$

where $\hat{P}'$ is the rate of inflation of the small country adjusted for exchange rate changes, and $\hat{P}_{us}$ is the U.S. rate of inflation. I have listed the results of this test in Table 30.

Significant causality, from U.S. inflation to the rate prevailing in the non-reserve currency country exists in only three cases, at the 5% level of significance: Argentina, Brazil, and Mexico. Paraguay and Peru have significant F-statistics at the 10% level. That the rates of inflation of only a handful of countries have been significantly influenced by the U.S. rate of inflation is consistent with the earlier naive purchasing power parity results (see Chapter V). However, the lack of evidence of causal influence emanating from the U.S., demonstrated in Table 30, suggests that price level arbitrage between Latin America and the United States was not great in the variety of cases which this sample represents. It is interesting to note that the three countries for which the evidence is most clear, in favor of the PPP relationship with lagged adjustment, are three most developed countries in the sample.

I also tested the hypothesis that domestic credit expansion on the part of the U.S. monetary authorities had no direct influence on the rates of inflation of Latin American countries. Inasmuch as

TABLE 30

TEST OF CAUSALITY FROM U.S. INFLATION AND U.S. DOMESTIC CREDIT EXPANSION TO SMALL COUNTRY INFLATION

$$Y_t = \delta_o + \delta_1 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{m} \gamma_j X_{t-j}$$

H_o: $\gamma_j = 0 \quad j = 1, \ldots, m$; X does not cause Y

Annual Data $t = 1953, \ldots, 1976$

	$Y_t = \hat{P}'_t$ [1] $X_t = \hat{P}_{ust}$ [2]		$Y_t = \hat{P}'_t$ [1] $X_t = \hat{DH}_{ust}$ [3]	
Country	F(3,16)	F(2,18)	F(3,16)	F(2,18)
Argentina	6.03**	6.17**	2.75	2.28†
Bolivia	0.71	0.05	0.68	0.77
Brazil	11.53**	0.18	2.91†	1.68
Chile	0.60	1.56	6.65**	3.39†
Colombia	1.18	1.11	1.68	0.31
Costa Rica	0.64	0.40	0.51	0.86
Ecuador	0.16	0.03	0.12	0.17
El Salvador	0.99	1.88	2.15	1.50
Guatemala	0.69	1.85	6.35**	4.34**
Honduras	0.68	0.59	2.17	1.23
Mexico	4.11*	1.50	9.76**	7.47**
Nicaragua	1.10	1.34	6.03**	5.39*
Paraguay	2.68†	0.39	2.95†	2.37
Peru	1.83	3.14†	0.25	0.51
Uruguay	1.37	0.80	0.29	0.10
Venezuela	1.63	1.78	0.19	0.41

† Reject null hypothesis at $\alpha = 0.10$;
* Reject null hypothesis at $\alpha = 0.05$;
** Reject null hypothesis at $\alpha = 0.01$.

[1]The domestic rate of inflation adjusted for exchange rate changes, except El Salvador, Guatemala and Honduras.

[2]The U.S. rate of inflation.

[3]The rate of growth of the domestic component of the U.S. high-powered money stock.

the U.S. dollar was the reserve currency to which these small countries tied their currency during the period of analysis, U.S. domestic credit expansion represented growth in the world money supply. World money growth could affect the rate of inflation experienced by a small country in either or both of two ways. First, if expectations are rational--knowing the model used to generate inflation, i.e., knowing that the long-run rate of inflation a small country will experience converges to the world rate of inflation and knowing that the latter rate is determined by world money growth, then the expected rate of small country inflation will be determined by the world rate of money growth, with exchange rates fixed. If the actual rate of inflation is equal to the expected rate, then the influence of world money growth on small-country inflation is complete. Second, the growth of the world money stock will be distributed according to the shares of each country in the world stock. Thus, a small country will receive a monetary impulse as the U.S. monetary authorities expand domestic credit. The new monetary impulse will affect the small-country price level, and its rate of inflation if the impulses are continued. In this direct way, the rate of inflation of a small country can be influenced by the U.S.

I have listed the results of causality tests of the hypothesis that U.S. domestic credit expansion did not cause the non-reserve currency countries' rates of inflation in Table 30. A significant causal relationship exists for Chile, Guatemala, Mexico and Nicaragua at the 5% level of significance. Argentina, Brazil and Paraguay have significant F-statistics at the 10% level.

The results of Tables 29.A-D and Table 30 are to some degree consistent. First, Argentina and Paraguay show evidence of influences which suggest a price level arbitrage cum rational expectations adjustment. That is, for these two countries, the domestic rate of inflation was shown to be exogenous and influenced by the U.S. rates of inflation and domestic credit expansion. Second, Ecuador, Uruguay and Venezuela show no evidence of exogenous rates of inflation vis-a-vis their balance of payments and the results reported in Table 30 suggest that neither U.S. inflation nor U.S. domestic credit expansion significantly influenced the rates of inflation of those three countries. It should be recalled, however, that both Uruguay and Venezuela frequently contracted their domestic credit (see Chapter II). Finally, the significant bi-directional causality between the rate of inflation and the balance of payments for Mexico is consistent with significant influences of U.S. inflation and domestic credit expansion on Mexican inflation. As indicated in Tables 29.A and 29.B, the Mexican rate of inflation caused its balance of payments --evidence of arbitrage operating. From Table 30, we note that the U.S. rate of inflation was a causative factor of the Mexican rate--consistent with the price arbitrage mechanism of the transmission on inflation. As indicated in Tables 29.C and 29.D, the Mexican balance of payments caused the rate of inflation there--evidence of significant specie-flow. From Table 30, we also note that the U.S. rate of domestic credit expansion was a causative factor of the rate of inflation in Mexico--consistent with the specie-flow mechanism of inflation transmission.

3. Tests of the Influence of Domestic Monetary Policy on Inflation in Latin American Countries

The final battery of causality tests which I conducted were aimed at detecting the direction of influence between the rate of inflation and the rates of growth of various monetary aggregates for each country. The effective operation of price level arbitrage will show up in the existence of uni-directional causality from the domestic rate of inflation to rates of domestic monetary growth. This influence may present itself in two ways. First, if inflationary expectations are formed rationally, then the expected rate of inflation of a small country will be related to rest-of-the-world monetary growth. As expectations are translated into actual inflation, monetary aggregates of the small country will passively adjust. If arbitrage is operating quickly, then the translation of expected to actual will be likewise quick and inflation will cause money growth. Second, even without an assumption of rational expectations, if price levels are equated rapidly, then monetary aggregates will not affect domestic inflation; rather, monetary aggregates will adjust in response to the equilization of rates of inflation.

If, on the other hand, price level arbitrage is not rapid, then domestic monetary growth will affect the domestic rate of inflation. That is, if the domestic rate of inflation is not equated to the rate prevailing in the rest of the world then by increasing the growth in the money supply upward pressure on domestic inflation will appear. Until the difference between domestic inflation and rest-of-the-world inflation is eliminated, domestic monetary growth will appear to influence the domestic rate of inflation.

I conducted causality tests, using the Granger technique, to test the above hypotheses using three definitions of monetary growth. The first measure I used was the rate of change of the nominal narrow money stock, i.e., $\hat{M1}$. The second measure I used was the rate of change of the nominal high powered money stock ($\hat{H}$). The third measure I used was the rate of domestic credit expansion, i.e., the rate of change of the domestic component of high powered money ($\hat{DH}$). The test results are listed in Tables 31 through 33 for the three measures of monetary growth.

The results for $\hat{M1}$ and $\hat{H}$ are nearly equivalent. The results for domestic credit expansion are generally inconclusive, which might have more to do with the residual nature of the definition of DH--high powered money minus foreign reserves--than a lack of causation in either direction. Measurement error in $\hat{DH}$ when it is used as the independent variable will tend to bias downward the regression coefficients thereby making $\hat{DH}$ appear not to be exogenous --in the tests using regressions of the rate of inflation on past values of itself and domestic credit expansion. When $\hat{DH}$ is used as the dependent variable and its lagged values as predetermined variables and $\hat{DH}$ is measured with error, the standard errors of the coefficients are biased upward as well as the coefficient estimates being biased downward--both effects tend to reduce the significance of the F-statistics used to test for causality. I will therefore only describe the results for the tests using $\hat{M1}$ and $\hat{H}$.

TABLE 31

TEST OF CAUSALITY BETWEEN INFLATION AND MONETARY GROWTH

$$Y_t = \delta_o + \delta_1 \cdot t + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{m} \gamma_j \cdot X_{t-j}$$

H_o: $\gamma_j = 0 \quad j = 1, \ldots, m$: X does not cause Y

Annual Data $t = 1953, \ldots, 1976$

	$Y_t = \hat{M1}_t$ [1] $X_t = \hat{P}_t$ [2]		$Y_t = \hat{P}_t$ [2] $X_t = \hat{M1}_t$ [1]	
Country	F(3,16)	F(2,18)	F(3,16)	F(2,18)
Argentina	0.81	1.29	1.63	2.47
Bolivia	5.91**	4.61*	5.51**	8.16**
Brazil	3.10†	4.60*	3.42*	5.13*
Chile	0.95	1.78	5.71**	10.33**
Colombia	2.10	0.77	1.66	2.42
Costa Rica	1.98	0.26	1.87	1.49
Ecuador	1.51	0.36	3.02†	4.53*
El Salvador	3.78*	2.43	3.86*	3.79*
Guatemale	3.21†	4.26*	0.81	2.09
Honduras	0.42	0.56	3.21†	5.25*
Mexico	1.75	1.43	3.71*	1.86
Nicaragua	0.88	1.48	4.39*	6.84**
Paraguay	1.63	3.74*	0.27	0.57
Peru	1.76	1.50	0.12	0.23
Uruguay	1.70	7.02**	2.47†	5.14*
Venezuela	1.64	1.60	5.18*	5.84*

† Reject null hypothesis at $\alpha = 0.10$;
* Reject null hypothesis at $\alpha = 0.05$;
** Reject null hypothesis at $\alpha = 0.01$.

[1] Growth rate of nominal narrow money stock.

[2] Growth rate of domestic price level.

TABLE 32

TEST OF CAUSALITY BETWEEN INFLATION AND HIGH POWERED MONEY GROWTH

$$Y_t = \delta_o + \delta_1 t + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{m} \gamma_j \cdot X_{t-j}$$

H_o: $\gamma_j = 0$ $j = 1, \ldots, m$: X does not cause Y

Annual Data $t = 1953, \ldots, 1976$

	$Y_t = \hat{H}_t$[2] $X_t = \hat{P}_t$[2]		$Y_t = \hat{P}_t$[2] $X_t = \hat{H}_t$[1]	
Country	F(3,16)	F(2,18)	F(3,16)	F(2,18)
Argentina	1.61	1.97	2.04	0.72
Bolivia	2.75†	2.27	4.77	6.96**
Brazil	1.79	2.70†	6.96**	9.76**
Chile	1.00	3.41†	14.42**	22.72**
Colombia	0.36	0.29	0.98	0.59
Costa Rica	2.60†	1.68	1.60	2.77†
Ecuador	0.76	0.79	3.83*	6.09**
El Salvador	4.26*	3.05	1.56	0.69
Guatemala	5.30**	5.10*	1.80	2.53
Honduras	0.24	0.22	3.00	3.52†
Mexico	1.45	0.35	5.89**	8.36**
Nicaragua	0.66	0.92	2.44	4.29*
Paraguay	2.41	3.77*	0.15	0.05
Peru	3.12†	2.29	0.12	0.03
Uruguay	1.25	7.30**	3.52*	7.51**
Venezuela	0.03	0.10	6.62**	6.97**

† Reject null hypothesis at $\alpha = 0.10$;
* Reject null hypothesis at $\alpha = 0.05$;
** Reject null hypothesis at $\alpha = 0.01$.

[1]Growth rate of high powered money.

[2]Growth rate of domestic price level.

TABLE 33

TEST OF CAUSALITY BETWEEN INFLATION AND DOMESTIC CREDIT EXPANSION

$$Y_t = \delta_o + \delta_1 t + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{j=1}^{m} \gamma_j X_{t-j}$$

H_o: $\gamma_j = 0$ $j = 1, \ldots, m$: X does not cause Y

Annual Data $t = 1953, \ldots, 1976$

	$Y_t = \hat{DH}_t$[1], $X_t = \hat{P}_t$[2]		$Y_t = \hat{P}_t$[2], $X_t = \hat{DH}_t$[1]	
Country	F(3,16)	F(2,18)	F(3,16)	F(2,18)
Argentina	0.10	0.06	2.78†	3.15†
Bolivia	3.05†	0.64	0.49	0.72
Brazil	0.24	0.31	0.65	1.17
Chile	0.64	0.66	4.13*	6.91**
Colombia	0.34	0.09	1.92	0.06
Costa Rica	0.71	0.83	0.73	0.67
Ecuador	0.78	1.72	2.21	1.86
El Salvador	0.68	0.40	1.98	0.39
Guatemala	0.67	0.52	0.16	0.30
Honduras	4.13*	1.35	4.64*	5.23*
Mexico	2.82†	1.77	0.80	0.63
Nicaragua	1.75	1.33	0.55	0.52
Paraguay	7.04**	2.92	0.03	0.28
Peru	1.03	0.24	1.24	1.85
Uruguay	0.09	0.17	0.29	0.40
Venezuela	0.18	0.19	0.82	0.14

† Reject null hypothesis at $\alpha = 0.10$;
* Reject null hypothesis at $\alpha = 0.05$;
** Reject null hypothesis at $\alpha = 0.01$.

[1] Growth rate of domestic component of high powered money.

[2] Growth rate of domestic price level.

A significant uni-directional causal relationship from the domestic rate of inflation to both measures of domestic monetary growth exists for Guatemala and Paraguay. In addition, El Salvador exhibits a similar pattern for $\hat{H}$ only while exhibiting a bi-directional relationship for $\hat{M1}$. The results for Guatemala and Paraguay are consistent with the test results from the analysis of the relationship between the domestic rate of inflation and the balance of payments (Tables 29.A-D). Those earlier results indicated that a significant uni-directional causal relationship from inflation to the balance of payments--indicative of price level arbitrage and implying an exogenous inflation rate vis-a-vis the balance of payments--exists for Guatemala and Paraguay. The results presented in Tables 31 and 32 confirm that conclusion. These latter results suggest that the domestic rates of inflation of these two countries are exogenous vis-a-vis their respective domestic monetary growth rates.

A significant uni-directional causal influence from both measures of monetary growth to the domestic rate of inflation exists for Chile, Ecuador, Honduras, Mexico, Nicaragua and Venezuela. This result suggests that these countries were able to operate a monetary policy which was not completely dependent upon the rest of the world. Interestingly enough, of these six countries, only Chile has had a serious inflation problem--over 30% per annum rate of inflation on average. Moreover, with the exception of Chile, these countries have either not changed their exchange rate during the period of analysis--

Honduras and Mexico--or have adjusted their exchange rate infrequently and at moderate[22] rates.

The results for Ecuador and Venezuela from Tables 31 and 32 conform to the results of the tests concerning the balance of payments and inflation rates of these countries, Tables 29.A-D. In the earlier test, Ecuador and Venezuela were shown to have significant specie-flow. Those results also showed that the domestic rates of inflation for those two countries could not be treated as an exogenous determinant of the balance of payments. Thus, the results for Ecuador and Venezuela, from Tables 31 and 32, confirm the result that their respective domestic rates of inflation are endogenous with respect to monetary policy.[23]

The results for Chile and Mexico from Tables 31 and 32 are partly consistent with earlier tests. Previous tests indicated that there exists bi-directional causality between the balances of payments and the respective rates of inflation for these two countries (Tables 29.A-d), and the growth in U.S. domestic credit was a significant determinant of the rate of inflation, whereas the U.S. rate of inflation was important only in the case of Mexico--and only for the three year lag structure. While these earlier tests results suggest that Chile and Mexico could not operate a completely independent monetary policy, when coupled with the direct tests of the influence of domestic monetary policy, the combined results suggest that some policy freedom was exercized and therefore the domestic rate of inflation cannot be considered a purely exogenous variable.

Significant bi-directional causality between the domestic narrow money growth rate and the respective domestic rate of inflation exists for Bolivia, Brazil, El Salvador and Uruguay. However, when using the growth in high powered money to reflect monetary policy, only Uruguay exhibits bi-directional causality at the 5% level of significance. Bolivia and Brqzil show a much stronger relationship from H growth to domestic inflation than the other way around.

The results for Bolivia and Uruguay from Tables 31 and 32 would be consistent with the existence of bi-directional causality between the domestic rate of inflation and the balance of payments (for Bolivia, see Tables 29.A-D) or a specie-flow mechanism operating (for Uruguay, see Tables 29.A-D), if the central banks of those countries were conducting a central bank reaction policy.[24] That is, a central bank may act to validate or negate an anticipated rise in the price level by creating or destroying domestic credit, respectively. So, for example, in the face of a rise in the world rate of inflation (with sluggish arbitrage), the central bank might increase its rate of growth of domestic credit and the domestic rate of inflation will rise. If the rate of domestic monetary growth is still lower than world money growth, reserves will flow into the small country. In this way, monetary policy would appear to affect the rate of inflation, and foreign reserve changes and the domestic rate of inflation would appear to simultaneously affect each other until an equilibrium in the movement of reserves prevailed.

C. Conclusions

The main issue I sought to resolve by the empirical tests utilized in this chapter was the treatment of the rate of inflation experienced by a small open economy as an exogenous determinant of the respective balance of payments. For the sample of Latin American countries for the period from 1953 to 1976, the results from applying the Granger technique for causality tests indicate that the rates of inflation for Argentina, Guatemala and Paraguay can be validly treated as exogenous variables in models for their respective balance of payments. Weak evidence along the same lines was shown to exist for Nicaragua.

However, evidence of an endogenous rate of inflation with respect to the balance of payments was shown to exist for Bolivia, Chile, Colombia, Mexico, Uruguay and Venezuela. The lack of any clear cut results from these tests for the remaining five countries is a disappointment.

I conducted tests concerning the importance of domestic monetary policy in determining the domestic rate of inflation. In only two cases, for which the tests proved conclusive, there was evidence that domestic monetary policy was unimportant: Guatamala and Paraguay. This result is consistent with the initial set of tests. Moreover, the test results regarding monetary policy were generally consistent with the results regarding the exogeneity of the domestic rate of inflation vis-a-vis the balance of payments.

FOOTNOTES TO CHAPTER VI

1. I do not mean to imply that questions of causality in general have not been discussed prior to Koopmans and Simon. I have cited only those references with which I am familiar and from which I believe the recent development of causality tests in economics derive.

2. Some of the notation and most of the following ideas draw heavily on the work of Sims (1972b), with the singular exception of the examples used.

3. A question should be raised here as to the supposition that adjustments of the exchange rate under a Bretton Woods type system are autonomous. The expression in the text only suggests that the exchange rate does not adjust continually (as needed) in response to disequilibrating impulses within the workings of the markets for currencies. Such a flexible exchange rate would result in outcomes circumscribed by the complement of space R_1.

4. See Sims (1972b), p. 36.

5. See Sims (1972b), p. 31. In other words the distributed lags are all one-sided; that is, they do not involve future values.

6. That is, the correlation between u(r) and v(s) is zero for all r and s.

7. Once I drop the infinite lag structure.

8. See also Ciccolo (1978), Haugh (1976), Mehra (1977, 1978), Sims (1972a), Sargent (1973, 1976a), and Williams et al. (1976). None of these authors has applied the causality tests in the same context analyzed below.

9. By stability of the money demand function I mean a relationship among variables which demonstrates consistent marginal effects of changes in variables across time or economic conditions. For example, real income is expected to influence real money holdings in a positive fashion. This was borne out for Latin America in Chapter III, above.

10. Interestingly enough, most empirical tests of the monetary approach to the balance of payments do not specify the demand for real cash balances in per capita terms. See Chapter III.

11. I could also allow for partial adjustment of money demand to money supply as follows (assuming P and N fixed). I begin with k_1^* $\hat{M}^d = k_2^* \hat{M}^s = u_6$. Let $k_1(r) = 0$ for $r \neq 0$ and $k_1(0) = \lambda$. Further,

let $k_2(4) = 0$ for $r \neq 0,1$, $k_2(0) = -1$, and $k_2(1) = (1 - \lambda)$. Then $\lambda\hat{M}^d(t) + (1 - \lambda)\hat{M}^s(t-1) - u_6 = \hat{M}^s(t)$. Except for not using the appropriate adjustment of real cash balances demanded to real supply, this specification replicates the partial adjustment model analyzed in Chapter IV.

12. This leaves aside the more obvious criticism of the influence of anticipated money growth on the price level through changes in the money multiplier and domestic credit expansion/contraction. See Darby (forthcoming) for a theoretical discussion of the inappropriateness of treating domestic credit as an exogenous variable.

13. See Zellner (1978) for a critical discussion of the Granger concept of causality.

14. See Granger (1969), p. 427.

15. The F-statistic would be the explained sum of squares from regression (33) minus the explained sum of squares from regression (32) divided by the change in degrees of freedom, in this case, m. This adjusted difference in explained variation is then divided by the unexplained mean square from regression (33). Thus, the test is analogous to the specification analysis of constraining the coefficients of some variables in a regression to take on specific values, in this case, zero.

16. See Pierce and Haugh (1977), pp. 269-72. I should also put in the proviso that both series are measured without error (see Schwert, 1978, pp. 36-37).

17. See Schwert (1978), p. 35.

18. Prewhitening a series using Box-Jenkins methods is a time consuming process and one which is not easily practiced. Moreover, if the ARIMA process required to reduce series to white noise involves second differences and moving averages of even small orders, valuable degrees of freedom are lost in addition to the observations lost due to the distributed lag structure. Unfortunately, the annual data I have encompasses a short-time horizon, therefore making ARIMA estimation impractical.

19. Since 1976 Argentina's exchange rate has sky-rocketed from 275 new pesos per dollar to a rate approaching 1000 new pesos per dollar.

20. While the criticisms of the Granger causality test raised earlier may be brought to mind, the fact that the economic characteristics of these five countries are generally disparate suggests that statistical problems such as serial correlation or measurement error

may not be the only problems. Indeed, policies aimed at offsetting foreign influences might be important.

21. As it was shown in Chapter V.

22. I use the limit for exchange rate adjustments of 20% (or less). Ecuador did, however, devalue its sucre approximately 40% in 1970.

23. This should be qualified to indicate the short run nature of this conclusion. The short-run in this case is at most three years.

24. As alluded to earlier (see Chapter II), the central bank of Uruguay attempted to sterilize inflows of reserves through domestic credit destruction.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The main question I sought to answer in this dissertation was empirical in nature. Namely, is the assumption of instantaneous price arbitrage and a corollary assumption, that the rate of inflation experienced by a small open economy is an exogenous determinant of the official settlements balance of payments, an appropriate specification of the monetary model of balance of payments theory for Latin American countries? The answer to this question can be expressed in the main as:

1) instantaneous price argitrage is not a good short-run empirical assumption for these countries;

2) purchasing power parity, without due allowance for lags in adjustment, is similarly inappropriate;

3) the domestic rate of inflation is only strictly exogenous in three cases: Argentina, Guatemala, and Paraguay.

The work on this dissertation proceeded along three lines. First, a description of the macroeconomic experiences of the sixteen Latin American countries was outlined and compared to the United States. In this connection, a number of policy questions--derived from the models of Lucas and Barro--were answered. This discussion shed light on the interaction of political and economic phenomena for a sample of countries over which these attributes differed. The analysis also pointed up the importance of variability in economic aggregates as explanatory factors.

Second, two previously used single equation models were tested. The first being the reduced form equation expressing the balance of payments as a function of the domestic rate of inflation, real income growth, the percentage change in the money multiplier, and domestic credit expansion/contraction. This model was shown to be inefficient and subject to several points of criticism. On the other hand, a single equation relating the level of real cash balances per capita to the level of real per capita income and a number of (imperfect) measures of opportunity cost was shown to be useful even for countries with such diverse monetary experiences as Chile and Costa Rica. Since the money demand estimation was effective in picking up a stable relationship, I concluded that the failure of the simple (single equation) monetary model of the balance of payments was not due to instability on the demand side of the money market.

Finally, as an alternative explanation of the failure of the simple monetary model, I proceeded to demonstrate the sluggishness of price arbitrage and the inappropriateness of assuming that the domestic rate of inflation is an exogenous determinant of the balance of payments.

These results are important for future research in several respects. First, they clearly demonstrate how a desire for simplicity can obfuscate the basic thrust of a model. A monetary approach to balance of payments analysis need not utilize a price arbitrage assumption. The specification and implementation of the monetary model are greatly facilitated by such assumptions as is ease of (theoretical) prediction. However, whether the balance of payments is truly a monetary phenomenon is not dependent upon instantaneous arbitrage of price levels nor even simply some prices, e.g., tradeables.

Second, these results suggest that the data used in empirical analysis should and can be the final judge of the specification of a model. That is, theoretical considerations allow us to rule out or incorporate certain behavioral, institutional, definitional, and equilibrium conditions. Prior beliefs regarding observable phenomena should only be incorporated so long as they can be generally expected to be true. For example, we have reliable estimates of the real per capita income elasticity of demand for real cash balances per capita. From these estimates, we notice that such elasticities are approximately unity for developed economies. However, we have a priori reason to suppose that the per capita income elasticity of demand for real cash balances per capita is unity only in the long run, when velocity is constant. Thus, restricting the estimation of a money demand function to reflect a unitary per capita income elasticity could involve a specification error. Why not simply let the data decide?

Finally, the use of causality tests as developed by Granger and innovated by Sims were shown to be useful in a variety of contexts especially as a form of tests for possible specification error.

Specifically, I demonstrated that the empirical issue of short-run monetary independence can be answered by using the incremental prediction criterion of Granger; and that this test procedure is useful in the analysis of the dynamics of inflation.

Conclusions

The general conclusions drawn from this study are that price arbitrage was not completed within three years for these countries and that the rate of inflation could not be considered as an exogenous variable which explains the balance of payments of Latin American countries. This latter conclusion is a contradiction of the most simple formulation of the monetary approach to the balance of payments. The simple model considers a small (non-reserve currency) country open to trade with an additional assumption of instantaneous price arbitrage.

These general conclusions can be made more specific to reflect the circumstances of each country. However, I believe it would be illustrative to analyze the results in terms of groups and clearly connect the results of each level of analysis. Consider grouping the countries according to exchange rate regime. El Salvador, Guatamala, and Honduras each maintained a constant fixed exchange rate with the U.S. dollar. A second group would be those countries which operated under a fixed exchange rate regime but which intermittently adjusted the value of its currency: Costa Rica, Ecuador, Mexico, Nicaragua, Paraguay, Peru, and Venezuela. The third group would consist of those countries which frequently adjusted its exchange rate but were not operating a truly freely-floating regime: Argentina, Bolivia, Brazil, Chile, Colombia, and Uruguay.

This grouping is interesting in several respects. First, I noticed that each of the countries in the first group, completely fixed exchange rate, had lower average rates of growth in money income, the price level, and monetary aggregates than did each of the countries in the second group. Each country in the third group, those countries which adjusted their exchange rate frequently, experienced higher average growth rates in these variables than each of the countries with a less flexible or rigid exchange rate regime. Variability in the rates of growth in money income, the price level, and monetary aggregates showed the same pattern.

A second aspect of the results when grouped by rigidity of exchange rate is that those countries with a fixed exchange rate or even those which revised its exchange rate intermittently were not likely to adjust more rapidly to short-run monetary disequilibrium. That is, the speed of adjustment of actual to desired real cash balances has been suggested as a possible indicator of how open an economy is and therefore how susceptible it is to foreign impulses. Whether or not this is true, the estimates of the speed of adjustment do not conform to the notion that fixed exchange rate countries are susceptible. Both El Salvador and Honduras have very slow speeds of monetary adjustment (indicative of closed economies, i.e., insulated from the rest of the world) and each has maintained a fixed exchange rate with the dollar. In fact, the estimates for the speed of adjustment indicate a greater similarity between El Salvador and Honduras and, for example, Argentina and Chile, than El Salvador and Honduras share with Guatemala, another fixed exchange rate country.

Third, it has often been the case that the purchasing power parity (PPP) principle has been used in theoretical arguments to suggest that a small country cannot escape the influence of inflation in the rest of the world. Unfortunately, the principle was never really meant to apply instantaneously. How long it takes for the relationship to fully reflect the adjustment to differences in inflation rates is an empirical question. I demonstrated that for Latin America one year is not a sufficient time interval. In terms of grouping according to exchange rate regime, there does not exist any discernible pattern in the performance of the tests. That is, neither fixed-exchange-rate countries nor variable-exchange-rate countries exhibit a stable PPP relationship which conforms to my expectations. This, again, is only disturbing insofar as such a simple theoretical proposition as instantaneous PPP cannot validly be used in empirically testing economic models for Latin American countries. It remains to be shown that more elaborate models of PPP are useful. In this connection I also incorporated real per capita income growth as an explanatory variable in the PPP relation. Only the results for Colombia and Ecuador are encouraging; neither country maintained a fixed exchange rate.

Finally, by using Granger type tests for causality. I allowed for lags in adjustment of inflation in Latin American countries to U.S. inflation, as well as other avenues of transmission. This test again showed no particular pattern in terms of the exchange rate grouping. Only the rates of inflation in Argentina, Brazil, and Mexico were caused by the U.S. rate of inflation. The F statistics for the fixed exchange rate countries were very low indicating almost no relationship for those countries and the U.S. Interestingly, the affect of U.S. domestic credit expansion on rates of inflation was significant for a greater number of countries, only one of which was operating a fixed rate: Guatemala.

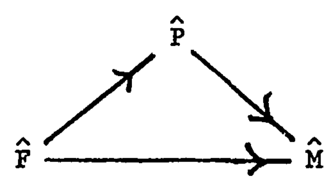
I would like to depart from the exchange rate regime grouping to explicitly outline the results of the causality tests. Uni-directional causality from the domestic rate of inflation to the balance of payments exists for Argentina, Guatemala, and Paraguay. Uni-directional causality from the balance of payments to the domestic rate of inflation exists for Ecuador, Uruguay, and Venezuela. Bi-directional causality exists for Bolivia, Chile, and Mexico. Moreover, I noticed that those countries with slow to moderate speeds of real monetary adjustment exhibited uni-directional causality from domestic monetary growth to inflation: Chile, Ecuador, Honduras, Mexico, Nicaragua, and Venezuela. Whereas those countries with moderate to fast speeds of adjustment exhibited bi-directional causality.

This suggests that those countries with slow to moderate speeds of adjustment will have a pattern of causality of

$$\hat{M} \rightarrow \hat{P} \rightarrow \hat{F}$$

Here M is nominal money supply, P is the price level, F is foreign

Here M is nominal money supply, P is the price level, F is foreign reserves, a circumflex indicates a rate of change, and the direction of the arrow indicates the direction of causality. That is, slower adjustment to monetary impulses leads to adjustments in the domestic price level initially, and only later the difference between world and domestic rates of inflation is resolved via specie-flow. Whereas, the faster adjusting countries exhibit a pattern such as:



Thus, bi-directional causality might also show up between $\hat{M}$ and $\hat{P}$ and, therefore, $\hat{P}$ and $\hat{F}$. That is, growth in world money which shows up as foreign reserve impulses is translated into monetary and price level growth. The faster monetary adjusting countries have monetary impulses feedback to the price level and, as the domestic price level differs from the rest of the world in the short run, the inflation impulses then feedback to foreign reserve changes. Except for Guatemala--fast speed of adjustment and causality from inflation to balance of payments only--and Chile--slow speed of adjustment and bi-directional causality--the results of the causality tests conform to the notions described above.

A Digression on Harberger

In his lecture, "A Primer on Inflation," *Journal of Money, Credit, and Banking* (November 1978), Arnold Harberger discusses several points which are relevant to the work done for this dissertation in that his analysis is directed toward the concepts of the transmission of inflation, the notion of a "world" inflation, and, indirectly, monetary independence, as well as analyzing nearly all of the countries I studied. He also studies other less-developed-countries and analyzes the issue of the role of deficit financing as a causative factor for chronic and acute cases of inflation, which I do not discuss.

Harberger suggests that it is reasonable to analyze a group of countries which has a "normal" rate of inflation as a unit, whereas those countries which have experienced chronic inflation (at least 20% inflation per annum on average over an extended period), or acute inflation (at least 80% inflation per annum on average for three years or more), should be treated as separate units of observation. Presumably hyperinflationary cases (at least 50% per month) would also be treated as separate units although Harberger does not discuss such cases. In order to support his assertion, Harberger lists inflation rates for a group of 16 developed countries for several contiguous periods and the corresponding rates for 28 less developed countries. Harberger points out that the percentage point spread for 80% of each group is small for each time period and that the spread in inflation rates increases for the period 1972 to 1976. These statistics lead him to conclude that a "world inflation" is a valid notion.

Although the results of the analysis conducted in my study of Latin America in the main indicate that most of those countries should be treated as a single unit of observation, the concept of a common inflationary tendency is not one I would reject. I do, however, object to the presentation of the statistics made by Hargerger for a number of statistical and conceptual reasons.

First, unless the exchange rate for each country was never changed or only changed insignificantly (by less than 5%) during the periods on analysis, the cross-country comparisons implicit in the tables presented by Harberger are difficult to accept. Because the inverse of the price level represents the purchasing power of a currency, the rate of inflation is the absolute value of the rate of change of the purchasing power of that currency. In other words, the rate of inflation represents the depreciation of a currency in its <u>own</u> units. How does this depreciation compare to the purchasing power the currency has elsewhere in the world? Clearly, the answer to this question depends on the original and final purchasing powers of that currency over other currencies, i.e., the exchange rate at each point in time. By adjusting the rate of inflation for exchange rate changes we effectively measure the rates of inflation in terms of the depreciation of the purchasing power of a reserve currency, e.g., the U.S. dollar.

The need to adjust for exchange rate changes is not only true for most of the less-developed countries which both Harberger and I analyze--Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, and Venezuela--but this is also true of many developed countries, notably Canada, which experimented with floating exchange rates several times. The question then remains, would the average annual rates of inflation adjusted for exchange rate changes exhibit greater disparity than shown in the Harberger lecture. Whatever the answer, once having adjusted for exchange rate changes, the rates of inflation would reflect the rate of depreciation on a common unit of currency.

A second question concerns the appropriate benchmark against which to compare the range of rates of inflation. Should we compare the range of inflation rates of the less developed countries to the range for developed countries? According to the tables Harberger presents, the dispersion in inflation rates across the less-developed countries (as measured by the range) is twice the dispersion across the developed countries. Is this difference significant in a statistical sense? It seems to me that the variability over time in average rates of inflation is important in drawing cross-country comparisons inasmuch as the within-country variability offers a measure of the norm for each country. In my analysis of Latin American countries, the dispersion across countries in exchange-rate-adjusted inflation relative to the average (across countries) dispersion within countries was not significant over long periods of time. However, over three and five year periods, the relative dispersion across countries was significant.

Finally, while the main thrust of the Harberger lecture is directed toward average rates of inflation, the important consideration of variability in inflation rates within countries has not been touched upon. Its importance lies in the relation between the unpredictability of prices, as measured by the variance of standard deviation of inflation, for example, and the variability in the growth in nominal income as in the Lucas model. My results seem to indicate that greater variability in inflation was associated positively with greater variability in the growth in nominal demand.

In this manner I believe utilizing a model which focuses on the individual country as the unit of observation is more useful than one which links countries and attempts to uncover regularities therein.

APPENDIX A

SOURCES AND NOTES ON ANNUAL DATA FOR LATIN AMERICA, 1947-1976

The annual data I collected are from secondary sources. Although presumably more data are available through the publications of each individual country, the data would have to be adjusted to fit the mold of some theoretical constructs. This has been done by the sources from which I obtained the data.

Specifically, I obtained most of the data for all countries from the monthly publication of the International Monetary Fund (IMF) entitled International Financial Statistics (IFS). For most countries I was able to extract data of consistent reliability throughout the entire period. I also obtained data, mostly on income, from two publications of the United Nations: Economic Survey of Latin America (ESLA), and Yearbook of National Accounts (YNA). The two U.N. publications frequently had data for years for which I had figures from IFS which made checks on compatibility very easy.

One additional source requires specific mentions. Data on Chile are available in the sources noted above generally only from 1955 and for monetary data from 1960. James R. Lothian of CITIBANK, New York, informed me of a very fine study of the Chilean economy performed by Rolf Luders (1968). In his unpublished University of Chicago doctoral dissertation, "A Monetary History of Chile, 1925-1958," Luders presents a very interesting analysis of the Chilean economy in the "Chicago" tradition, analyzing monetary trends and how they relate to the inflationary experiences of Chile from 1925. In the study, Luders provides tables of data which he obtained, in part, from the publications of the Chilean central bank and general statistics office. These tables were invaluable in providing data on Chile which I would otherwise have not obtained.

General Notes

The data base which I use to analyze several issues in the text contains annual data only. For many variables quarterly (in some cases, monthly) data are available. Unfortunately, for some series, most notably nominal and real income, only annual data are available for all countries. For many countries only annual data are available for other series, e.g., central government budget data. To compound this problem, series which are likely to be useful as interpolators, using Friedman's (1962) method, are not available on a quarterly basis for the entire period. For example, I considered using an index of industrial production to interpolate real income. For nearly all countries quarterly data on industrial production was only available for a small part of the sample period--frequently less than ten years. I therefore abandoned the notion of using quarterly data.

The monetary and inflationary experiences of some of these Latin American nations can be summed up in noting that they experienced one (and sometimes more than one) currency reform. That is, the basic unit of economic accounting was revised. This necessitated changing the published units of data for years prior to each reform into the currency unit that existed in the last year of collected data, 1976. For example, the nominal stock of money (defined below) for Chile was 3278.7 million new pesos at the end of 1975. At the end of 1964 the money stock was 1100 million escudos, where 1000 escudos = 1 new peso. Hence, the money stock at the end of 1964 was 1.1 million new pesos compared to approximately 3.3 billion new pesos only eleven years later--a three-thousandfold increase.

Data in index form, e.g., price levels, frequently are reported in different bases over a long period. I converted all indices to a 1970 base for convenience. I used the mean of the ratio of the series in 1970 base to the series in a different base as the conversion factor. I used a similar mean-of-the-ratio method to splice any series which had a break in the series and for real income when the base year changed.

Finally, all data on the U.S. were taken from IFS. Although other sources are readily available, the quality of data on the U.S. does not seem to differ dramatically by source. Thus, by using IFS data, the definitions of variables would be conformable as between the U.S. and Latin America.

Definition of Variables

As noted earlier, I obtained most of the data from IFS, specifically for: 1970-1976 from the July 1977 issue; 1952-1969 from the

May 1977 issue; 1947-1951 from various monthly issues. The use of other sources will be noted for the specific country where applicable, by variable.

I will proceed by describing the variables of the real sector and then proceed to monetary variables. After the description for each variable I will note any deviations from this definition for each country, additional sources used, and any specific problems in obtaining the series. All series are denominated in millions of the 1976 domestic currency unit, except index numbers.

1. The Real Sector

A. National Income. Three series were available:

1) Gross National Product (Y_N) is the current expenditure on final goods and services produced domestically, line 99a IFS.

2) Gross Domestic Product (Y_D) is gross national product plus net factor payments abroad, line 99b IFS.

3) Gross Domestic Product in 1970 prices (y) is gross domestic product deflated by an implicit price index, line 99b.p IFS. The implicit price index was not directly available from the IFS; only by using the ratio, Y_D/y, can the index be derived.

Argentina	Data on nominal and real income were obtained from YNA for the period 1947-1951. Real GDP was converted from 1950 prices and nominal GDP was converted from an index of GDP in current prices.
Bolivia	No data available from the listed sources prior to 1950.
Brazil	Data on real GDP for 1947-1963 were estimated from ELSA, 1953. Data were available in 1950

	U.S. dollars and converted using exchange rates given there.
Chile	Data for 1947-1955 were estimated from Luders, Table 41, p. 337, which had real GDP in 1947 prices.
Colombia	Data on real GDP for 1947-1953 were estimated from ESLA, 1953. Data were in 1950 U.S. dollars, and converted using exchange rates given there.
Costa Rica	Nominal income data were not available for 1947-1949. Real income data for 1950-1959 were estimated by first interpolating an implicit price index for GDP using the consumer price index and then deflating nominal income.
Ecuador	Nominal income data were not available for 1947-1949. Real income data for 1950-1964 were estimated in a similar fashion used for Costa Rica.
El Salvador	Data for 1947-1951 were estimated from ESLA, 1953. Data were available in 1950 U.S. dollars, and converted using exchange rates given there.
Guatemala	Data for 1947-1949 were estimated from ESLA, 1953. Data were available in 1950 U.S. dollars, and converted using exchange rates given there.
Honduras	Nominal income data for 1947 was estimated from ESLA, 1953. Real income data for 1947-1951 were estimated by first interpolating a GDP implicit price index from the consumer price index and then deflating nominal income.
Mexico	Data for 1947-1951 on real GDP were estimated from nominal GDP data using the consumer price index to interpolate a GDP deflator and then deflating nominal income.
Nicaragua	Data on real GDP for 1947-1951 were estimated from nominal income using the consumer price index to interpolate the GDP implicit price index and then deflating nominal income.
Paraguay	Data on real GDP for 1947-1951 were estimated using a method similar to that used for Nicaragua.

Peru	All data taken from IFS.
Uruguay	Data on nominal and real GDP for 1947-1954 were not available.
Venezuela	Data for 1947-1951 were estimated from ESLA, 1953. Data were available in 1950 U.S. dollars and converted using exchange rates given there.
U.S.	All data taken from IFS.

B. Consumer Price Index. This is an index of retail prices in metropolitan areas. For most of these countries the general index for the capital city was used with 1970 = 100. All index values are annual averages, line 64, IFS.

Argentina	a general index for Buenos Aires.
Bolivia	a general index for La Paz.
Brazil	a general index for Guanabora--the county which includes Rio de Janeiro.
Chile	a general index for Santiago. Data for 1947-1955 were taken from Luders (1968) and converted from a 1947 base, Table 39, pp. 333-34.
Colombia	an index for laborers in Bogota.
Costa Rica	a general index for metropolitan San Jose.
Ecuador	an index for middle and low income workers in Quito
El Salvador	a general index for San Salvador.
Guatemala	a general index for Guatemala City.
Honduras	a general index for Tegucigalpa.
Mexico	a general index for Mexico City.
Nicaragua	a general index for Managua.
Paraguay	an index for workers' households in Asuncion.

Peru	a general index for metropolitan Lima.
Uruguay	a general index for montevideo.
Venezuela	a general index for metropolitan Caracas.
U.S.	an index for city wage earners and clerical workers.

C. Central Government Budgets. Two series were collected:

a) Central government expenditure (G) are current and capital account expenditures of the central government for the calendar government for the calendar year, line 82, IFS.

b) Central government deficit (d), line 80, IFS.

Argentina	No data available for 1947-1969.
Bolivia	No data available for 1947-1958.
Chile	No data available for 1947-1953.
Costa Rica	No data available for 1947-1969.
Ecuador	No data available for 1947.
Guatemala	No data available for 1947-1957.
Mexico	No data available for 1947-1965.
Paraguay	No data available for 1947-1957.
Uruguay	No data available for 1947-1964.

D. International Transactions.

1) Exports (EX) are total current account exports, f.o.b., line 70.d, IFS.

2) Imports (IM) are total current account imports, f.o.b., line 71.vd, IFS.

Chile	No data available for 1947-1959.

E. Balance of Payments. Balance of payments (B) was measured as the official settlements balance, line 79..d, IFS. The data published in IFS were in millions of dollars. The data were converted to domestic currency units using the average exchange rate for the period. In general, this form of estimation is not desirable because of the inaccuracy of applying an average rate for all transactions which sometimes differed from those of foreign trade transactions.

Chile	No data available for 1947-1959.

2. The Monetary Sector

A. Currency held by the public outside of commercial banks (CP), excluding currency at the Treasury and Central Bank, line 14a, IFS.

Chile	Data for 1947-1960 were obtained from Luders, Table 13, p. 304.

B. Demand deposits of the public at commercial banks, the Treasury and the Central bank (DD), line 24, IFS.

Chile	Data for 1947-1960 were obtained from Luders, Table 13, p. 304.
U.S.	No deposits of the public are held by the Treasury or the Federal Reserve Banks.

C. Commercial bank reserves held (at the central bank) against demand deposits (BR), line 20, IFS.

Chile	Data for 1947-1960 were obtained from Luders, Table 12, pp. 301-02.

D. High Powered Money. High powered money (MH) is defined as total currency in circulation plus commercial bank reserves plus deposits of the public at the central bank and Treasury, line 14, IFS.

Chile	Data for 1947-1960 were obtained from Luders, Table 12, pp. 301-02.
U.S.	No deposits of the public are held by the Treasury or the Federal Reserve Banks.

E. Narrow Money Stock. Narrow money stock (M1) is defined as currency held by the public outside commercial banks (CP) plus demand deposits of the public at commercial banks, the Treasury and the Central Bank (DD), line 34, IFS.

Chile	Data for 1947-1960 were obtained from Luders, Table 13, p. 303.

F. Nominal Market Exchange Rate. Nominal market exchange rate rate (e) is the market exchange rate in domestic currency units per U.S. dollar, line ae, IFS.

Chile	Data for 1947-1960 were obtained from Luders, Table 43, pp. 340-41.

G. Official International Reserve Assets. Official international reserve assets (F) are the gross holdings of gold, foreign exchange and special drawing rights held by the central bank, line 1.a.d + 1d.d + 1.b.d, IFS. The IFS reports these data in dollars at the end of period. The exchange rate of domestic currency units

(DCU) per dollar was used to convert the foreign reserve figures to DCU's.

Chile Data for 1947-1960 were obtained from Luders, Table 3, pp. 21-22.

H. Data on the Central Bank Discount Rate were the only figures for interest rates. Since these rates do not represent market rates, they were not useful as measures of the opportunity cost of holding money.

I did obtain data for the U.S. for the full period from IFS on two market interest rate series:

1) The short-term interest rate (i_s) is the yield on new three-month (U.S.) Treasury bills in percent per annum, line 60c, IFS.

2) The long-term interest rate (i_L) is the average of yields on all fully taxed federal government bonds maturing or callable in ten years or more, line 61, IFS.

APPENDIX B

THE CONSTRUCTION OF WORLD PRICE INDICES FOR LATIN AMERICA, 1955-1975

One of the basic assumptions of the simplest expression of the monetary approach to the balance of payments concerns the treatment of the rate of inflation experienced by a small open economy. In the Introduction and Chapter III, I discussed this assumption in terms of the single equation model. In Chapter V, I tested the proposition that rates of inflation converge. Indeed, the results of my test led me to conclude that over long periods of time, between 16 and 20 years, rates of inflation across Latin America do converge. On the other hand, I presented results which indicate that differences in rates of inflation exist, over three and five year periods, across the same countries.

It therefore is important to ask whether there are common elements to rates of inflation across countries. If I can isolate a common factor across Latin American price levels, then I can also use that factor to construct an index of prices--and inflation--which would be representative of the prices of those countries. The technique of principal component analysis is useful in isolating common elements of several variables and can be used in this regard.[1]

1. Principal Component Analysis[2]

The specific principal components that I wish to isolate can be described in the following (less than general) way. I have a matrix of T observations on K variables which I hope to describe simply as a linear function of a few variables. Ideally, I want to determine one variable which will represent the underlying movements of the K variables. In my case, I want to determine if a combination of the price levels of the sixteen Latin American countries and the United States, K = 17, can be represented by a single index for the period 1955-1975, T = 21.

If all 17 price levels moved in exact proportionality then one principal component would suffice to describe the movement of all the price levels. That is, I let P be the $T \times K$ matrix of price levels, p be the $T \times 1$ vector single principle component and a be the $K \times 1$ vector of wieghts for each country commonly called factor loadings which in combination with p would yield $P = p\ a'$. Where the price level for, say, Argentina, at time t, would be $P_{t,AR} = P_t\ a_{AR}$.

If movements of price levels were not completely proportional, then more than one component would be necessary to characterize the matrix P. That is, the principal components would be a $T \times R$ matrix and the factor loadings would be an $R \times K$ matrix, where R is the number of components. The price level for Argentina at time t would be described as

$$P_{t,AR} = P_{t,1} \cdot a_{1,AR} + p_{t,2} \cdot a_{2,AR} + \dots + P_{t,R} \cdot a_{R,AR}$$

If the factor loadings are the same for each country then, whatever value the principal component index, $p_{t,r}$, takes on for each year, I can construct an index from the price levels of each of the countries to represent the movements in the price levels of the group as a whole. That is, by applying a different weight to each observation of a country's price level and combining that with a similarly weighted price for all other countries, a "world" price index could be constructed.[3]

Second, third or higher order principal components would indicate the degree of association between country price levels not explained by the first. Such additional components would be useful in isolating the possible existence of common elements across a subgroup of countries as indicated by the similarity of factor loadings.[4]

2. The Empirical Analysis

I conducted the principal components analysis for the Consumer Price Index of all countries and the rate of change of the CPI for the period 1956-1975. For the levels and rates of change, I also conducted analyses for data adjusted for changes in the exchange rate.

I present the factor loadings and cumulative fraction of explained variation for the unadjusted and adjusted CPI's in Tables B.1 and B.2, respectively. I allowed for the possibility of four components. In comparing the results in Table B.1 with those in B.2, I note that the first principal component for the unadjusted

CPI's explains more of the variation across countries and time (0.914) than all four components for the adjusted CPI's (0.882). A characteristic of principal component analysis in that the technique is sensitive to scale and origin of the variables.[5]

However, the difference in factor loadings, as between unadjusted and adjusted price levels, suggests that to explain the variation in the movements of price levels of these countries during this period more threads need to be women when we try to account for exchange rate changes than are needed for nominal price levels. Interestingly enough, the countries which have first loading factors that are most different from the U.S. when no adjustments are made are those which did not experience any exchange rate changes during the period.

I present the factor loadings and cumulative fraction of explained variation for the unadjusted and adjusted rates of change of country CPI's in Tables B.3 and B.4, respectively. I also allowed for four principal components. In comparing Tables B.3 and B.4, I note that less variation is explained, with a given number of principal components, with exchange rate-adjusted rates of inflation than without adjustments. However, the difference in cumulative explained variation between unadjusted and adjusted rates of change is not as great as the corresponding comparison for price levels.

A major difference between the price level and the rate of change analyses is that there is much greater similarity in factor loadings for price levels than for rates of change, irrespective of

TABLE B.1
PRINCIPAL COMPONENT ANALYSIS:
CONSUMER PRICE INDEX, 1955-1975
UNADJUSTED FOR EXCHANGE RATE CHANGES

Country	Factor Loadings			
	$a_{1,K}$	$a_{2,K}$	$a_{3,K}$	$a_{4,K}$
Argentina	0.991	0.029	0.023	0.061
Bolivia	0.928	-0.344	0.038	-0.022
Brazil	0.984	0.138	0.027	0.081
Chile	0.981	0.154	0.076	0.002
Colombia	0.987	-0.087	-0.045	0.102
Costa Rica	0.983	-0.110	0.054	-0.034
Ecuador	0.995	-0.005	0.036	0.062
El Salvador*	0.888	0.309	-0.274	-0.194
Guatemala*	0.874	0.417	0.171	-0.094
Honduras*	0.982	-0.039	-0.106	0.108
Mexico	0.972	-0.198	0.002	-0.097
Nicaragua	0.946	0.178	-0.168	0.191
Paraguay	0.841	-0.530	0.029	-0.017
Peru	0.993	-0.047	-0.006	0.062
Uruguay	0.944	0.270	0.128	-0.013
Venezuela	0.953	-0.187	-0.084	-0.182
United States	0.992	0.041	0.092	-0.051
Cumulative Fraction of Variance Explained by Component	0.914	0.968	0.979	0.989

*These countries maintained an unchanging exchange rate vis-a-vis the U.S. dollar, for the period 1956-1975.

TABLE B.2
PRINCIPAL COMPONENT ANALYSIS
CONSUMER PRICE INDEX, 1955-1975
ADJUSTED FOR EXCHANGE RATE CHANGES

Country	Factor Loadings			
	$a_{1,K}$	$a_{2,K}$	$a_{3,K}$	$a_{4,K}$
Argentina	0.866	0.456	0.048	0.057
Bolivia	0.942	0.244	-0.082	-0.118
Brazil	0.788	-0.217	-0.026	0.211
Chile	0.105	0.750	0.133	0.277
Colombia	-0.186	-0.272	0.382	0.842
Costa Rica	0.686	-0.490	0.125	-0.263
Ecuador	0.480	-0.231	-0.649	0.193
El Salvador*	0.869	-0.317	0.110	-0.039
Guatemala*	0.854	-0.347	0.333	-0.132
Honduras*	0.989	-0.001	-0.047	0.057
Mexico*	0.958	0.182	0.015	-0.147
Nicaragua	0.932	-0.284	-0.063	0.121
Paraguay	0.863	0.421	-0.115	-0.071
Peru	0.930	0.144	-0.033	0.134
Uruguay	0.486	0.110	0.722	0.076
Venezuela	-0.648	0.027	0.468	-0.400
United States	0.979	-0.008	0.134	-0.133
Cumulative Fraction of Variance Explained by Component	0.616	0.721	0.810	0.882

*These countries maintained an unchanging exchange rate vis-a-vis the U.S. dollar, for the period 1956-1975.

TABLE B.3
PRINCIPAL COMPONENT ANALYSIS
RATE OF CHANGE OF CONSUMER PRICE INDEX, 1955-1975,
UNADJUSTED FOR EXCHANGE RATE CHANGES

Country	Factor Loadings			
	$a_{1,K}$	$a_{2,K}$	$a_{3,K}$	$a_{4,K}$
Argentina	0.131	0.566	0.447	0.142
Bolivia	0.867	-0.239	0.024	0.143
Brazil	-0.319	0.483	-0.578	0.482
Chile	0.232	-0.150	-0.055	0.743
Colombia	-0.182	-0.008	-0.489	0.447
Costa Rica	-0.409	-0.662	-0.297	-0.025
Ecuador	-0.782	-0.070	-0.305	-0.332
El Salvador*	-0.519	-0.225	0.432	0.549
Guatemala*	-0.403	-0.605	0.123	0.079
Honduras*	-0.874	0.153	-0.166	0.227
Mexico*	0.006	-0.402	0.579	0.137
Nicaragua	-0.912	0.116	-0.034	-0.0003
Paraguay	0.886	-0.007	-0.066	-0.023
Peru	-0.281	0.614	0.397	-0.162
Uruguay	-0.420	0.510	0.254	-0.316
Venezuela	-0.322	0.035	0.716	0.419
United States	-0.412	-0.680	0.239	-0.343
Cumulative Fraction of Variance Explained by Component	0.299	0.463	0.599	0.713

*These countries maintained an unchanging exchange rate vis-a-vis the U.S. dollar, for the period 1956-1975.

TABLE B.4
PRINCIPAL COMPONENT ANALYSIS
RATE OF CHANGE OF CONSUMER PRICE INDEX, 1955-1975,
ADJUSTED FOR EXCHANGE RATE CHANGES

Country	Factor Loadings			
	$a_{1,K}$	$a_{2,K}$	$a_{3,K}$	$a_{4,K}$
Argentina	0.714	0.365	0.219	0.118
Bolivia	-0.418	0.785	-0.114	0.271
Brazil	0.321	-0.372	-0.180	0.193
Chile	0.757	-0.207	0.222	0.026
Colombia	0.133	-0.184	0.709	-0.304
Costa Rica	-0.386	-0.364	0.134	0.255
Ecuador	-0.103	0.140	-0.169	-0.267
El Salvador*	-0.560	-0.621	0.297	-0.272
Guatemala*	-0.435	-0.513	0.428	0.353
Honduras*	-0.695	0.268	0.433	-0.231
Mexico*	-0.354	-0.440	-0.473	0.067
Nicaragua	-0.728	0.357	0.355	0.023
Paraguay	-0.334	0.793	-0.322	0.170
Peru	0.345	0.324	0.375	0.357
Uruguay	0.352	0.210	0.641	0.408
Venezuela	0.132	-0.399	-0.410	0.459
United States	-0.433	-0.213	0.093	0.764
Cumulative Fraction of Variance Explained by Component	0.220	0.405	0.542	0.643

*These countries maintained an unchanging exchange rate vis-a-vis the U.S. dollar, for the period 1956-1975.

adjustments. This difference implies that the construction of a "world" index would be more appropriate for price levels than for rates of inflation. Fortunately, by constructing a "world" index of prices, a corresponding rate of inflation can be derived.

3. The World Price Levels

I constructed price indices for each country in the sample, except the U.S. These indices are weighted averages of the consumer price index for all countries except the country for which the index is applied. In other words, I constructed rest-of-the-world price levels for the 16 Latin American countries. The indices are listed in Table B.5.

The rest-of-the world price levels were constructed using the share in nominal rest-of-the-world income as the weight applied to exchange-rate adjusted country CPI's. That is, I let $P_{t,j}$ represent the unadjusted CPI in time t for country j. The adjusted CPI is then

$$P'_{t,j} = P_{t,j} \cdot e_{1970,j}/e_{t,j}$$

where $e_{t,j}$ is the domestic currency price of the U.S. dollar for country j at time t. I obtained the weight for each country by first deriving the level of "world" income in U.S. dollar. I let $Y_{t,j}$ be nominal gross domestic product for country j at time t in j's domestic currency units. I let

$$Y'_{t,j} = Y_{t,j}/e_{t,j}$$

TABLE B.5

REST OF THE WORLD PRICE INDICES, 1970 = 1.00

Year	WPCAR	WPCBO	WPCBR	WPCCH	WPCCO	WPCCR	WPCEC	WPCES	WPCGU
1955	0.772	0.702	0.770	0.768	0.755	0.767	0.766	0.767	0.767
	0.724	0.719	0.716	0.718	0.704	0.719	0.718	0.719	0.718
	0.730	0.726	0.727	0.725	0.725	0.725	0.725	0.725	0.725
	0.747	0.742	0.745	0.742	0.741	0.742	0.742	0.742	0.742
	0.757	0.753	0.758	0.751	0.751	0.753	0.752	0.753	0.753
1960	0.771	0.769	0.773	0.767	0.767	0.769	0.769	0.769	0.769
	0.779	0.780	0.784	0.776	0.777	0.779	0.779	0.779	0.779
	0.781	0.779	0.784	0.779	0.778	0.779	0.779	0.779	0.779
	0.797	0.797	0.799	0.795	0.794	0.797	0.796	0.797	0.796
	0.800	0.801	0.808	0.800	0.797	0.801	0.801	0.801	0.801
1965	0.812	0.814	0.818	0.813	0.813	0.814	0.814	0.814	0.814
	0.848	0.849	0.846	0.846	0.847	0.849	0.848	0.849	0.848
	0.868	0.867	0.862	0.866	0.866	0.867	0.866	0.867	0.867
	0.897	0.898	0.899	0.898	0.897	0.898	0.897	0.898	0.898
	0.945	0.946	0.947	0.947	0.946	0.946	0.946	0.946	0.946
1970	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	1.043	1.043	1.043	1.044	1.044	1.043	1.043	1.043	1.043
	1.079	1.100	1.099	1.100	1.100	1.099	1.099	1.099	1.100
	1.153	1.228	1.226	1.230	1.228	1.228	1.228	1.228	1.228
	1.283	1.405	1.408	1.408	1.405	1.405	1.404	1.405	1.405
1975	1.406	1.398	1.397	1.401	1.398	1.398	1.397	1.398	1.398

TABLE B.5 (continued)

Year	WPCHO	WPCMX	WPCNI	WPCPA	WPCPE	WPCUR	WPCVE	WORLD WPC	WORLD WEXP
1955	0.767	0.770	0.767	0.767	0.768	0.767	0.763	0.767	447217.
	0.719	0.721	0.719	0.719	0.719	0.719	0.713	0.719	469277.
	0.726	0.727	0.725	0.726	0.726	0.726	0.720	0.726	490864.
	0.742	0.743	0.742	0.742	0.743	0.743	0.736	0.742	492744.
	0.753	0.754	0.753	0.753	0.754	0.753	0.746	0.753	536212.
1960	0.769	0.769	0.769	0.769	0.770	0.769	0.762	0.769	565278.
	0.779	0.779	0.779	0.779	0.780	0.779	0.773	0.779	586571.
	0.779	0.779	0.779	0.779	0.779	0.779	0.772	0.779	624240.
	0.797	0.797	0.797	0.797	0.797	0.797	0.791	0.797	671539.
	0.801	0.801	0.801	0.801	0.801	0.801	0.800	0.801	710805.
1965	0.814	0.813	0.814	0.814	0.813	0.814	0.813	0.814	771339.
	0.848	0.848	0.848	0.848	0.848	0.849	0.848	0.848	851957.
	0.867	0.866	0.867	0.867	0.867	0.867	0.866	0.867	897270.
	0.898	0.897	0.898	0.898	0.898	0.898	0.897	0.898	977840.
	0.946	0.946	0.946	0.946	0.946	0.946	0.946	0.946	1060460.
1970	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1120710
	1.043	1.043	1.043	1.043	1.043	1.044	1.043	1.043	1215010.
	1.099	1.099	1.099	1.099	1.099	1.100	1.100	1.099	1358670.
	1.228	1.228	1.228	1.228	1.228	1.228	1.229	1.228	1554860.
	1.405	1.400	1.404	1.404	1.404	1.405	1.407	1.405	1737350.
1975	1.398	1.381	1.398	1.398	1.397	1.398	1.399	1.398	1810110.

The last two letters indicate the country to which the consumer price index is external.

To construct a rest-of-the-world index for country i, the following formula was used:

$$P^R_{t,i} = \sum_{\substack{j=1 \\ j \neq i}}^{17} \frac{w_{t,j}}{1 - w_{t,i}} P'_{t,j}$$

where

$$w_{t,j} = \frac{Y'_{t,j}}{\sum_{k=1}^{17} Y'_{t,k}}$$

Hence the price levels have a base year of 1970 as do the unadjusted CPI's. The weights of most countries were very small since the weight for the U.S. was nearly 0.9 for all years. This is apparent from Table B.5 in that the value the price index takes on in any year is similar for all countries.

I have included in Table B.5 a world price index covering all 17 countries and the level of nominal world GDP denominated in U.S. dollars.

Footnotes to Appendix B

1. Genberg (1975) also uses the principal components technique to develop world price indices using data on 21 OECD countries including the U.S., Canada and Japan (pp. 28-48).

2. Theil's (1971) textbook contains a better general discussion of the technique (pp. 46-55).

3. If the value for each principal component were the same for every year, a similar inference could be drawn. Except that a fixed weight, for all T, could be applied for each country to obtain a "world" price index.

4. Significant higher order principal components might also be indicative of differences across sub-periods of time.

5. See Theil (1971), p. 55.

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