Dissertations, Theses, and Capstone Projects   CUNY Graduate Center

1979

Money, the Dynamics of Inflation and the Balance of Payments in Latin America, 1947-1976

Anthony Cassese
The Graduate Center, City University of New York

[How does access to this work benefit you? Let us know!](#)

INFORMATION TO USERS

7913118

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

    CITY UNIVERSITY OF NEW YORK, PH.D., 1979

PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark ✔.

1. Glossy photographs _____

2. Colored illustrations _____

3. Photographs with dark background _____

4. Illustrations are poor copy _____

5. Print shows through as there is text on both sides of page _____

6. Indistinct, broken or small print on several pages _____ throughout _____

7. Tightly bound copy with print lost in spine _____

8. Computer printout pages with indistinct print _____

9. Page(s) _____ lacking when material received, and not available from school or author _____

10. Page(s) _____ seem to be missing in numbering only as text follows _____

11. Poor carbon copy ✔

12. Not original copy, several pages with blurred type _____

13. Appendix pages are poor copy _____

14. Original copy with light type _____

15. Curling and wrinkled pages _____

16. Other _____

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

February 1979

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.

[signature]

Feb 8, 1979
Date

Chairperson of Supervisory Committee

[signature]

_2/8/1979_
Date

Executive Officer, Dept. of Economics

Professor Alvin L. Marty

Professor Damodar Gujarati

Professor Elliot Zupnick

Supervisory Committee

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.

vii

ball rolling. Moreover, I only began to appreciate the skill of good writing after Jim provided the copious stylistic comments which have made this dissertation readable.

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.

Professor Elliot Zupnick read and commented on each piece of the work as it slowly progressed and suggested several ways of improving the presentation. Professor Damodar Gujarati never acted as a disinterested third party; his comments were helpful in clarifying several empirical issues.

I would also like to thank my firend and fellow student, Dr. Nurhan Helvacian, for reading and commenting on parts of my dissertation at its most formative stage. Nurhan also proved to be a sounding board for some ideas as well as a source of encouragement.

Much thanks go to Linda Dunn of N.B.E.R. for supplying typing when time was short; to Fran Kong and Lenore Rutz of Rutgers University for typing the drafts of each successive chapter—always on short notice. I extend my thanks to Pat Maher for expertly typing the final draft. My thanks also go to the members of the International Transmission of Inflation Project of N.B.E.R. for financing the duplicating and typing services.

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.

TABLE OF CONTENTS

LIST OF TABLES

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 develop-
ing 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

1

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
SDR's	Commercial Banks
Government Securities	Accounts of the Treasury
	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, out-
lined above, of having to explain that variety. Finally, the group of
countries analyzed here permit me to make several cross-country com-
parisons.

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 varia-
bility. 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 subse-

quent 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, $\hat{y}/N$, two
observations are apparent. Firstly, in most cases the average rate
of growth was <u>not</u> 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 pay-
ments.[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, respec-
tively, imply that the Latin American countries were likely to have
experienced less favorable tradeoffs[5] and have experienced more vari-
able 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
nominal 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	$(\widehat{y/n})$		$\widehat{Y}$		$\widehat{P}_{GDP}$		$\widehat{P}_{CPI}$	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	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.

$y \equiv$ real gross domestic product; $N \equiv$ population; $Y \equiv$ nominal gross domestic product; $P_{GDP} \equiv$ GDP implicit price deflator $= Y/y$, 1970 = 1.00; $P_{CPI} \equiv$ 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 coun-

tries. 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, $\hat{g}/N$, 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 $\hat{g}/N$ 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	$-0.46^\dagger$		-0.56*		-0.50*			
	S.D.	-0.08	$0.48^\dagger$	-0.12	0.32	-0.01	-0.29		
$\hat{G}$	Mean	0.83**		0.80**		0.80**			
	S.D.	0.54**	0.70**	$0.49^\dagger$	0.68**	$0.49^\dagger$	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, $\hat{}$, indicates a percentage rate of change of the variable: $Y \equiv$ nominal GDP; $y \equiv$ real GDP; $P_{GDP} \equiv$ implicit price index; $P_{CPI} \equiv$ consumer price index; $G \equiv$ nominal central government expenditure; $TR \equiv$ sum of nominal current account exports and imports.

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

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	(g/N)		$\hat{G}$		G/Y	
	Mean	S.D.	Mean	S.D.	Mean	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. insigni-

ficantly 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	$(\widehat{tr/N})$		$\widehat{TR}$		TR/Y	
	Mean	S.D.	Mean	S.D.	Mean	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 vari-
ability 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 nomi-
nal 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   18

ANNUAL GROWTH RATES OF MONETARY AGGREGATES (%)

1947 - 1976[1]

Country	$\hat{M}1$ Mean	S.D.	$\hat{H}$ 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]

		$\hat{Y}$ Mean	$\hat{Y}$ S.D.	$\hat{P}_{GDP}$ Mean	$\hat{P}_{GDP}$ S.D.	$\hat{P}_{CPI}$ Mean	$\hat{P}_{CPI}$ S.D.	$\hat{y}$ Mean	$\hat{y}$ 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, $\hat{}$, 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; $M1 \equiv$ nominal narrow money stock; $H \equiv$ nominal high powered money stock; $F \equiv$ foreign reserves; $DH \equiv$ domestic component of high powered money; $V \equiv$ 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*		$\hat{M}1$	-0.50*
$\hat{P}_{GDP}$	-0.60*		$\hat{H}$	-0.61*
$\hat{P}_{CPI}$	-0.50*		$\hat{F}$	$-0.49^{\dagger}$
$\hat{y}$	0.28		$\hat{DH}$	$-0.49^{\dagger}$
$\hat{G}$	-0.55*			
$\hat{TR}$	-0.55*			
TR/Y^1	0.51*			

A circumflex, $\hat{}$, 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.

$\dagger$ 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 corres-
pondence 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-correla-

tions 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 ceteris paribus condition

holds.[11]

One interesting statistic is the significant negative correla-

tion 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		M1/H	
	Mean	S.D.	Mean	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 foreign-
ers 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 coun-
tries: 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, $\hat{}$, indicates a percentage rate of change of the variable:
y = 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,

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

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

7. Lucas (1973) estimates the following relationship:

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

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

$$\hat{P}_t^d = a_1 \hat{x}_t^d + a_2 \hat{x}_{t-1}^d + a_3 \hat{y}_{ct-1}, \tag{ii}$$

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

$$Var(\hat{P}_t) = (a_1^2 + a_2^2)\, VAR(\hat{x}_5) + a_3^2\, VAR(\hat{y}_{ct-1})$$

$$+ a_3(a_1 + a_2)\, COV(\hat{x}_t, \hat{y}_{ct-1})$$

$$+ a_1 a_2\, COV(\hat{x}_t, \hat{x}_{t-1}) \tag{iii}$$

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 mone-

tary 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,

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

$$M^s = h \cdot H \tag{2}$$

$$H = F + DH \tag{3}$$

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 $\hat{}$ denote percentage changes, I have:

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

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

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

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:

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

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

I estimated an ordinary least squares regression cf 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

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

$$= (F_t/H_t)\cdot(F_t - F_{t-1})/F_t$$

$$= (F_t - F_{t-1})/H_t$$

$$= B_t/H_t$$

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:

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

where the explanatory variables are the same as those in specifica-
tion (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 _per capita_
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)	$(1-\theta)\hat{DH}$ (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)

47

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 (0.203)	2.757* (0.661)	2.928 (1.959)	-1.410 (0.814)	-0.095* (0.040)	0.362†	2.02
1951-75	Bolivia	0.111 (0.227)	1.868* (0.563)	-1.147 (2.411)	5.470 (2.940)	-0.052* (0.116)	0.411†	2.25
1947-76	Brazil	0.209 (0.218)	1.765* (0.682)	-1.416 (1.290)	-0.867 (1.077)	-0.135* (0.043)	0.281†	c
1947-75	Chile	-0.138 (0.178)	1.314* (0.268)	0.730 (2.139)	-1.718* (0.662)	-0.028 (0.014)	0.535†	1.86
1947-75	Colombia	0.068 (0.164)	1.261 (0.787)	0.390 (2.315)	-2.461* (1.085)	-0.128* (0.040)	0.299†	2.37
1951-76	Costa Rica	0.133 (0.138)	1.516 (1.007)	2.482 (1.576)	-1.943 (1.428)	-0.571* (0.122)	0.549†	1.94
1951-76	Ecuador	0.051 (0.076)	1.315 (0.804)	2.412* (1.032)	-2.683 (0.600)	-0.592* (0.136)	0.490†	2.22
1947-76	El Salvador	0.072 (0.054)	0.587 (0.545)	0.439 (0.517)	0.094 (0.771)	-0.314* (0.108)	0.203†	c
1947-75	Guatemala	0.153* (0.045)	1.456* (0.620)	-1.210* (0.550)	-1.258 (0.856)	-0.467* (0.089)	0.480†	2.03

(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^o. 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

| Country | From Table 11 | | | From Table 12 | |
| | $\hat{P}_{CPI}$ | $\hat{y}$ | $\hat{h}$ | $(1-\theta)\cdot\hat{D}H$ | $[(1-\theta)/\theta]\cdot\hat{D}H$ |
	$H_0: \beta_1^o = 1$	$H_0: \beta_2^o = 1$	$H_0: \beta_3^o = -1$	$H_0: \beta_4^o = -1$	$H_0: \beta_4^o = -1$
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: $P_{CPI} \equiv$ consumer price index; $y \equiv$ real GDP; $h \equiv$ money multiplier; DH $\equiv$ domestic component of high powered money; $\theta \equiv$ 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 l1 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 l3 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 insignifi-

cant.[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 regres-

sions 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:

$$\theta \cdot \hat{P} = 1.19\ \hat{P}_{CPI} + 0.52\ \hat{y} - 0.11\ \hat{i} - 0.82\ \hat{h} - 0.67\ (1-\theta)\hat{DH}$$
$$\quad\ (5.38)\qquad\quad (6.36)\quad (-1.22)\quad (-5.29)\qquad (-8.32)$$
$$R^2 = 0.65 \qquad DW = 1.99$$

   2. Table 14.2, column 2:

$$\hat{P} = 0.89\ \hat{P}_{CPI} + 0.37\ \hat{y} - 0.13\ \hat{i} - 0.82\ \hat{h} - 0.52\ (1-\theta)/\theta)\hat{DH}$$
$$\quad (4.87)\qquad\quad (4.71)\quad (-1.70)\quad (-4.88)\quad (-6.20)$$
$$R^2 = 0.48 \qquad DW = 1.96$$

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

$$(1-\theta)\cdot\hat{DH} = 0.011 - 0.53\ \theta\cdot\hat{F} + 0.02\ \hat{G}$$
$$\qquad\qquad\quad (0.004)\ (0.27)\qquad (0.06)$$

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

$$\qquad - 1.23\ [(1-\theta)\cdot\hat{DH}] - 0.04\ \ln(M_{t-1})$$
$$\qquad\quad (0.63)\qquad\qquad\qquad (0.02)$$

C. Guitain on Spain, Annual data 1955 - 1971, OLS;
   1. Table 15.6, equation 4:

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

   2. Table 15.6, equation 10:

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

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

$$\theta \cdot \hat{F} = 0.65\ \hat{P}_{CPI} + 1.11\ \hat{y}_p - 0.035\ \hat{i} - 0.89\ \hat{h} - 1.06\ (1-\theta)\hat{DH}$$
$$\quad (3.70)\qquad\quad (6.54)\quad (-0.75)\qquad (-5.08)\qquad (-7.97)$$
$$R^2 = 0.93 \qquad DW = 1.69$$

---

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 4 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 4 are
good. However, upon closer examination this "goodness-of-fit" can be
seriously questioned. Indeed, given the criticisms below, the results
described in Table 4 are no better than those for the Latin American
countries described in Tables 1 and 2. Moreover, I propose here that
the results presented in tables 1, 2 and 4 are sufficiently poor as to
contradict the claim that these results represent a test of the valid-
ity 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 tech-
nique. 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 4 refer to his fourth measure which con-
forms 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 statis-

tics 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):

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

$$+ \beta_6 \log M_{t-1} \qquad\qquad (8)$$

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 relation-
ship (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 simul-
taneous 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. $\hat{D}$ 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. nply 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 pay-
ments 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 mone-
tary 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 real cash

balances, M/P, is homogeneous of degree zero 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 alter-

natives 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 deficit 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 specifi-
cation 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 alter-

natives 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[1]	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	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)		
	$\hat{M1}$	$\hat{P}$	$\hat{V}$	$\hat{M1}$	$\hat{P}$	$\hat{V}$	$\hat{M1}$	$\hat{P}$	$\hat{V}$	$\hat{M1}$	$\hat{P}$	$\hat{V}$
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[2]	15.71	8.50	-2.03	19.75	9.27	-4.63	22.23	11.88	-5.50
Uruguay	26.07	27.93	3.20	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 1971-19 75 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[2]	4.37	2.14	7.61	1.49	7.37	2.36
Uruguay	-2.80	-0.46	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. Argen-
tina, 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 addres-
ses 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:

$$i_k = r_k + \hat{P}^E_k$$

and

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

where i_k = the nominal interest rate in country k, r_k = the real
rate of interest and $\hat{P}^E_k$ = 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

$\qquad = M./(P\ N);$

$y_t \equiv$ real measured income per capita

$\qquad = Y/(P^* N);$

$c_1 \equiv$ change in the rate of inflation

$\qquad = \hat{P}_t - \hat{P}_{t-1};$

$c_2 \equiv$ Klein's measure of return on money

$\qquad = \ln (H/M)_t;$

$i_t \equiv$ 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 speci-
fication (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

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

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

(continued)

TABLE 18 (continued)

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

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 de-
    flated 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

$$\ln\left(\frac{M}{P.N}\right)_t = \beta_0 + \beta_y \ln\left(\frac{Y}{P.N}\right)_t + \beta_{c2}\, C_{zt} + \beta_i \cdot i_t + u_t;\ u_t = \rho u_{t-1} + \varepsilon_t$$

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

(continued)

TABLE 19 (continued)

$$\ln\left(\frac{M}{P \cdot N}\right)_t = \beta_0 + \beta_y \ln\left(\frac{Y}{P \cdot N}\right)_t + \beta_{c2}\, C_{zt} + \beta_i \cdot i_t + u_t; \quad u_t = \rho u_{t-1} + \epsilon_t$$

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

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

$$\ln\left(\frac{M}{P.N}\right)_t = \beta_0 + \beta_y \ln\left(\frac{Y}{P.N}\right)_t + \beta_{c2}{}^1 C_{zt} + \beta_1 i_t + \beta_{-1} \ln\left(\frac{M}{P.N}\right)_{t-1} + u_t; \; u_t = \rho u_{t-1} + \epsilon_t$$

Country	β_y	$\beta_{is}{}^2$	$\beta_{-iL}{}^2$	β_{-1}	interest rate elasticity at mean β''_1	long-run interest elasticity of demand [4]	long-run income elasticity of demand [4]	$\bar{R}^2$	SER $(\hat{\rho})$
Argentina	0.712† (0.476)		-6.789 (6.024)	0.945* (0.132)	-0.238	-4.327	12.981	0.654	0.140 (-0.045)
Bolivia[1,5]	1.127*† (0.401)		-0.436 (3.161)	0.254 (0.198)	-0.020	-0.027	1.512	0.563	0.124 (-0.244)
Brazil	0.732*† (0.219)		-8.116* (4.230)	0.311* (0.155)	-0.349	-0.507	1.063	0.823	0.089 (-0.219)
Chile	1.641*† (0.404)	-12.204* (3.276)		0.657* (0.134)	-0.427	-1.245	4.789	0.643	0.163 (-0.157)
Colombia[1]	0.722*† (0.282)	0.934 (1.504)		0.361 (0.218)	0.033	0.052	1.129	0.905	0.063 (-0.115)
Costa Rica[1]	1.344*† (0.260)	-2.218* (1.263)		0.108 (0.180)	-0.087	-0.098	1.508	0.958	0.053 (-0.106)
Ecuador	0.695*† (0.290)	2.130 (1.215)		0.588* (0.149)	0.084	0.204	1.685	0.972	0.062 (0.121)
El Salvador	0.582*† (0.209)	-1.076 (1.593)		0.553* (0.176)	-0.038	-0.085	1.302	0.818	0.082 (-0.144)

(continued)

TABLE 20 (continued)

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 $(\hat{\rho})$
Guatemala	0.827*† (0.267)		-0.562 (2.593)	0.291* (0.166)	-0.024	-0.028	1.167	0.758	0.055 (-0.445)
Honduras[5]	0.842*† (0.389)	-1.075 (1.789)		0.831* (0.133)	-0.038	-0.227	4.992	0.858	0.087 (0.105)
Mexico[2]	0.407*† (0.178)	-0.048 (0.098)		0.576* (0.175)	-0.004	-0.011	0.960	0.941	0.056 (-0.041)
Nicaragua	0.761*† (0.245)		-1.192 (2.724)	0.378* (0.169)	-0.051	-0.082	1.223	0.913	0.085 (-0.328)
Paraguay	1.636*† (0.486)		-11.829* (4.147)	0.706* (0.118)	-0.509	-1.728	5.561	0.663	0.117 (0.005)
Peru[2,5]	0.496* (0.143)		-0.068 (0.145)	0.752* (0.098)	-0.009	-0.036	2.002	0.934	0.088 (-0.120)
Uruguay	0.758† (1.138)		-9.711* (4.059)	.092 (0.318)	-0.479	-0.528	0.835	0.412	0.150 (0.030)
Venezuela	0.702*† (0.254)	-1.117 (2.198)		0.497* (0.201)	-0.039	-0.078	1.397	0.819	0.099 (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_1
    by the appropriate mean interest rate.

4. The long-run elasticities were calculated by dividing coeffi-
    cients β_1'' 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 α = 0.05, one-tailed test.

† = not significantly different from unity at α = 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 note-worthy to point out that, except for Costa Rica, those countries which have negative and 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]

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

where $m_t \equiv$ real cash balances per capita, a superscript "d"

indicates a desired level, and λ is the speed of adjustment. Then,

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

If the previously specified demand function represents the desired

level of real cash balances demanded then the estimated demand function

function should be:

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

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 depen-

dent 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 <u>slow</u> 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 $h_t \equiv H/(P'N)$ 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 signifi-
cant 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

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

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

(continued)

TABLE 21 (continued)

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

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_1 by the appropriate mean interest rate.

3. The long-run elasticities were calculated by dividing coefficients, β_1 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 might 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 all 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 theoreti-
cal 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 quan-
tity 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 trans-
mission 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 com-
pletely 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 conver-
gence proposition implies that, in an analysis of average rates of
inflation, observed variation across countries should not be signifi-
cantly 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 parti-
cular 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]:

$$P_d = e_d' \, P_w (1 - \tau) \qquad\qquad (14)$$

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

$$E(P_d) = e_d'(1 - \tau) \, E(P_w) \qquad\qquad (15)$$

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.,

$$VAR(P_d) = (e_d')^2 \, (1 - \tau)^2 \, VAR(P_w) \qquad\qquad (16)$$

with $e_d' = 1$ and $\tau = 0$, $VAR(P_d) = VAR(P_w)$. 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):

$$\hat{P}_d = \hat{e}_d' + \hat{P}_w - \hat{\tau} \tag{14'}$$

where a circumflex, $\hat{\ }$, represents a percentage change.

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

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

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

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

$$P_d = e_d' P_w \tag{17}$$

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

$$E(P_d) = e_d' \, E(P_w) \tag{18}$$

and

$$VAR(P_d) = (e_d')^2 \, VAR(P_w) \tag{19}$$

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):

$$\hat{P}_d = \hat{e}_d' + \hat{P}_w \tag{17'}$$

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

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

and

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

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

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

$$H_0: \quad \bar{\hat{P}}_i = \bar{\hat{P}}_j = \bar{\hat{P}} \text{ , that average unadjusted rates of}$$

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: $\overline{\hat{P}'_i} = \overline{\hat{P}'_j} = \overline{\hat{P}'}$, 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 and 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: $\bar{P}_i = \bar{P}_j = \bar{P}$, 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

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

$F(16,285) = 10.11$, 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 dis-

persion 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 α = 0.10.
* statistically significant at α = 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 dis-
persion. 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

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

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, $\tilde{\ }$, 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 deter-

mination. 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 fortuitously 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, con-

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

(continued)

TABLE 27.A (cont'd)

136

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

$\hat{P}_{dt}$ ≡ 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.

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	$-3.338^\dagger$		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	$0.208^\dagger$		0.567	0.192	2.36
	(0.099)	(0.054)	(3.207)				
	0.099	0.250*		$0.130^\dagger$	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	$-0.374^\dagger$		-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	$-0.255^\dagger$		-0.146	0.071	2.24
	(0.036)	(0.079)	(1.175)				
	0.117'	-0.006		$-0.524^\dagger$	0.084	0.070	2.22
	(0.034)	(0.080)		(0.943)			
Costa Rica	0.006	0.076	$0.543^\dagger$		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	$0.850^\dagger$		0.010	0.028	0.74
	(0.014)	(0.084)	(0.489)				
	0.013	0.031		$0.556^\dagger$	0.036	0.023	0.89
	(0.014)	(0.085)		(0.394)			
El Salvador[2]	-0.0008		$0.239^\dagger$		-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)   138

Country	Constant	$\overset{*}{e}{}'_d$	$\hat{P}_{us}$	$\hat{P}_w$	$\overline{R}^2$	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; $\overset{*}{e}{}'_d$ ≡ 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 signifi-

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

(continued)

TABLE 27.C (cont'd)

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

$\hat{P}'_{dt}$ ≡ 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 (0.104)	-2.685[†] (3.480)		-0.111	0.212	2.75
	0.211' (0.091)		-4.600[†] (2.616)	0.006	0.196	2.59
Bolivia	-0.310 (0.358)	8.509[†] (11.955)		-0.113	0.729	1.55
	-0.217 (0.355)		4.073[†] (9.732)	-0.140	0.737	1.59
Brazil	0.024 (0.105)	0.261[†] (3.507)		-0.153	0.214	2.47
	0.116 (0.099)		-3.015[†] (2.983)	-0.075	0.206	2.22
Chile	0.087 (0.120)	-1.971[†] (4.008)		-0.134	0.244	2.45
	0.172 (0.110)		-4.430[†] (3.070)	-0.004	0.230	2.18
Colombia	0.022 (0.124)	-2.128[†] (4.128)		-0.133	0.253	2.47
	0.073 (0.115)		-3.414[†] (3.192)	-0.066	0.246	2.41
Costa Rica	-0.021 (0.019)	1.222*[†] (0.649)		0.079	0.040	2.24
	-0.022 (0.019)		1.040*[†] (0.514)	0.108	0.039	2.28
Ecuador	0.028 (0.045)	-1.122[†] (1.505)		-0.110	0.092	2.53
	0.018 (0.044)		-0.621[†] (1.220)	-0.133	0.093	2.53
Nicaragua	-0.012 (0.015)	0.609[†] (0.516)		-0.049	0.031	0.83
	-0.014 (0.015)		0.568[†] (0.407)	-0.012	0.031	0.76

(continued)

TABLE 27.D (cont'd)

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

$\hat{P}'_{dt}$ ≡ domestic rate of inflation adjusted for exchange rate changes; 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 hypo-
thesis 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 speci-
fications 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:

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

and

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

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

(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

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

$\hat{P}_d \equiv$ domestic rate of inflation; $\hat{P}_{us} \equiv$ the U.S. rate of inflation; $\hat{P}_w \equiv$ the rest-of-the-world rate of inflation; $\hat{e}'_d \equiv$ the rate of exchange rate adjustment; $\hat{y}_d \equiv$ the domestic rate of real per capita income growth; $\hat{y}_w \equiv$ 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 and 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' (0.091)		-3.062* (0.728)	0.814 (1.462)		0.490	0.299	1.85
Bolivia	-0.214 (0.227)	1.647† (5.713)		9.111* (4.251)		0.186	0.596	2.28
Brazil	-0.012 (0.073)	2.755† (2.266)			-1.996 (1.428)	0.003	0.184	2.56
Chile	0.134 (0.123)		-3.273 (1.979)	0.693 (1.538)		0.101	0.325	2.55
Colombia	-0.116 (0.088)	-0.650† (1.943)		6.228* (2.966)		0.119	0.211	2.72
Costa Rica	-0.015 (0.014)		0.382* (0.016)	0.783* (0.333)		0.464	0.042	2.39
Ecuador	-0.030 (0.023)		0.373 (0.228)	1.320* (0.489)		0.426	0.076	2.37

(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 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 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)	5.035[†] (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

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

161

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 relation-
ships 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 <u>and</u> the monetary authorities behave as if the rate of inflation is out of their control or, more strictly, that they do not <u>try</u> 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:

$$a_1^* \, y + a_2^* \, x = u \qquad\qquad (i)$$

$$b_1^* \, y + b_2^* \, x = v \qquad\qquad (ii)$$

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 n 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 $\dot{P}$. 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.

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

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

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

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

$$g_1^* \hat{P} + g_2^* \hat{P}^E = u_5 \qquad (30)$$

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

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   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

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

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 restric-
tive 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, cf 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 signifi-

cance. 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 $(\theta_t \hat{F}_t)$

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

Annual data   t = 1953,...,1976

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

$Y_t = \theta_t \cdot \hat{F}_t$ = 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	1.77	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	0.88	1.88
Mexico	2.69÷	3.25†
Nicaragua	0.93	1.56
Paraguay	6.35**	1.85
Peru 1	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 ($\hat{P}_t$)

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

Annual data t = 1953,...,1976.

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

$Y_t = \hat{P}_t$ = 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	0.40	0.29
Chile[1]	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	0.95	1.60
Mexico[1]	1.27	1.48
Nicaragua	1.58	2.81†
Paraguay	0.68	0.52
Peru[1]	0.56	1.27
Uruguay[1]	0.53	0.42
Venezuela	0.91	0.28

† Reject null hypothesis at α = 0.10.

* " " " " α = 0.05.

** " " " " α = 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

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

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	1.14	1.01
Mexico[1]	2.07	1.60
Nicaragua	0.70	1.62
Paraguay	0.33	0.12
Peru[1]	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

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

Annual data   t = 1953,...,1976.

H_0 : $\gamma_j = 0$, j = 1,..., 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	1.32	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 α = 0.10.

* "   "   "   " α = 0.05.

** "   "   "   " α = 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 signifi-
cantly 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 hypo-

thesis 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

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

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

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

Country	$Y_t = \hat{P}'_t{}^{1}$ $X_t = \hat{P}_{ust}{}^{2}$ F(3,16)	F(2,18)	$Y_t = \hat{P}'_t{}^{1}$ $X_t = \hat{DH}_{ust}{}^{3}$ 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 coun-
tries 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 influ-

ences 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 Chap-

ter 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 expec-

tations, 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 infla-

tion. 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 $\hat{H}$.

TEST OF CAUSALITY BETWEEN INFLATION AND MONETARY GROWTH

$$Y_t = \delta_0 + \delta_1 \cdot t + \sum_{i=1}^{m} \beta_1 Y_{t-1} + \sum_{j=1}^{m} \gamma_j \cdot X_{t-j}$$

$$H_0: \quad \gamma_j = 0 \quad j = 1, \ldots, m: \quad\quad X \text{ does not cause } Y$$

Annual Data   t = 1953, ..., 1976

Country	$Y_t = \hat{M1}_t^1$ $X_t = \hat{P}_t^2$		$Y_t = \hat{P}_t^2$ $X_t = \hat{M1}_t^1$	
	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 α = 0.10;
* Reject null hypothesis at α = 0.05;
** Reject null hypothesis at α = 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

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

$H_0: \gamma_j = 0 \quad j = 1, \ldots, m:$ X does not cause Y

Annual Data   t = 1953, ..., 1976

Country	$Y_t = \hat{H}_t^2$ $X_t = \hat{P}_t^2$		$Y_t = \hat{P}_t^2$ $X_t = \hat{H}_t^1$	
	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.

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

Annual Data t = 1953, ..., 1976

Country	$Y_t = \hat{DH}_t{}^1$ $X_t = \hat{P}_t{}^2$		$Y_t = \hat{P}_t{}^2$ $X_t = \hat{DH}_t{}^1$	
	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^*

$$\hat{M}^d = k_2^* \quad \hat{M}^s = u_6.$$ 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

203

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., trade-ables.

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 arbi-

trage.

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 group-
ing. 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 Venezu-
ela. 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:

$$\hat{F} \longrightarrow \hat{P} \longrightarrow \hat{M}$$
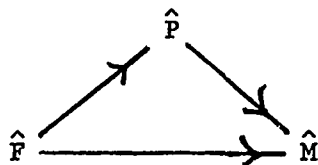
Thus, bi-directional causality might also show up between $\hat{M}$ and $\hat{P}$

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 mone-

tary 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 dis-
sertation 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 own 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 statis-

tical 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) dis-

persion 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 considera-

tion 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 <u>IFS</u>.
Uruguay	Data on nominal and real GDP for 1947–1954 were not available.
Venezuela	Data for 1947–1951 were estimated from <u>ESLA</u>, 1953. Data were available in 1950 U.S. dollars and converted using exchange rates given there.
U.S.	All data taken from <u>IFS</u>.

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, <u>IFS</u>.

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 inter-
national 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 fig-ures 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

$$P_{t,AR} = P_{t,1} \cdot a_{1,AR} + P_{t,2} \cdot a_{2,AR} + \cdots + P_{t,R} \cdot a_{R,AR}$$

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 sub-group 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 loadin3s 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 <u>rates of change</u> 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

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

$$w_{t,j} = \frac{Y'_{t,j}}{\sum\limits_{k=1}^{17} Y'_{t,k}}$$

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.

BIBLIOGRAPHY

Adelkunle, Joseph O. "The Demand for Money: Evidence from Developed and Less Developed Countries." International Monetary Fund Staff Papers, 15 (May 1968), 221-65.

Barro, Robert J. "Unanticipated Money, Output, and the Price Level in the U.S." Journal of Political Economy, 86 (August 1968), 549-80.

------. "Unanticipated Money Growth and Unemployment in the U.S." American Economic Review, 67 (March 1977), 101-15.

Bean, Donna. "International Reserve Flows and Money Market Equilibrium, the Japanese Case." In Frenkel and Johnson (eds.), The Monetary Approach to the Balance of Payments. Toronto: University of Toronto Press, 1976.

Blejer, Mario I. "The Short-Run Dynamics of Prices and the Balance of Payments." American Economic Review, 67 (June 1977), 419-28.

Box, George E.P. and Gwilym Jenkins. Time Series Analysis: Forecasting and Control. Revised Edition. San Francisco: Holden-Day, 1976.

Box, George E.P. and David A. Pierce. "Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series Models." Journal of the Americal Statistical Association, 65 (December 1970), 1509-26.

Burger, Albert. The Money Supply Process. Belmont, Calif.: Wadsworth, 1971.

Cagan, Phillip. "The Monetary Dynamics of Hyperinflation." In Milton Friedman (ed.), Studies in the Quantity Theory of Money. Chicago: University of Chicago Press, 1956. Pp. 25-117.

------. Determinants and Effects of Changes in the Money Stock, 1867-1960. New York: Columbia University Press, 1965.

Chetty, V. Karuppen. "On Measuring the Nearness of Near-Moneys." American Economic Review, 59 (June 1969), 270-282.

Ciccolo, John H. "Money, Equity Values, and Income." Journal of Money, Credit and Banking, 10 (February, 1978), 48-64.

Clark, Carolyn. "The Demand for Money and the Choice of a Permanent Income Estimate: Some Canadian Evidence, 1926-1956." Jouranl of Money, Credit and Banking, 5 (August 1973), 773-93.

Darby, Michael R. "The Monetary Approach to the Balance of Payments: Two Specious Assumptions." Economic Inquiry (forthcoming).

Deaver, John V. "The Chilean Inflation and the Demand for Money." In David Meiselman (ed.), Varieties of Monetary Experience. Chicago: University of Chicago Press, 1970. Pp. 9-67.

Diz, Adolfo Cesar. "Money and Prices in Argentina, 1935-1962." In Meiselman (ed.), Varieties of Monetary Experience. Chicago: University of Chicago Press, 1970. Pp. 71-162.

Dhrymes, Phoebus J. Distributed Lags: Problems of Estimation and Formulation. San Francisco: Holden-Day, 1971.

Dornbusch, Rudiger. "Devaluation, Money, and Nontraded Goods." American Economic Review, 63 (December 1973), 871-80.

Durbin, James. "Testing for Serial Correlation in Least Squares Regression When Some of the Regressors are Lagged Dependent Variables." Econometrica, 38 (May 1970), 410-21.

Frenkel, Jacob. "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence." Scandinavian Journal of Economics, 78 (May 1976), 200-24.

———— and Harry G. Johnson (eds.). The Monetary Approach to the Balance of Payments. Toronto: University of Toronto Press, 1976.

Friedman, Milton. "The Quantity Theory of Money—A Restatement." In M. Friedman (ed.), Studies in the Quantity Theory of Money. Chicago: University of Chicago Press, 1956(a).

———— (ed.). Studies in the Quantity Theory of Money. Chicago: University of Chicago Press, 1956(b)

————. "The Demand for Money: Some Theoretical and Empirical Results." Journal of Political Economy, 67 (August 1959), 327-51.

————. Time Series Interpolation by Related Series. Technical Paper 16. National Bureau of Economic Research, 1962.

————. A Theoretical Framework for Monetary Analysis. Occasional Paper No. 101. National Bureau of Economic Research, 1971.

————— and Anna J. Schwartz. A Monetary History of the United States: 1867-1960. New York: Columbia University Press, 1970.

————— and Schwartz. Monetary Trends in the U.K. and the U.S. (forthcoming).

Gandolfi, Arthur E. "The Stability of the Demand for Money During the Great Contraction, 1929-1933." Journal of Political Economy, 82 (October 1974), 969-83.

————— and James R. Lothian. "The Demand for Money from the Great Depression to the Present." American Economic Review, 66 (May 1976), 46-51.

————— and Lothian. "A Comparison of Price Movements Among Countries and States." Unpublished manuscript, July 1977.

————— and Lothian. "Preliminary Estimates of the Demand for Money in Eight Industrialized Countries." Unpublished manuscript, 1978.

Genberg, Hans. World Inflation and the Small Open Economy. Stockholm, Sweden: Swedish International Publications, Economic Research Report No. 17, November 1975.

—————. "Aspects of the Monetary Approach to Balance-of-Payments Theory, An Empirical Study of Sweden." In Frenkel and Johnson (eds.), The Monetary Approach to the Balance of Payments. Toronto: University of Toronto Press, 1976.

————— and Alexander K. Swoboda. "Worldwide Inflation Under the Dollar Standard." Geneve: The Graduate Institute of International Studies, Discussion Paper No. 12, January 1977.

Girton, Lance and Don Roper. "A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience." American Economic Review, 67 (September 1977), 537-48.

Granger, Clive W.J. "Investigating Causal Relationsh by Econometric Models and Cross-Spectral Methods." Econometrica, 37 (July 1969), 424-28.

————— and Paul Newbold. "Spurious Regressions in Econometrics." Journal of Econometrics, 2 (January 1974), 111-20.

————— and Newbold. Forecasting Economic Time Series. New York: Academic Press, 1977.

Guitain, Manuel. "The Balance of Payments as a Monetary Phenomenon, Empirical Evidence, Spain 1955-71." In Frenkel and Johnson

(eds.), The Monetary Approach to the Balance of Payments. Toronto: University of Toronto Press, 1976.

Harberger, Arnold C. "The Dynamics of Inflation in Chile." In Carl F. Christ (ed.), Measurement in Economics. Stanford: Stanford University Press, 1963.

Haugh, Larry D. "Checking the Independence of Two Covariance-Stationary Time Series: A Univariate Residual Cross-Correlation Approach." Journal of the American Statistical Association, 71 (June 1976), 378-85.

Heller, H. Robert. "International Reserves and World-Wide Inflation." IMF Staff Papers, 23 (March 1976), 61-87.

------. "Determinants of Exchange Rate Practices." Journal of Money, Credit and Banking, X (August 1978), 308-21.

International Monetary Fund. Internation Financial Statistics. Washington, D.C.: various issues.

Johnson, Harry G. "Toward a General Theory of the Balance of Payments." In . _ . . . : ., International Trade and Growth London: Allen and Unwin, 1956.

Klein, Benjamin. "Competitive Interest Payments on Bank Deposits and the Long-Run Demand for Money." American Economic Review, 64 (December 1974), 931-49.

------. "The Demand for Quality-Adjusted Cash Balances: Price Uncertainty in the U.S. Demand for Money Function." Journal of Political Economy, 85 (August 1977), 691-714.

Koopmans, Tjalling C. "When is an Equation System Complete for Statistical Purposes." In T.C. Koopmans (ed.), Statistical Inference for Dynamic Models. New York: John Wiley and Sons, 1950.

Laidler, David. The Demand for Money: Theories and Evidence. International Textbook Co., 1969.

Lothian, James R. "The Demand for High-Powered Money." American Economic Review, 66 (March 1976), 56-68.

Lucas, Robert E., Jr. "Econometric Testing of the Natural Rate Hypothesis." In Otto Eckstein (ed.), Econometrics of Price Determination. Washington, D.C.: Board of Governors of the Federal Reserve System, June 1970. Pp. 50-59.

------. "Expectations and the Neutrality of Money." Journal of Economic Theory, 4 (April 1972), 103-24.

——. "Some International Evidence on Output-Inflation Tradeoffs." American Economic Review, 63 (June 1973), 326-34.

——. "Econometric Policy Evaluation: A Critique." In Karl Brunner and Allan Meltzer (eds.), The Phillips Curve and Labor Markets. Amsterdam: North-Holland, 1976. Pp. 19-46.

Luders, Rolf J. "A Monetary History of Chile, 1925-1958." Unpublished doctoral dissertation, University of Chicago, 1968.

Macesich, George. "Supply and Demand for Money in Canada." In David Meiselman (ed.), Varieties of Monetary Experience. Chicago: University of Chicago: University of Chicago Press, 1970. Pp. 251-96.

Magee, Stephen P. "The Empirical Evidence on the Monetary Approach to the Balance of Payments and Exchange Rates." American Economic Review, 66 (May 1976), 163-170.

Mehra, Y.P. "Money Wages, Prices and Causality." Journal of Political Economy, 85 (December 1977), 1227-44.

——. "Is Money Exogenous in Money Demand Equations?" Journal of Political Economy, 86 (April 1978), 211-29.

Meiselman, David (ed.). Varieties of Monetary Experinces. Chicago: University of Chicago Press, 1970.

Melitz, Jacques. "Inflationary Expectations and the French Demand for Money, 1959-1970." The Manchester School, 44 (March 1976), 17-41.

Mundell, Robert A. International Economics. New York: Macmillan, 1968.

——. Monetary Theory. Palisades, Calif.: Goodyear, 1971.

Pierce, David A. "Relationships—and the Lack Thereof—Between Economic Time Series, with Special Reference to Money and Interest Rates." Journal of American Statistical Association, 72 (March 1977), 11-22.

—— and Larry D. Haugh. "Causality in Temporal Systems: Characterizations and a Survey." Journal of Econometrics, 5 (May 1977), 265-94.

Salant, Walter S. "The International Transmission of Inflation." In Lawrence B. Crause and Walter S. Salant (eds.), Worldwide Inflation. Washington, D.C.: The Brookings Institution, 1977.

Sargent, Thomas J. "Interest Rates and Prices in the Long Run."
Journal of Money, Credit and Banking, 5 (February 1973), Part
II, 385-449.

————. "A Classical Macroeconometric Model for the United States."
Journal of Political Economy, 84 (April 1976a), 207-38.

————. "The Observational Equivalence of Natural and Unnatural
Rate Theories of Macroeconomics." Journal of Political
Economy, 84 (June 1976b), 631-40.

———— and Neil Wallace. "'Rational' Expectations, the Optimal
Monetary Instrument and the Optimal Money Supply Rule." Jour-
nal of Political Economy, 83 (April 1975), 241-54.

Schwert, G. William. "Tests of Causality: The Message in the
Innovations." Paper presented at the Carnegie-Rochester
Conference on Public Policy, April 1978.

Silveira, Antonio M. "The Demand for Money: The Evidence from the
Brazilian Economy." Journal of Money, Credit and Banking, 5
(February 1973), 113-40.

Simon, Henry A. "Causal Ordering and Identifiability." In W.C. Hood
and T.C. Koopmans (eds.), Studies in Econometric Methods.
Cowles Commission Monograph No. 14, 1953.

Sims, Christopher A. "Are There Exogenous Variables in Short Run
Production Relations?" Annals of Economic and Social Measure-
ment, 1 (January, 1972a), 17-36.

————. "Money, Income and Causality." American Economic Review, 62
(September 1972b), 540-52.

————. "Exogeneity Tests and Multivariate Time Series: Part I."
Minneapolis: University of Minnesota, Discussion Paper 75-54,
June 1975.

————. "Exogeneity and Causal Ordering in Macroeconomic Models." In
Christopher A. Sims (ed.), New Methods in Business Cycle
Research. Minneapolis: Federal Reserve Bank of Minneapolis,
1977. Pp. 23-44.

Stern, Robert. The Balance of Payments. Chicago: Aldine, 1972.

Stigler, George J. and James K. Kindahl. The Behavior of Industrial
Prices. New York: Columbia University Press, 1971.

Swoboda, Alexander K. "Gold, Dollars, Euro-dollars and the World
Money Stock." Geneva: The Graduate Institute of International
Studies, Discussion Paper No. 2, November 1974.

————. "Monetary Approaches to Worldwide Inflation." In Krause and Salant (eds.), Worldwide Inflation. Washington, D.C.: The Brookings Institution, 1977. Pp. 9-50.

Theil, Henri. Principles of Econometrics. New York: John Wiley and Sons, 1971.

United Nations. Economic Survey of Latin America. Various issues.

Vogel, Robert C. "The Dynamics of Inflation in Latin America, 1950-1969." American Economic Review, 64 (March 1974), 102-14.

Wallace, Neil. "Microeconomic Theories of Macroeconomic Phenomena and Their Implications for Monetary Policy." In P. Miller (ed.), A Prescription for Monetary Policy . Minneapolis: Federal Reserve Bank of Minneapolis, 1976. Pp. 87-98.

Whitman, Marina v. N. "Global Monetarism and the Monetary Approach to the Balance of Payments." Brookings Papers on Economic Activity, 3 (1975), 491-536.

Williams, C. Regression Analysis. New York: John Wiley and Sons, 1959.

Williams, David, C.A.E. Goodhart and D.H. Gowland. "Money, Income, and Causality: The U.K. Experience." American Economic Review, 66 (June 1976), 417-23.

Zecher, Richard. "Monetary Equilibrium and International Reserve Flows in Australia." In Frenkel and Johnson (eds.), The Monetary Approach to the Balance of Payments. Toronto: University of Toronto Press, 1976.

Zellner, Arnold. "Causality and Econometrics." Paper presented at the Carnegie-Rochester Conference on Public Policy, April 1978.