MONEY AND ECONOMIC ACTIVITY IN DEVELOPING COUNTRIES: EVIDENCE BASED ON COINTEGRATION AND CAUSALITY TESTS

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Abstract

This paper examines whether or not the fluctuations in monetary and credit aggregates contain useful information about subsequent future movements in nominal or real income in 10 developing countries. Using annual data covering the 1960–1990 period, empirical results showed that narrow (M1) and broad (M2) monetary aggregates as well as domestic credit (DCR) contain statistically significant information about future movements in *nominal income* in some of the developing countries examined, while either M1 or M2 or DCR does in some other countries. However, when nominal income is decomposed into its real income and price components, the results suggest that these aggregates contained no statistically significant information about future movements in real income in nearly all the developing countries in the sample.

I. Introduction

The role of money supply in the inflationary process in developing countries has been a subject of considerable debate among economists {see Vogel (1974), Nugent and Glezakos (1979), Saini (1982), Darrat (1986), Ghatak and Deadman (1989), and Montiel (1989)}. While some researchers have provided empirical evidence that supported or refuted the monetarist explanation of inflation, others have also provided evidence that either supported or refuted the structuralist argument.[1] In contrast to the monetarist and structuralist debate, other economists {e.g. Otani (1975), Sheehey (1979), London (1989)} have argued and provided evidence to support the imported inflation hypothesis. Furthermore, others have also argued that the underdeveloped money and financial markets in these countries have forced the governments to resort to deficits financing from the banking system to meet their development targets, thus creating inflationary pressures. Along this line of argument, the studies by Aghevli and Kahn (1978), and Tanzi (1977, 1978, 1982) have indicated that the process of deficit financing in developing countries gives rise to rapid monetary growth which, in turn, leads to higher inflation. On the other hand, one of the objectives of monetary authorities in these countries is to achieve economic growth and development through the use of monetary policy. They have done so through the provision of easy credit to domestic investors. Obviously, these diverse views of inflation suggest that there is no general consensus about the causes of inflation in developing countries.

While the debate continues, a cursory examination of the annual data shows that despite the inflationary pressures that the developing countries experienced over the past two or three decades, monetary expansions continue as well. Arguably, the monetary authorities in these countries are probably convinced that monetary expansions have some significant impact on nominal or real income. If one assumes that the monetary authorities in less developed countries (LDSs) are autonomous as in many developed countries, one may find it difficult to provide any explanation as to why they have not exercised tighter control over the growth of the money stock, which several studies consider to be the cause of inflation in their countries or why they have not followed the monetarist prescriptions which typically stressed the importance of a constant money growth and the absence of activist attempts to vary these rates countercyclically. Furthermore, the persistent monetary growth could be indicative of several

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factors. First, the fluctuations in the monetary aggregates in LDCs could be that they contain potentially useful information about future nominal or real income movements. Second, the rapid monetary growth could also signify the lack of central bank autonomy. Third, it could also be that monetary growth provides revenue from seigniorage. The latter issue will be discussed in the next section of this paper when we highlight some of the general characteristics of the monetary authorities in LDCs.

Rather than continue with the debate regarding the validity of the monetarist explanation or the structuralist view of inflation in developing countries, which may likely not be productive from the standpoint that there have been several studies on the subject, this paper innovates by investigating whether or not the fluctuations in monetary and credit aggregates are useful for predicting fluctuations in nominal or real income in 10 developing countries: Côte d'Ivoire, Ecuador, Ghana, India, Indonesia, Morocco, Nigeria, Philippines, Peru, and Venezuela.[2] The issues of the usefulness of any of the monetary and credit aggregates in the conduct of monetary policy and the structural relationships between these aggregates and economic activity have either been neglected and/or have not been adequately addressed in the literature with respect to the developing countries. By analyzing the ability of the monetary and credit aggregates to forecast fluctuations in nominal or real income during the 1960–1990 period, some important insights can be gained as to which of the aggregates could be useful in conducting monetary policy in developing countries.

As the studies of the inflationary process in less developed countries indicate, there was never any lack of debate about the empirical relationship between money and prices (a relationship which is also confirmed later in this study) or the fact that interest rates do not reflect the opportunity costs of holding money or investment. As far as these countries are concerned, a comprehensive analysis of the influence of the monetary and credit aggregates in the movements of nominal or real income is very important for several reasons. First, the movements of nominal or real gross domestic product provide consistent gauges of total economic activity in terms of the estimates of economic growth. Second, measures of gross domestic product fluctuations are important indicators of the success or failure of current macroeconomic policies, therefore, the knowledge about the predictive power of monetary policy instruments with respect to movements in nominal or real income could help policymakers in their policy decisions. Third, in less developed countries where interest rates are often controlled by government policies, measures of gross domestic product are arguably the best indicators of economic activity in comparison to different types of interest rates. In effect, if we use interest rates as measures of economic activity in less developed countries the way they are used in industrialized countries, we could get misleading results because of the structural bottlenecks. Fourth, this study will also shed some light as to which monetary aggregate can serve the useful role as either an information variable, an intermediate target, or when possible, an instrument of monetary policy in less developed countries. In essence, it will be helpful if the monetary authorities in these countries know whether or not a relationship exists between these monetary aggregates and economic activity or whether the monetary and credit aggregates could be used as information variables, or perhaps as intermediate targets, or as instruments in the conduct of monetary policy.

The rest of this paper is organized as follows. Section II provides the discussion of the general characteristics of the monetary authorities in the developing countries. Section III discusses the empirical methodology. Section IV presents the data and empirical results while Section V is devoted to the conclusions and policy implications of the study.

II. Characteristics of Central Banks in LDCs

This section provides a discussion of the general characteristics of monetary authorities in LDCs. It is worthwhile to point out that the 10 countries considered here have differing political outlooks, cultural traditions, and economic capacities. Despite these differences, a look at the general characteristics of the central banks may provide useful insights as to why the monetary authorities continued to engage in rapid monetary growth despite the inflationary

consequences.[3] To begin, we need to consider the basic functions and goals of central banks in LDCs. It is important to note that central banks in the developed and developing countries share certain basic functions and goals in common. By the same token, we must hasten to add that the ways central banks choose to carry out their functions and the importance they attach to specific monetary policy instruments or tools to achieve their goals differ cross countries. Similarly, we must add that the degree of independence that central banks have within their governments varies widely across countries.

Central bank autonomy is a reflection of economic and political independence. In this paper, central bank independence is defined as in Alesina and Summers (1993), as the ability of the central bank to select its policy objectives without influence from the government. Central bank independence is one of the several distinguishing features in central banking in the developed and developing countries. Several studies have indicated that these differences reflect each country's history, traditions, legal system, and financial market structures.[4] This is an important issue which can dictate how central banks behave in the pursuit of their objectives. Generally, the governments in LDCs interfere in the affairs of central banks thus inhibiting the banks' ability to function effectively in their formulation and implementation of monetary policy. In many LDCs, the most common constraint central banks face is the constant pressure from the government to finance its deficits. As Alesina and Summers (1993) have argued, an independent central bank that is free from political pressure may not only behave more predictably, promoting economic stability, and reducing risk premia in real interest rates, but more importantly, it may serve to insulate the economy from internal and external disturbances.

Before the empirical estimation, there are two important issues that should be analyzed to bring into focus the main thesis of this paper. The first issue which we alluded to earlier relates to the basic functions and goals that central banks in developed and developing countries have in common. First and foremost, the primary duty of a central bank in any country, presumably, is to formulate and implement monetary policy with the aim of stimulating high employment and real output growth while maintaining stability in the product, financial, and foreign exchange markets. Generally, central banks implement monetary policy by affecting the growth of money and credit in the economy in response to changing economic conditions (inflationary and deflationary pressures). The implementation of monetary policy is accomplished through the use of instruments or tools which include the: (a) setting of reserve requirements for banks, (b) setting of discount rate and making loans to banks, and (c) open market operations. The emphasis placed on these instruments differs across the developed and less developed countries. For example, one should expect open market operations to be more successful in advanced countries where the money and capital markets are well developed than in LDCs where the relevant markets are still underdeveloped (see Masha, 1983).

A second major function of central banks is the supervision and regulation of banking and financial systems to ensure a structurally sound economy. Arguably, a sound monetary system is essential for an effective monetary policy. In their supervisory and regulatory roles, central banks gain knowledge on how to respond to and prevent financial disruptions before they cause serious economic crises. In this regard, we should add that just as the central banks in the LDCs have managed to avert serious monetary and financial crises that may devastate their economies, they have also managed to contribute to mounting inflationary pressures through rapid monetary growth. A third major responsibility of the central banks is that they serve as clearing houses and as lenders of last resort. In other words, they facilitate the efficient clearing and settlement of interbank transactions, and they stand ready to use the available policy instruments to prevent national liquidity crises and financial panics.

An important issue that has been addressed in the literature is the rapid monetary growth which is common in nearly all the LDCs. To a large extent, the rapid monetary growth in LDCs is closely related to the degree of central bank autonomy. As studies by Humpage (1994) and Alesina and Summers (1993) pointed out, central bank independence depends rather imprecisely on a host of legal, institutional, and customary ar-

rangements. Given these criteria and a close examination of the conditions (e.g., economic and political instability) that prevail in the countries under study, it is safe to conclude that the central banks in the LDCs are less independent in comparisons to those in the industrialized countries. In more recent studies, attempts have been made to measure the relative independence of the world's central banks by quantifying different aspects of their institutional and political structures, and to correlate the resulting numerical ranking with several measures of macroeconomic performance.[5] In general, these studies seem to confirm that higher levels of central bank independence across countries are correlated with lower, more stable rates of inflation. In effect, we can argue that the higher and very volatile rates of money growth and inflation that are usually observed in LDCs may be indicative of less (lack of) central banks autonomy.

Table 1 shows the average annual rates of growth of money supply, real output, and inflation for the 1960–1990 period. Table 1 points not only to a wide range of monetary, real output, and inflationary experiences, but more importantly, these rates are substantially higher in LDCs in comparisons to the industrialized countries. A frequent argument usually put forward for the persistently high monetary growth in LDCs is that monetary policy is subservient to fiscal and other government policies. This is particularly true with respect to deficit financing. This is an argument which is predicated on the fact the governments in LDCs are not fiscally prudent even though they have ill-structured and inefficient tax systems. The narrow tax base and the underdeveloped financial markets place disproportionate burden of deficit financing on the central bank system. This practice has prevented the central banks in LDCs from holding inflation in check. As McDonough (1994) argued, an integral part to achieving price stability is the need for central banks to avoid direct financing of government budget deficits. Unfortunately, this is beyond the control of central banks in LDCs. Recently, some studies found strong correlation between central banks in LDCs. Recently, some studies found strong correlation between central banks's independence and the rate of inflation.[6]

TABLE 1
Average Annual Growth Rates of Money, Real Income, and Prices, 1960–1990

	(in percentages)		
Countries	M	y	p
Côte d'Ivoire	11.9	3.3	6.5
Ecuador	21.9	5.6	17.2
Ghana	28.7	2.3	31.8
India	13.0	4.2	7.7
Indonesia	111.3	5.7	44.5
Morocco	12.5	4.4	5.9
Nigeria	20.3	4.8	12.9
Peru	245.1	3.1	157.9
Philippines	13.8	4.3	11.3
Venezuela	14.2	3.9	10.7
Industrial Countries	7.9	3.6	5.4

Source: Computed from the annual data obtained from various issues of *International Financial Statistics*.

Another major reason for the high growth rates of money supply in LDCs is the revenue from *seigniorage* that the governments obtain through the right to create money. Given the very narrow tax base in these countries, the monetization of deficits is an alternative to explicit taxation. When governments finance their deficits through the creation of money, the public adds to its holding of nominal balances to maintain the real value of money balances constant. In this way, the governments finance their expenditures through the inflation tax. Recently, in a study of 79 countries that covered the 1971–1982 period, Cukierman *et. al.* (1993) argued that a positive relationship exists between political instability and seigniorage as well as inflation and seigniorage. The implication of their study is that countries with a more unstable and polarized political system tend to have more inefficient tax structures and, thus, will tend to rely more heavily on seigniorage.[7] Dornbusch and Fischer (1994) have also shown that the amounts of revenue generated by the governments through seigniorage are significantly higher for the developing countries than the industrialized countries.

Table 2 shows the average inflation rate and seigniorage for the 1971–1982 and 1960–1990 periods. Both periods show that the degree to which these countries use money creation to finance their expenditures differs widely, with some countries relying on seigniorage to cover almost 34 percent of their revenues.[8] The results for the 1960–1990 period are in line with the findings of Cukierman *et al.* (1993) and

TABLE 2
Inflation and Seigniorage

Countries	Average 1971–1982[a]		Average 1960–1990[b]	
	Inflation	Seigniorage	Inflaton	Seigniorage
Côte d'Ivoire	11.5	1.1	6.5	0.7
Ecuador	13.2	14.4	17.2	16.5
Ghana	47.8	28.0	31.8	20.9
India	8.4	13.1	7.7	7.4
Indonesia	16.7	9.0	44.5	27.9
Morocco	9.0	7.3	5.9	4.1
Nigeria	15.5	7.2	12.9	8.6
Peru	38.2	20.7	157.9	33.6
Philippines	14.3	6.7	11.3	8.4
Venezuela	9.2	5.7	10.7	8.7

Source:

[a] Taken from Alex Cukierman, Sebastian Edwards, and Guido Tabilleni, "Seigniorage and Political Instability," *American Economic Review*, vol. 82, No. 3 (June 1992), pp. 538–539.

[b] Computed from the data obtained from various issues of *International Financial Statistics*.

Dornbusch and Fischer (1994). It is worthwhile to note that of these 10 countries, Côte d'Ivoire is the only country where the government is less dependent on revenues from seigniorage. The apparent reason for this is that Côte d'Ivoire is a member of the CFA franc zone countries whose currency is tied to the French franc. As Boughton (1991) indicated, the CFA countries have gained monetary discipline and credibility through rules, especially, the rule that limits the extension of credit to each government in the franc zone to a maximum of 20 percent of the previous year's fiscal revenue.[9]

Given our discussion of the general characteristics of the central banks and the reasons for the high growth rate of money supply, the central thesis of this paper is the examination of the relationship between monetary aggregates and economic activity in LDCs. Obviously, the relationship between monetary and credit aggregates and economic activity is an empirical question, therefore, we now turn to the empirical analysis.

III. Empirical Methodology

To analyze the relationship between the monetary aggregates and economic activity in less developed countries, we follow the methodology and model used in recent studies by Friedman and Kuttner (1992, 1993a), Becketti and Morris (1992), Friedman (1993), and Dotsey and Otrok (1994), with some modifications. In this section, we specify equations in which the primary focus is on the ability or inability of the monetary and credit aggregates to predict future movements in either nominal or real income in each of the countries in our sample. Before we perform the causality tests, there are two important econometric issues that should be addressed. These issues relate to the tests for stationarity and long-run relationships between the variables—cointegration. Engle and Granger (1987), among others, have shown that proper estimation of nonstationary time series must account for any cointegrating relationships.

Several studies have also shown that differencing nonstationary time series before estimation does not adequately account for the long-run relationships. To eliminate the possibility of spurious regressions and erroneous inferences, the first stage of the testing procedure involves the determination of the order of integration of the variables. A frequently used test for determining whether a time series is nonstationary is the Augmented Dickey-Fuller (ADF) test which requires running the following regression:

$$\Delta X_t = \alpha_0 + \alpha_1 X_{t-1} + \sum_{t-i}^{k} \beta_i \Delta X_{t-i} + \mu_t \quad (1)$$

where X_t is a vector of all the variables of the model, μ_t is the error term, and k is the number

of lagged first difference terms such that μ_t is white noise. The null hypothesis is that X_t has a unit root (that is, nonstationary).

Table 3 presents the results of the unit root tests for the variables in logarithm levels and logarithm first differences. The results indicate that the levels of the variables contain unit roots and are, therefore, nonstationary. However, stationarity is achieved for all the variables after first differencing of the levels for the 10 countries in the sample. Based on these results, we conclude that the variables are nonstationary in levels but stationary in first differences, that is, they are integrated of order one—I(1). The next step is to test whether or not the I(1) variables are cointegrated. To test for cointegration between variables (for example, say M_t and Y_t) which the results in Table 3 show to be individually I(1) processes, the following cointegrating equation is estimated:

$$Y_t = \gamma + \Gamma M_t + \epsilon_t \qquad (2)$$

where Y_t represents nominal GDP (Y), as well as its two components—real GDP (y) and the price deflector (p); M_t represents narrow money (M1), broad money (M2), and domestic credit (DCR) as reported in Table 3; and Γ is the cointegrating factor. The rationale for equation (2) is to determine whether or not these variables share a common trend. If Y_t and M_t (which are differenced stationary in Table 3) are cointegrated then the estimated residual (ϵ_t) from the cointegrating equation will be stationary, that is, $\epsilon_t \sim I(0)$. Since the objective of this paper is to examine whether or not the fluctuations in monetary and credit aggregates can predict significantly the movements in either nominal or real income, we estimated several bivariate cointegrating equations.

The results of the cointegrating regressions

TABLE 3
Results of Stationarity Tests

	Variables in log levels and log first differences					
Countries	M1	M2	DCR	Y	P	y
Côte d'Ivoire	−1.63	−1.83	−1.83	−1.06	−0.76	−1.96
	−2.89*	−3.45*	−2.98*	−3.03*	−2.99*	−3.80**
Ecuador	2.92	3.68	2.23	2.61	3.27	−1.33
	−2.82†	−2.84†	−2.98*	−2.68†	−2.79†	−2.82†
Ghana	1.40	1.62	0.61	0.58	0.86	0.58
	−2.08*	−2.92*	−2.62†	−3.09*	−3.99**	−3.08*
India	1.19	0.80	1.47	0.88	−0.17	0.46
	−4.64**	−2.82*	−2.86†	−4.83**	−4.76**	−6.59**
Indonesia	−1.42	1.17	−1.55	−1.45	−1.52	−1.83
	−4.65**	−5.25**	−3.41*	−6.73**	−9.02**	−3.74**
Morocco	1.03	1.18	−1.32	0.52	0.53	−0.96
	−2.99*	−2.86†	−6.05**	−3.82*	−2.63†	−3.92**
Nigeria	0.07	0.08	−0.71	0.40	1.76	−0.56
	−3.31*	−3.22*	−4.35**	−3.04*	−3.74**	−4.02**
Peru	8.45	3.02	2.44	6.17	3.05	2.77
	−3.63*	−3.15*	−2.91†	−3.93**	−4.85**	−5.29**
Philippines	1.81	1.21	−0.79	0.19	0.53	−0.58
	−3.52*	−3.81**	−2.62†	−3.94**	−4.02**	−2.65†
Venezuela	−0.35	−1.59	−0.12	0.75	−2.29	0.94
	−2.68†	−5.54**	−4.03**	−3.72*	−3.40*	−2.68†

Note: M1 = Narrow money, M2 = Broad money, DCR = Domestic credit, Y = Nominal gross domestic product, P = Aggregate price deflator, y = Real gross domestic product. First and second rows for each country show results for log levels and log first differences respectively.

* Significant at the 0.05 level.

** Significant at the 0.01 level.

† Significant at the 0.10 level.

are presented in Table 4. We could not reject the null hypothesis of no cointegration between the variables in majority of the countries in the sample. For those pairs of variables where the null hypothesis of no cointegration could not be rejected, the standard Granger-causality tests may be employed to examine the causal relationships between them. These tests are based on the following pairs of equations:

$$\Delta Y_t = \phi_1 + \sum_{t=1}^{n} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{m} \alpha_i \Delta M_{t-i} + \xi_1 \quad , \tag{3}$$

$$\Delta M_t = \phi_2 + \sum_{t=1}^{m} b_i \Delta M_{t-i} + \sum_{i=1}^{n} \pi_i \Delta Y_{t-i} + \xi_2 \quad , \tag{4}$$

$$\Delta y_t = \gamma_1 + \sum_{t=1}^{y} c_i \Delta Y_{t-i} + \sum_{i=1}^{m} \beta_i \Delta M_{t-i} + \mu_1 \quad , \tag{5}$$

$$\Delta M_t = \gamma_2 + \sum_{t=1}^{m} d_i \Delta M_{t-i} + \sum_{i=1}^{y} \theta_i \Delta y_{t-i} + \mu_2 \quad , \tag{6}$$

$$\Delta p_t = \lambda_1 + \sum_{t=1}^{p} \tau_i \Delta p_{t-i} + \sum_{i=1}^{m} \Psi_i \Delta M_{t-i} + \nu_1 \quad , \tag{7}$$

$$\Delta M_t = \lambda_2 + \sum_{t=1}^{m} \sigma_i \Delta M_{t-i} + \sum_{i=1}^{p} \delta_i \Delta p_{t-i} + \nu_1 \quad , \tag{8}$$

where Δ is the difference operator, Y and y are the logarithms of nominal and real gross domestic product respectively; M is the logarithm of monetary as well as the total credit aggregates; p is the logarithm of the price deflator; ξ_i, μ_i, and ν_i are the disturbance terms; and α_i, π_i, β_i, ψ_i, and δ_i are all the relevant coefficients to be estimated.

TABLE 4
Results of Cointegration Tests

	Bivariate Cointegrating Regressions								
Countries	Y, M1	Y, M2	Y, DCR	y, M1	=y, M2	y, DCR	P, M1	P, M2	P, DCR
Côte d'Ivoire	−1.85	−2.33	−1.02	−1.69	−1.70	−1.80	−3.03	−3.49	−1.62
Ecuador	−2.25	−3.51	−3.80*	−1.04	−1.07	−1.18	−2.14	−3.75*	−4.18*
Ghana	−2.89	−2.90	−5.76**	−2.05	−2.06	−2.04	−2.21	−2.16	−2.77
India	−2.05	−1.54	−1.08	−1.39	−1.42	−1.35	−1.84	−1.86	−1.49
Indonesia	−4.03*	−1.04	−1.56	−0.76	−0.53	−1.18	−1.11	−0.66	−1.49
Morocco	−1.32	−0.93	−0.75	−0.88	−0.90	−2.36	−1.01	−1.06	−1.54
Nigeria	−1.29	−1.49	−1.77	−2.72	−2.55	−2.34	−1.39	−2.07	−2.67
Peru	−1.21	−2.91	−2.64	−3.75*	−3.04	−2.08	3.32	−0.52	3.54
Philippines	−2.20	−2.14	−3.07	−0.72	−0.85	−2.27	−2.66	−2.72	−3.23
Venezuela	−3.95*	1.09	−3.27	−1.89	−1.11	−1.26	−1.84	−1.58	−1.39

Note: M1 = Narrow money, M2 = Broad money, DCR = Domestic credit, Y = Nominal gross domestic product, P = Aggregate price deflator, y = Real gross domestic product. First and second rows for each country show results for log levels and log first differences respectively.

* Significant at the 0.05 level.

** Significant at the 0.01 level.

The monetary aggregates examined in these equations are the narrow (M1) and broad (M2) money stocks, and the credit aggregate is the total domestic credit (DCR).[10] This is similar to the study for the United States in which Friedman and Kuttner (1992, 1993) used five monetary aggregates. Equations (3) and (4) are specified on the assumption that the monetary authorities in the countries examined may be interested in the forecasts of nominal income when making their monetary policy decisions. Following the lead of Friedman and Kuttner (1992, 1993), equations (5) through (8) are specified to decompose nominal income into its real income and price components. They argued that it is possible that any or all the five monetary aggregates may bear some useful informative relationship to the movements of either real income or prices separately, and that such relationship is obscured by the combination of real income and prices into the single measure of nominal income. This line of argument is also applicable to the countries in our sample. In addition, using equations (7) and (8), one can take a fresher look at the old monetarist-structuralist debate in a vector autoregressive framework, but more importantly, these equations are specified based on the results of the tests for unit roots and cointegration, therefore, our examination of whether the fluctuations in monetary and credit aggregates anticipate fluctuations in nominal or real income should yield robust results.

For equations (3) through (8), the causality tests involve testing the significance of the coefficients (e.g. α_i's and β_i's) of the causal variables conditional on the chosen lag lengths. Instead of choosing the lag lengths arbitrarily as done in some of the previous studies, the lag lengths are assigned on the basis of minimizing Akaike's final prediction error (FPE). From equations (3) through (8), the null hypotheses, H_0: $\Sigma\ \alpha_1 = 0$, $\Sigma\ \alpha_2 = 0$, $\Sigma\ \alpha_3 = 0$, $\Sigma\ \beta_1 = 0$, $\Sigma\ \beta_2 = 0$, $\Sigma\ \beta_3 = 0$, $\Sigma\ \psi_1 = 0$, $\Sigma\ \Psi_2 = 0$, and $\Sigma\ \psi_3 = 0$ can be rejected in favor of the alternatives, H_a: $\Sigma\ \alpha_1 \neq 0$, $\Sigma\ \alpha_2 \neq 0$, $\Sigma\ \alpha_3 \neq 0$, $\Sigma\ \beta_1 \neq 0$, $\Sigma\ \beta_2 \neq 0$, $\Sigma\ \beta_3 \neq 0$, $\Sigma\ \psi_1 \neq 0$, $\Sigma\ \psi_2 \neq 0$, and $\Sigma\ \psi_3 \neq 0$.[11] If some or all of the null hypotheses are true for each country, it means that the fluctuations in some or all the monetary aggregates cannot forecast movements in nominal or real income or the price level. On the other hand, if some or all the alternative hypotheses are true, it means that the fluctuations in some or all the monetary aggregates are useful for predicting future movements in either nominal or real income in developing countries.

In the case of those countries where variables are nonstationary but cointegrated, the dynamic relationship between the two variables is more correctly specified by an error-correction representation. In this case, one uses the error-correction terms derived from the cointegrating regressions. Using equation (3) for the purpose of illustration, the error-correction model (ECM) is specified as follows:

$$\Delta Y_t = \phi_1 + \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{m} \alpha_i \Delta M_{t-i} + \varphi \epsilon_{t-1} + \zeta_t \quad (9)$$

where Y_t and M_t represent the pair of cointegrated variables reported in Table 4, ϵ_{t-1} is the lagged value of the estimated ϵ_t from equation (2). With ECM, the lagged changes in M_t affect Y_t through ϵ_{t-1}. In other words, the error-correction term provides additional channel through which causality could emerge.[12] In addition, the rationale behind this specification is that if Y_t and M_t are cointegrated, a part of the current change in Y_t reflects the alignment that Y_t tries to achieve with the trend value of M_t. Basically, this adjustment corrects the error from cointegrating relationship between the two variables which may currently exist. In this case, causality tests involve not only testing the joint significance of coefficients of the causal variables, but also testing the significance of φ. As Miller and Russek (1990), and Miller (1991) pointed out, if two variables are cointegrated, a causal link must exist in at least one direction between them. Therefore, a statistically significant φ indicates such a causal link even when the coefficients of the lagged changes of the causal variable are jointly insignificant.

IV. Data and Empirical Results

The tests of whether the monetary aggregates can predict future movements in nominal or real income were based on annual data for the 1960–1990 period. The data on nominal and real GDP, M1, M2, DCR, and the GDP deflator for each country in the sample were obtained from the 1988 and 1993 issues of the *International Financial Statistics Yearbook*. Even though these annual data cover the 1960–1990 period, the sample period varies across counties due to data length. The empirical tests were performed using the first log differences of each variable on the basis of the lag lengths that minimize the FPE. Table 5 reports the results of the empirical exercises which test whether or not the respective growth of M1, M2, and DCR conveys any information about nominal GDP growth for each of the countries in the sample, apart from what is already known about nominal GDP growth itself.

Table 5 presents the F-statistics for tests of the null hypotheses that the sums of the coefficients on the lagged growth of M1, M2, and DCR are zero. As the F-statistics in Table 5 indicate, M1, and M2 contained statistically significant information about future nominal income movements at the 5% level or better in two of the 10 countries (Morocco and Philippines) in the sample. In Peru, only M2 is statistically significant with respect to movements in nominal income. For India and Indonesia, M1 and DCR, and M2 and DCR contained information about future fluctuations in nominal income respectively. In the cases of Côte d'Ivoire and Ecuador, only the domestic credit variable (DCR) is statistically different from zero. For Ghana, Nigeria, and Venezuela, none of the aggregates contained information about future movements in nominal income.

TABLE 5
F-Statistics for the Monetary and Credit Aggregates in Nominal Income Equations

	Variables		
Countries	ΔlnM1	ΔlnM2	ΔlnDCR
Côte d'Ivoire	0.46 (3)	0.43 (3)	3.63*** (2)
Ecuador	0.99 (2)	0.69 (2)	2.38** (2)
Ghana	0.35 (3)	0.19 (3)	0.61 (3)
India	1.06 (2)	4.13*** (2)	5.88*** (2)
Indonesia	2.50** (4)	0.66 (4)	2.64** (4)
Morocco	3.43*** (3)	4.42*** (3)	3.81*** (3)
Nigeria	0.99 (3)	1.24 (3)	0.36 (3)
Peru	1.94 (4)	3.11*** (4)	0.64 (4)
Philippines	6.06*** (2)	4.53*** (2)	1.27 (2)
Venezuela	0.45 (4)	2.05 (4)	0.69 (4)

Note: The lags used are in parentheses.
** Significant at the 0.05 level.
*** Significant at the 0.10 level.

The F-statistics for the monetary and credit aggregates in the real income equations are presented in Table 6. The results are remarkably different from those reported in Table 5 for the nominal income equations. From the results in Table 6, we can safely conclude that in nine of the 10 countries examined, none of the monetary and credit aggregate provides statistically significant information about future movements in real gross domestic product once the relationships allow for the price effects. In other words, the price effects absorb what appeared to be the statistically significant information that any of the aggregates may have with respect to nominal income as soon as nominal income is decomposed into its real income and price components. M1 is statistically significant in predicting future movements in real income only in Venezuela. For Peru and the Philippines, only M2 contained statistically significant information about fluctuations in real income, while only DCR does for Côte d'Ivoire. For Peru and the Philippines, M2 remained highly significant in the real income equations even when we added the price variable that appeared to have caused these aggregates to lose their significance in those countries where these aggregates were statistically significant in the nominal income equations. For these two countries, the difference may be attributable to the structure of their financial system.

Finally, Table 7 presents the F-statistics for the tests of the causal link between the price level and the monetary aggregates. The results reported in Table 7 are consistent with much of the existing literature on the monetarist explanation of inflation which we alluded to earlier. As we can see, the monetary aggregates contained statistically significant information about future price movements in six of the 10 countries examined. The domestic credit variable is only significant in Côte d'Ivoire and Morocco. This particular result suggests that domestic credit may not cause inflationary pressures in the other countries in the sample if they choose to use

TABLE 6
F-Statistics for the Monetary and Credit Aggregates in Real Income Equations

Countries	Variables					
	ΔlnM1		ΔlnM2		ΔlnDCR	
Côte d'Ivoire	0.37	(3)	0.12	(3)	2.69**	(3)
Ecuador	0.69	(2)	0.99	(2)	2.38	(2)
Ghana	0.36	(3)	0.20	(3)	0.62	(3)
India	1.25	(2)	2.11	(2)	2.13	(2)
Indonesia	1.32	(4)	1.81	(4)	0.84	(4)
Morocco	0.85	(3)	0.48	(3)	0.93	(3)
Nigeria	0.69	(3)	0.54	(3)	0.22	(3)
Peru	1.19	(4)	8.75***	(4)	0.42	(4)
Philippines	1.16	(2)	7.02***	(2)	1.57	(2)
Venezuela	2.31**	(5)	0.57	(5)	1.58	(4)

Note: The lags used are in parentheses.

** Significant at the 0.10 level.

*** Significant at the 0.05 level.

DCR as an information variable. From the results in Table 7, we can safely conclude that monetary and/or credit aggregates cause inflationary pressures in eight of the 10 countries in the sample. It should be pointed out here that for Ecuador, Ghana, Indonesia, and Venezuela where we found cointegration especially with respect to nominal income and the monetary aggregates, the results of the error-correction model do not change the overall results reported in Tables 5 through 7. The error-correction terms confirm that causation runs from nominal or real income to the monetary and credit aggregates (that is, $Y \Rightarrow M1$, $Y \Rightarrow M2$, $Y \Rightarrow DCR$, $y \Rightarrow M1$, and $y \Rightarrow M2$).[13] Basically, the results of the error-correction models provide empirical support for Keynesian theory which suggests that money supply could be demand determined.[14]

V. Conclusions and Policy Implications

This paper has examined whether or not the monetary and credit aggregates contain information about future movements in either nominal or real income in developing countries. The

TABLE 7
F-Statistics for the Monetary and Credit Aggregates in Price Equations

Countries	Variables					
	ΔlnM1		ΔlnM2		ΔlnDCR	
Côte d'Ivoire	1.97	(3)	1.88	(3)	3.49***	(3)
Ecuador	0.79	(3)	1.84	(3)	0.84	(3)
Ghana	3.83***	(2)	3.36***	(2)	0.20	(2)
India	0.73	(2)	3.63***	(2)	2.08	(2)
Indonesia	4.18***	(3)	3.16***	(3)	1.38	(3)
Morocco	1.22	(3)	2.02	(3)	3.45***	(3)
Nigeria	3.30***	(3)	2.90**	(3)	0.64	(3)
Peru	3.62***	(2)	3.88***	(2)	0.62	(2)
Philippines	3.79***	(2)	7.23***	(2)	0.57	(2)
Venezuela	0.80	(3)	0.03	(3)	0..23	(3)

Note: The lags used are in parentheses.

** Significant at the 0.10 level.

*** Significant at the 0.05 level.

empirical results show that these aggregates contain statistically significant information about future fluctuations in *nominal income* in seven of the 10 developing countries examined. However, in nearly all the countries, none of these aggregates provides statistically significant information about subsequent future movements in real income when the model we estimated allowed for the price effects. This is consistent not only with economic theory that suggests that money does not influence or predict real magnitudes, but also with the empirical findings of Friedman and Kuttner (1992, 1993) for the United States. Again, the results of the price equations overwhelming support the monetarist explanation of inflation in LDCs.

There are two main policy lessons that can be drawn from the results of this study. First, for those countries where statistically significant relationships exist between the monetary and credit aggregates and economic activity, the monetary authorities may find these aggregates useful as information variables, or as intermediate targets, or possibly as monetary policy instruments in the conduct of monetary policy if the objective is to forecast movements in nominal income over the horizons. Second, the relationship between the monetary aggregates and the price level suggests that restricting monetary growth could be an effective anti-inflationary device in LDCs if the objective of the central banks (assuming central banks are autonomy) is truly price stability.

Notes

1. The monetarists generally contend that "inflation is always and everywhere a monetary phenomenon" while the structuralists contend that inflation is the result of an attempt by developing countries to grow without making the appropriate structural reforms and adjustments. For an example of a study that supported the monetarist explanation of inflation, see Darrat (1986), and for an example of studies that refuted that monetarist view, see Saini (1982), and Ghatak and Deadman (1989). Similarly, for an example of studies that either supported or refuted the structuralist contention, see Olivera (1964).
2. Apart from Ghana, these countries are classified as emerging market economies. However, Ghana is included as one of the emerging market economies based on its recent economic performance under IMF's structural adjustment program.
3. I am grateful to Professors Frank Wykoff and Stephen Knack and the other participants in session 36 of the 69th Annual Conference of Western Economic Association International for suggesting this additional direction of inquiry in an earlier version of this paper. Due to space constraint, the discussion in this section does not fully reflect the differences in individual country's experiences, but the general characteristics with respect to the central banks that we have highlighted here should provide us with some knowledge as to why developing countries have rapid money growth rates.
4. For more detailed discussion on the differences in the formulation and implementation of monetary policy, see Masha (1983) and Adedeji (1991).
5. For detailed discussion of central bank independence and macroeconomic performance, see Alesina and Summers (1993), McDonough (1994), and Humpage (1994).
6. For the relationship between central bank independence and macroeconomic performance, see the studies by Cukierman *et al* (1992), and Alesina and Summers (1993).
7. See Table 1 of the study by Cukierman *et. al* (1992).
8. The calculation of seigniorage for the 1960–1990 period is based on the definition provided by Cukierman *et. al* (1992). They defined seigniorage as $\Delta H/E$, $\pi H/Y$, $\pi H/E$, where H is high-powered money, E is total government expenditures, π is inflation, and Y is nominal GDP (see their footnote 2).
9. For detailed discussion about some of the general characteristics of the CFA countries, see Boughton (1991).
10. Interest rates are not included in equations (1) and (2) for two reasons. First, there are no sufficiently long data for interest rates for these countries. Second, interest rates are not market determined.
11. The subscript for each of the coefficient is used to identify each monetary aggregate. Subscripts 1, 2, and 3 are for the coefficients of M1, M2, and DCR respectively.
12. The error-correction methodology has been used extensively in the literature. For more on this, see for example, Miller and Russek (1990), Miller (1991), and Oxley (1993).
13. The results of the error-correction model are available from the author upon request.

14. For more discussion on the subject of money supply being supply determined or demand determined, or both, see Harris (1981).

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