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Money, Exchange Rate, Price Links during Hyperinflationary Episodes in Developing Economies

Using Hsiao's approach to Granger non-causality test

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Abstract

The determination of the causal pattern among inflation, money growth, and exchange rate has important implications for policymakers regarding appropriate stabilization policies in developing economies. Using Congolese data where the pace of broad money growth and hyperinflation (23,760% annual change) reached record levels in early 1990s, we use single-equation multivariate autoregressive models with the optimal lag selected using Hsiao's approach to Granger causality. Results indicate feedback causality between inflation and money growth on one side, and unidirectional Granger causality from money growth to the exchange rate and from the exchange rate to inflation on the other. These results suggest that the over-riding goal of disinflation needs to be accomplished initially by exchange rate stabilization, followed by a direct inflation targeting.

Keywords: Money, exchange rate, hyperinflation, Hsiao's Granger causality, Congo

1. Introduction

Inflation has always been a great concern of policy makers in Less Developed Countries (LDCs) and analysts within international development agencies. Despite the fact that the causal relations among inflation, money growth, and exchange rates have been well studied in the literature, previous empirical studies have produced mixed and conflicting results on the nature and direction of such links. Although the review of the literature on inflation and its predictors is beyond the scope of the present analysis, it should be said that inflationary analyses have been largely dominated by monetarist theories and to a certain extent by structuralist views.

The first line of research (known as the monetarist approach) focuses on the causal roles assigned to monetary growth. For instance, the theoretical explanation of inflationary phenomenon by Cagan (1956) is largely developed within the monetarist view traditionally represented by Milton Friedman, which asserts that inflation results from money supply in excess of potential output or demand dictated by trade. As a variant, the fiscal-monetary approach emphasizes the impact of rising government deficits as cause of expected money supply growth, which in turn fuels the inflationary process (Sargent, 1973). One of the crucial characteristics of the monetarist interpretation of inflation is that the increase in the money supply precedes the rise in the price level.

The main alternative to the monetarist viewpoint is cost-push inflation, mainly supported by a structuralist approach. This second view explains the role of exchange rate (depreciation) in an inflationary process and in turning price increases into a vicious cycle. In the context of LDCs where the share of imported intermediary inputs is large, initial depreciation is likely to result in higher import prices, which then affect costs and ultimately prices of products in the economy. Also, the structural dependency of capital imports along with the lack of foreign reserves implies that developing countries have recurrent balance of payments problems and that currency depreciation is endemic (Vernengo, 2005). Not only is inflation seen as resulting from balance of payments crises, but fiscal crises also are thought to be the result of the initial balance of payments crisis.

The effect of exchange rate in the inflationary process can be exacerbated under conditions where the money supply reacts passively to any inflationary pressures. It is possible for exchange rate depreciation to play a key role in sustaining the inflationary spiral regardless of whether the process is initiated by internal rather than external factors (Burdekin and Burketi, 1996).

Minshki (2004) provides an excellent reconciliatory remark in that sustained cost-push inflation is also a monetary phenomenon because it cannot occur without the acquiescence of the monetary authorities to a higher rate of money growth. Although theoretically we can distinguish between monetarist and structuralist inflation, it is much harder to do so in application since both types of inflation are associated with high rates of money growth.

Studies of LDC inflation causality have focused on Latin-America rather than inflationary episodes in sub-Saharan Africa, with the exception of Canetti and Greene (1991). Using vector autoregression analysis to separate the influence of money supply growth from exchange rate changes on prevailing and predicted rates of inflation in Africa, Canetti and Greene (1991) find that both exchange rate movements and monetary expansion affect consumer price changes in a number of Sub-Saharan African countries. In particular, the two authors find that both the bivariate and trivariate Granger causality tests suggest that exchange rates had a significant causal impact on prices in Sierra Leone, Tanzania, and Democratic Congo (then Zaire), while monetary dynamics led inflationary processes in Gambia and Uganda.

The causal nature of these relationships is known to exhibit considerable variation across countries, and there is a call for empirical investigation for specific cases. The present study investigates the Granger-causal links among the afore-mentioned variables in the context of the Democratic Republic of the Congo (hereafter Congo) using Hsiao's approach of Granger-causality. The choice of the Congo is justified on the grounds that the country experienced severe episodes of high inflation in the first half of the 1990s and the resulting dollarization[1] may have rendered the relationships among price, the money supply, and the exchange rate more complex, and may well provide new light to understand these linkages. This question is important because the determination of the causal pattern among inflation, money growth, and the exchange rate has important implications for policy-maker choice of appropriate stabilization policies.

The remaining part of this article is organized as follows. Section 2 describes the model and methodological considerations. Section 3 presents empirical results, mainly stationarity and cointegration tests along with the results from the Hsiao's variant of Granger-causality tests. Section 4 discusses the results, followed by policy implications and a conclusion.

2. Model, Data, and Methodological Considerations

The present analysis proceeds in four steps. The first involves the Phillips-Perron (1988) tests of stationarity and Johansen (1988) test of cointegration, followed by a multivariate cointegration test. The third step focuses on Hsiao's version (1981) of the

[1] Dollarization is the unofficial and partial replacement of the domestic currency by foreign ones either as store of value, unit of account, or medium of exchange.

Granger non-causality method (Granger, 1969) to estimate causality for each equation of the model. Causality results are then examined with conventional diagnostic tests.

Results from causality tests are highly sensitive to the order of lags in the autoregressive process. An inadequate choice of the lag length would lead to inconsistent model estimates, and any inferences would likely be misleading. Appropriate identification of lag order for each variable requires some care. Hsiao's approach responds to this concern by combining the Granger concept of causality and Akaike's final prediction error criterion, and is specifically designed to avoid imposing false or spurious restrictions on the model. For a detailed discussion of Hsiao's version of the Granger causality method, see Hsiao (1981, 1982), Cheng and Lai (1997), and Bajo-Montavez (2002).

Hsiao's variant of Granger-causality proceeds as follows. Suppose we want to test Granger-causality for two stationary variables, X_t and Y_t. Consider the models:

$$\mathrm{X_t} = \alpha + \sum_{i=1}^{m} \beta_i \mathrm{X_{t-i}} + \mathrm{u_t} \tag{1}$$

$$\mathrm{X_t} = \alpha + \sum_{i=1}^{m} \beta_i \mathrm{X_{t-i}} + \sum_{j=1}^{n} \gamma_j \mathrm{Y_{t-j}} + \mathrm{v_t} \tag{2}$$

where α is a constant term, β and γ are coefficient of exogenous variables, and u_t and v_t are white noise error terms. The following steps are used to apply Hsiao's procedure.

(i) Consider X_t a univariate autoregressive process as in (1), and compute its final prediction error criterion (FPE) with the order of lags i varying from 1 to m. Choose the lag m that yields the smallest FPE and denote the corresponding FPE as $FPE_X(m, 0)$.

The corresponding FPE is

$$FPE(m) = \frac{(T+m+1)}{T-m-1} x \frac{SSE}{T} \tag{3}$$

where T denotes the number of observations in the regression and SSE is the sum of squared residuals. The determination of causality is performed as follows.

(ii) Treat X_t as a controlled variable with *m* lags, add lags of Y_t to (1) as in (2), and compute the FPEs with the order of lags *j* varying from 1 to *n*. Choose the lag *n* that yields the smallest FPE and denote the corresponding FPE as $FPE_X(m, n)$.

The corresponding FPE is given by

$$FPE(m^*, n) = \frac{(T + m^* + n + 1)}{T - m^* - n - 1} x \frac{SSE(m^*, n)}{T} \quad (4)$$

(iii) Compare $FPE_X(m, 0)$ with $FPE_X(m, n)$. If $FPE_X(m,0) > FPE_X(m, n)$ then Y_t is said to Granger-cause X_t, whereas if $FPE_X(m, 0) < FPE_X(m, n)$ then X_t is not Granger-caused by Y_t.

Reverse causality (whether X_t Granger-causes Y_t) is determined by repeating steps (i) to (iii) with Y_t as the dependent variable.

In practice, the implicit assumption that *Xt* and *Yt* are stationary has to be confirmed before proceeding with (1) and (2). If the series are non-stationary with unit roots, they have to be transformed into stationary ones by means of a difference filter. If variables are all non-stationary but some linear combination of the three series is stationary, it should be checked whether there is any systematic co-movement among variables over the long run. Such cointegration would imply that any standard Granger causal inferences will be invalid and error correction models should be adopted. Unit root and cointegration techniques are well documented (Engle and Granger, 1987; Johansen, 1988; Johansen and Juselius, 1990).

If variables are cointegrated it is useful to modify (1) and (2) by incorporating an error-correction term as follows,

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \delta z_{t-1} + u_t \tag{1}$$

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + \delta z_{t-1} + v_t \tag{2}$$

where z_t is the vector error-correction term (Engle and Granger, 1987). Notice that if X_t and Y_t are I(1) but are not cointegrated, no error correction mechanism binds the two variables and three is no one period lagged error term in (1') and (2').

One purpose of the present paper is to analyze the trivariate causal relation of price-money supply-exchange rate. Testing for Granger-causality in the trivariate case requires amending (1') and (2') by adding a third variable, *W*. The trivariate model examines the causal relationship between X_t and Y_t conditional on the presence of W_t,

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{k=1}^{p} \theta_k \Delta W_{t-k} + \delta z_{t-1} + u_t \tag{3}$$

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + \sum_{k=1}^{p} \theta_k \Delta W_{t-k} + \delta z_{t-1} + v_t \tag{4}$$

with the corresponding FPE given by

$$FPE(m^*, n, p) = \frac{(T + m^* + n^* + p + 1)}{T - m^* - n^* - p - 1} x \frac{SSE(m^*, n^*, p)}{T} \tag{5}$$

In the trivariate case, the relevant comparison is between $FPE_{\Delta X}(m, 0, p)$ and $FPE_{\Delta X}(m, n, p)$ where (*m*, 0, *p*) and (*m*, *n*, *p*) are the combinations of lags leading to the smallest FPE in each case. If $FPE_{\Delta cpi}(m, 0, n) > FPE_{\Delta cpi}(m, n, p)$ money supply (y) Granger-causes CPI (x) conditional on the presence of the exchange rate (w). The differenced time series have no information about the long-run relationship between the trend components of the original series since these have, by definition, been removed. "Standard" Granger-causality tests may at best describe only short-run relations among price, money growth, and the exchange rate.

Before moving into estimation results, a word on the data series is in order. The analysis uses monthly data covering the period January 1990 to September 1996 in Zaire. All data series are obtained from Beaugrand (1997). Price level (denote *lnP*) is natural logarithm of the consumer price index (December 1981 = 1). Money expansion is the natural logarithm of money outside of banks (denoted *lnM*). The exchange rate is the natural logarithm of the parallel Zaire per unit of US dollars, period average (denoted *lnZ*). The use of the parallel exchange rate is justified on the grounds that the official exchange rate did not affect any transaction in the economy at the margin and that the parallel market represented the relevant marginal price for most transactions in the Congo over the whole period under analysis (IMF, 1996). The nominal exchange rate is expressed as the price of dollars in terms of domestic currency.

A visual inspection of the data in Figures 1, 2 and 3 shows a distinct tendency for the three series to move together while showing no tendency for the series to revert to a constant mean, which suggests that the series are nonstationary. The stationarity of the series is examined by a more formal testing in the next section.

Figure 1. Price

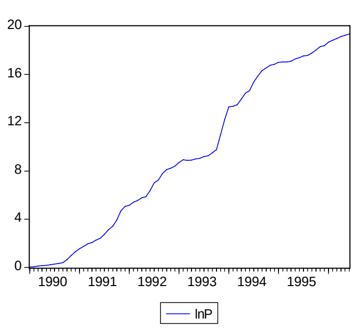


Figure 2. Money

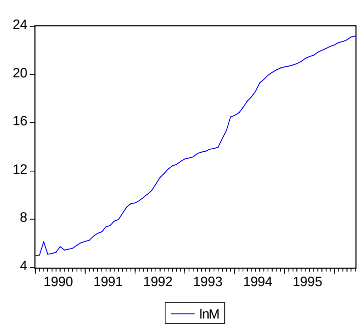
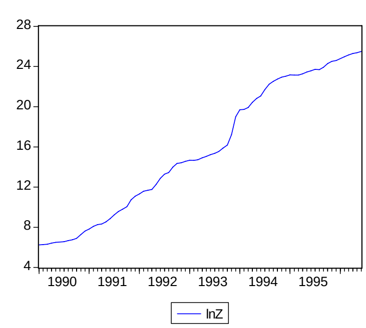


Figure 3. Exchange rates



3. Estimation Results

3.1. Results from stationary and cointegration tests

This section explores causality between variables in a multivariable setting to avoid possible spurious results due to the omission of relevant variables. Before proceeding with cointegration tests, it must be established that the variables are integrated processes of the same order. All the three variables are subjected to the Dickey-Fuller and Augmented Dickey-Fuller tests (Dickey and Fuller; 1979, 1981). An intercept and a time trend is included in the ADF regression and the null hypothesis of a single unit root cannot be rejected at the 10% level for the three variables *lnP*, *lnM*, and *LnZ*. The three series each become I(0) after first differencing as shown in Table 1 at the 5% level for prices and money growth, and at the 10% level for the exchange rate variable.

Table 1. Unit Root Tests

	Level		First Difference	
	DF	ADF	DF	ADF
LnP	-2.11	-2.54	-4.18*	-4.35*
LnM	-1.32	-1.94	-8.31*	-8.39*
LnZ	-2.13	-2.48	-3.01**	-3.22**

* 1%, **10%

The three variables are integrated of the same order and we proceed to the next step. The order of the VAR model often plays a crucial role in empirical analysis, and the Akaike Information Criterion (AIC) selects the number of lags required in the cointegration test. A VAR model is first fit to the data and the AIC gives lag 5 as the appropriate lag structure. To test for cointegration, we use the maximum eigenvalue and the trace tests suggested by

Johansen (1988) and Johansen and Juselius (1990) shown in Table 2. Our tests fail to reject the null hypothesis that the variables are not cointegrated. Starting with a maximum of three cointegrating vectors, both Trace and Eigenvalue tests indicate no cointegration at 5% among price, money growth, and exchange rate. The lack of cointegration between variables suggests that there exists no long-run relationship among variable under consideration.

Table 2. Cointegration results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.199856	26.22698	29.79707	0.1220
At most 1	0.126069	10.17356	15.49471	0.2676
At most 2	0.006525	0.471317	3.841466	0.4924

*denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values.
Trace test indicates no cointegration at the 0.05 level.
We used trend (unrestricted), constant, and five lag of each of the variables to test the cointegrating relationship.

Since cointegration is ruled out, our results include only the differenced term, which captures short-term adjustments. Therefore, the analysis proceeds with equations (1'), (3), and (4) with the coefficient δ assumed equal to zero. Note that because of the presence of unit root in the three variables, they are used in first difference form. However, for simplicity, we still retain the terms money and exchange rate to represent the rate of change of these two variables while the term "price" and "inflation" are used interchangeably hereafter.

3. 2. Results from Hsiao's version of Granger Causality

The lag lengths m, p and n were set at 12 because in applied econometrics, maximum lags of 12 are generally used for monthly data. For causality tests, Table 3 reports the minimum FPEs of the three univariate autoregressions with both lnP and lnM at lag 1 and *LnZ* at lag 4. Causality is established by comparing the minimum FPE from a bivariate and a trivariate VAR. As indicated in Table 4 in the price equation, the exchange rate (*LnZ*) is added first as the first manipulated variable in the first step, and *lnM* is added to the previous equation in the next step. Since the FPE obtained in the first step is smaller than the one obtained in the second step, we conclude that *lnM* Granger-causes inflation. Subsequently, the *lnM* variable is first added to the equation, followed by *LnZ*, and the result points to the conclusion that *LnZ* Granger-causes *lnP* in the short run.

For the money supply equation in Table 4 the exchange rate is entered into the equation first followed by inflation, and the result infers inflation Granger-causes money expansion. Next, inflation is entered into the equation followed by the exchange rate and it is found that the exchange rate Granger-causes money growth in the short run.

Applied to the exchange rate equation, the above procedure leads to two findings. One is that inflation does not Granger cause the exchange rate, and the other that monetary expansion Granger causes the exchange rate.

Table 3. FPE of One-Dimensional AR Processes

Order of Lags	FPE of *lnP*	FPE of *lnM*	FPE of *LnZ*
0	0.0705	0.0383	0.0757
1	0.0496*	0.0321*	0.0555
2	0.0501	0.0328	0.0512
3	0.0516	0.0338	0.0475
4	0.0527	0.0347	0.0474*
5	0.0527	0.0358	0.0489
6	0.0537	0.0369	0.0503
7	0.0554	0.0379	0.0518
8	0.0571	0.0391	0.0533
9	0.0586	0.0400	0.0544
10	0.0599	0.0406	0.0562
11	0.0609	0.0416	0.0572
12	0.0622	0.0429	0.0589

(*) indicates lag order selected by FPE criterion at 5% level

Table 4. Results of the Hsiao's version causality tests

	Controlled variable	First manipulated variable	Second manipulated variable	FPE	F-value	Causality Inferences
Inflation (lnP)	lnP (1)	LnZ (8)		0.0418		
	lnP (1)	LnZ (8)	lnM (7)	0.0322	5.63*	lnM causes lnP
	lnP (1)	lnM (0)		0.0342		
	lnP (1)	lnM (0)	LnZ (9)	0.0277	8.96*	LnZ causes lnP
Money growth (lnM)	lnM (1)	LnZ (4)		0.0368		
	lnM (1)	LnZ (4)	lnP (1)	0.0347	2.46**	lnP causes lnM
	lnM (1)	lnP (1)		0.0367		
	lnM (1)	lnP (1)	LnZ (3)	0.0370	2.13**	LnZ does not cause lnM
Exchange rates (lnZ)	lnZ (4)	lnM (3)		0.0400		
	lnZ (4)	lnM (3)	lnP (6)	0.0411	5.36*	lnP does not cause LnZ
	lnZ (4)	lnM (8)		0.0535		
	lnZ (4)	lnM (8)	lnP (3)	0.0450	4.26*	lnM causes LnZ

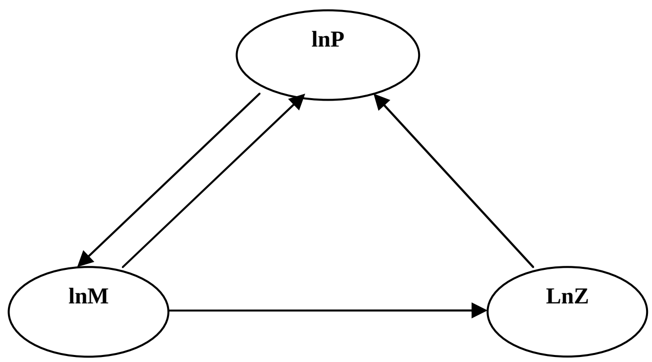
Note: (*) and (**) denote significance, respectively, at 5% and 10% level.
lnP, lnM and lnZ are in first difference form.

As shown by Hsiao (1982), for *X* to be a direct Granger-cause of *Y*, *X* should Granger-cause *Y* both in bivariate and multivariate models. It follows that bivariate results can be found by comparing minimum FPEs given by univariate estimations in Table 3 and bivariate FPEs in Table 4. Bivariate Granger-causality is found between all pairs of variables except from inflation (*lnP*) to money growth (*lnM*). This exception somehow weakens the conclusion derived from trivariate Granger causality from inflation to money growth. It should be note that results in Table 4 are further confirmed by the F-value revealing that coefficients in each of the trivariate equations are significant at either the 5%

or 10% levels.

The causal relationships in Table 4 are summarized in Figure 1 showing that money growth is at the crossroads of this complex relationship between the three variables. This may also be interpreted as the fact that in the DRC money supply changes were mainly used by authorities as automatic responses to price and exchange rate shocks often originated from either fiscal or external stimuli.

Graph.1. Trivariate causality



4. Explanation of the causality relationships

The present results suggest feedback causality between inflation and money growth, along with unidirectional Granger causality from money growth to the exchange rate and from the exchange rate to inflation. It is important to review the theories consistent with these results. Money supply changes predicting inflation is consistent with the monetarist theory that the root cause of inflation is an increase in money supply beyond its demand, that "inflation is always and everywhere a monetary phenomenon" as Friedman (1968) puts it. This finding corroborates that of Beaugrand (1997) in that at the beginning of the inflationary process in the early 1990s, attempts by the Congo’s government to finance through money creation resulted in an increase in the price level.

After the sharp decline in government revenue from 11% of GDP during 1986-89 to about 5% during 1990-94 which accompanied the democratic unrests following 1990, the government of the Congo (then Zaire) was unable to recapture its spending through taxes. The government essentially resorted to printing money which resulted in hyperinflation reaching a cumulative increase in prices from October 1990 to December 1995 of 6.3 billion percent (IMF, 1996).

What is also noteworthy is the present result that inflation and money growth predict each other and are contemporaneously determined. The feedback between inflation and money supply changes could be interpreted as a validation of the claim that the Congolese monetary authority allowed the money supply to respond passively to demand with inflation causing monetary growth. Similar to the German case as noted by Webb (1985), the central bank did not aim for target growth rates of the money supply, but rather aimed to guarantee that neither the corporate sector nor the government would need to restrain its activities because of unavailable foreign exchange for imported intermediate inputs.

During the hyperinflation episode, the Congolese Central Bank followed an accommodative monetary policy that let the size of the money stock be determined by government financing, and marginally by the private sector choice of the dollar and local currency in its portfolio mix.

The pace of broad money growth reached record levels in early 1990s, from about 84% in 1986-89 to more than 2,000% during 1990-94. According the IMF (1996), in 1994 alone, broad money grew by 5,546%, which mainly reflected the deficit in government operations (2,284%).

A critical element in the finding that money growth Granger-causes the exchange rate is that with inflation becoming permanent and sustained, currency substitution increases making the distinction between domestic currency depreciation and movement in foreign exchange rate closely correlated. An increase in the money supply causes depreciation, and following monetary theory, the exchange rate depends on relative money supplies in the long run.

Our results confirm the finding by Canetti and Greene (1991) that in the Congo the exchange rate Granger causes inflation. The prediction of inflation by the exchange rate follows the fact that depreciation implies that the domestic price of imported and exported final goods increases. Because these goods enter the Consumer Price Index (CPI), inflation increases. The causality from this inference supports the structuralist view considering inflation as tightly linked to exchange rate changes. Furthermore, the effect of exchange alteration on inflation may reflect the fact that importers pass on exchange rate changes to buyers rather than absorbing them in their profit margins, the pass-through of exchange rate changes.

Under widespread currency substitution, the domestic price level and exchange rate become equivalent, or the latter may become the most pertinent forward indicator for expectations and measurement. In such a situation, depreciation would itself contribute to further inflation if that is what people expect. Anticipating future depreciation, economic agents increase the demand of foreign currencies in anticipation of expected depreciation and other deterioration of economic fundamentals.

The present results furnish evidence that relationships among inflation, money growth, and the exchange rate in the Congo over the 1990s have been complex as attested by the successive failures of disinflation attempts by different transitional governments during 1994-1996.

5. Policy Implication and Conclusions

The present study utilizes Hsiao's approach to Granger-Causality to test the relationships among money growth, the exchange rate, and inflation in the Congo during the 1990s. Results reveal a feedback causality between inflation and money growth on one side, and unidirectional Granger causality from money growth to the exchange rate and from the exchange rate to inflation on the other.

Although the monetarist literature on inflation strongly holds the relative money supply as the main cause of inflation, the three variables analyzed in the present paper appear to be involved in a more complex web of interdependences. In particular, money supply and the exchange rate appear to be mutually connected to inflation, both directly and indirectly.

These results suggest that a reduction in the money supply will not simply reverse the consequences of its previous increase unless the central bank takes accompanied measures susceptible of bringing the exchange rate under control. The evidence supporting the role of both money growth and exchange rate as leading indicators of inflation leads to concern of how to turn this evidence into a useful tool for monetary assessment.

A key condition for a successful stabilization policy in an economy with currency substitution is the commitment of the government to balance its budget, and rigorously manage domestic and foreign currency cash flows of the public sector to minimize unnecessary volatility in the foreign exchange market. Stabilization policy should tackle high inflation by not only relying on the money supply but also focusing on variables that impact the circulation of foreign currencies. Furthermore, variations in expected depreciation change the share of foreign currency related to domestic currency for current transactions implying instability of money demand and difficulties for implementing the money targeting rule. In addition, the extensive currency substitution brings about exchange rate instability, alters the demand for domestic money, and makes the implementation of monetary policy futile.

The conclusion is that the over-riding goal of disinflation needs to be accomplished initially by exchange rate stabilization, followed by a direct inflation targeting. Such a sequence of targets is appropriate for developing economies: exchange rate targeting to bring inflation down to single-digit levels, then money growth targeting since control instruments such as open market operations is not available, and finally inflation targeting as data and forecasting tools become sophisticated.

References

1. Bajo, R., Montavez, G., 2002. Was there monetary autonomy in Europe on the eve of EMU? The German dominance hypothesis re-examined. Journal of Applied Economics 2 November 2002, 185-207.

2. Beaugrand, P. 1997. Zaire's hyperinflation, 1990-96. Working Paper WP/97/50, Washington, DC: International Monetary Fund.

3. Burdekin, R.C.K., Burketi, P. 1996. Hyperinflation, the exchange rate and endogenous money: post-World War I Germany revisited. Journal of International Money and Finance 15, 599-621.

4. Cagan, P. 1956. The monetary dynamics of hyperinflation. Studies in the Quantity Theory of Money. University of Chicago Press; Chicago, 25–117.

5. Canetti, E., Greene J. 1991. Monetary Growth and Exchange Rate Depreciation as Causes of Inflation in African Countries: An Empirical Analysis. Center For Economic Research on Africa Research Monograph Series. School of Business-Montclair State University, New Jersey.

6. Cheng, B. S., Lai, T.W. 1997. An investigation of cointegration and causality between energy consumption and economic activity in Taiwan. Energy Economics 19, 435-444.

7. Dickey, D. A. and Fuller, W. A. 1979. Distribution of the estimator for autoregressive time series with a unit root. Journal of the American Statistical Association 74, 427-431.

8. Dickey, D. A., Fuller, W. A. 1981. Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, Econometrica, 49, 1057–1072.

9. Engle, R.F., Granger, C.W.J. 1987. Co-integration and error correction: representation, estimation, and testing. Econometrica 55, 251-276.

10. Friedman, M. 1968. Dollars and Deficits: Inflation, Monetary Policy and the Balance of Payments. Prentice-Hall, Englewood Cliffs.

11. Granger, C.W.J. 1969. Investigating causal relations by econometric models and cross spectral methods. Econometrica 37, 428-438.

12. Hsiao, C. 1981. Autoregressive modeling and money income causality detection. Journal of Monetary Economics 7, pp. 85–106.

13. Hsiao, C. 1982. Autoregressive modelling and causal ordering of economic variables. Journal of Economic Dynamics and Control 4, 243-259.

14. IMF. 1996. Zaire-Background Information and Statistical data. IMF Staff Country report No. 96/28. Washington, D.C.

15. Johansen, S. 1988. Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control 12, 231-254.

16. Johansen, S., Juselius, K. 1990. Maximum likelihood estimation and inferences on cointegration with application to the demand for money. Oxford Bulletin of Economics and Statistics 52, 169-210.

17. Minshki, F. S. 2004. The Economics of Money, Banking, and financial markets, 7th ed. International Ed. Boston.

18. Phillips P., Perron, P. 1988. Testing for a unit roots time series regression. Biometrika 75, 335-346.

19. Sargent J.J., Wallace, N. 1973. Rational Expectations and the dynamics of hyper-inflation. International Economic Review 14, 328-350.

20. Vernengo M. 2005. Money and Inflation. Handbook of Alternative Monetary Economics. to be edited by Philip Arestis and Malcolm Sawyer. http://www.econ.utah.edu/~vernengo/, retrieved on April 15th, 2005.

21. Webb S. B. 1985. Government Debt and Inflationary Expectations as Determinants of the Money Supply in Germany 1919-23. Journal of Money, Credit and Banking 17, 479-492.