The Monetary Approach to Exchange Rates: A Review of Recent Empirical Studies

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I. Introduction and Overview

In recent years there has been a resurgence of interest in the monetary approach to exchange rates. Most analysts are willing to accept the proposition that money supply developments are a major determinant of exchange rates. Other aspects of the monetary approach have been more controversial, however. In particular, in its strong form, which assumes Purchasing Power Parity (PPP), this approach views the exchange rate as a function only of the demand and supply of money in the economies in question. Coupled with the assumption of constant real interest rates, these monetary models indicated two important propositions about exchange rate behaviour which were at variance with the widely held conventional wisdom.

One is that ceteris paribus, real income growth would lead to an appreciation rather than a depreciation of the exchange rate as assumed in traditional analysis. The difference is because in the monetary approach the increase in real income is seen as increasing the home demand for money, causing an excess demand for money and currency appreciation. In the traditional Keynesian approach, real income growth is seen as primarily leading to an increase in the demand for imports and generating a current account deficit and currency depreciation. It had been recognized in the Keynesian literature that higher growth could attract capital inflows which might dominate the deterioration in the trade balance and thus also lead to currency appreciation, but at the beginning of the 1970's the belief that higher growth would tend to lead to currency depreciation was probably still a majority view.

The second novel conclusion was that high interest rates would be associated with a weak rather than a strong currency. In the traditional analysis, interest rate changes were implicitly assumed to reflect liquidity effects (i.e., they represented changes in real interest rates). High interest rates were seen as reflecting tight money and generating capital inflows which strengthened the currency. From a monetarist perspective, however,

high interest rates tend to reflect easy money and inflationary expectations which reduce the quantity of real balances demanded and lead to currency depreciation.

While critics were quick to point out that some of the crucial theoretical assumptions of the monetary approach models such as PPP and constant real interest rates do not hold empirically, early published studies found nevertheless that small monetary models fit the data rather well, and that the estimated coefficients on the income and interest rate terms tended to support the predictions of the monetary models rather than traditional analyses.[1] Thus summarizing the first generation of published studies, *John Bilson* concluded that,

All these models support the general predictions of the monetary approach. In particular, most find that a monetary expansion results in a proportional depreciation of the exchange rate. In addition, increases in real income, for a given rate of monetary growth, lead to an appreciation of the exchange rate, and higher levels of nominal interest rate, again for given levels of monetary growth, tend to depreciate the exchange rate. At the moment, however, insufficient empirical work has been done to determine which of the particular models discussed in this paper offers the most apt description of the current floating rate experience.[2]

In a similar vein in his recent survey paper on the empirical regularities in exchange rate behavior *Michael Mussa* states:

A number of empirical studies have applied the monetary model of the exchange rate to actual data. By and large, these studies conclude that the behavior of exchange rates is consistent with the monetary model and that this model is of assistance in explaining a significant fraction of exchange rate movements. In my judgment, this body of evidence is sufficiently impressive to justify the conclusion that the monetary model of the exchange rate does have empirical content.[3]

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[1] Strictly speaking, these models need to assume only that goods are perfect substitutes and that deviations from PPP are exogenous to the model, rather than requiring that PPP always holds. Obviously the less is the quantitative importance of exogenous disturbances which cause deviations from PPP, the higher will be the explanatory power of the model. Of course, where these disturbances are not randomly distributed, the estimated coefficients in the model may be biased.

[2] A brief survey of the monetary approach literature can be found in *John Bilson,* "Recent Developments in Monetary Models of Exchange Rate Determination," I.M.F. Staff Papers Vol. 26, No. 2 (June 1979), pp. 201 - 223. The quote is taken from p. 220.

[3] See *Michael Mussa,* "Empirical Regularities in the Behavior of Exchange Rates and Theories of the Foreign Exchange Market," in *Karl Brunner* and *Allan Meltzer* (eds.), Policies for Employment, Prices and Exchanges Rates (Carnegie-Rochester Conference Series on Public Policy, Vol. 11, Amsterdam: North-Holland, 1979), pp. 9 - 57. This quote is taken from p. 45.

While we believe that the monetary approach literature has made important contributions to exchange rate analysis, recent research indicates that these models do not fit the data nearly as robustly as was suggested by the initial studies surveyed by *Bilson* and *Mussa*. We would certainly not question the proposition that trends in monetary factors are a and probably the major factor determining trends in exchange rates, but the ability of monetary models to depict the key elements of shorter term exchange rate dynamics are open to serious question, a conclusion accepted by a growing number of researchers. For example, as is documented in the literature surveyed in this paper, in many instances monetary models which perform well for a particular country break down or yield non-monetarist results when applied to other countries. This conclusion was found in work by *Sven Arndt* and *Charles Pigott* prepared for the Office of International Monetary Research at the U.S. Treasury in 1976[4] and is further supported by the results reported by *Joachim Harnack* in Appendix A to this paper.

Instability of estimates has also plagued attempts to generalize the monetary model to include short-run *Keynes*ian interest rate effects. For example, *Jeffrey Frankel*'s influential composite model[5] found strong support for a view which combined short-run Keynesian liquidity effects and exchange rate dynamics with longer run monetarist trend behavior for the dollar-DM exchange rate. Short-run changes in real interest rates were estimated to induce substantial exchange rate overshooting, while the exchange rate behaved in a monetarist manner with respect to changes in real income and inflationary trends. As Frankel himself notes in a recent paper,[6] when the sample period is extended, the model falls apart.

Even over the original sample period, however, results are not robust with respect to alternative econometric techniques for dealing with serial correlation and alternative proxies for inflationary expectations.[7] Not only does the finding of substantial exchange rate overshooting disappear, but

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[4] *Sven Arndt* and *Charles Pigott,* "The Influence of Monetary Aggregates on Exchange Rates Under the Current Float: Some Empirical Results," Discussion Paper, Office of the Assistant Secretary for International Affairs, U.S. Treasury, 1976.

[5] *Jeffrey Frankel,* "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials," American Economic Review, Vol. 69, No. 4 (September, 1979), pp. 610 - 621.

[6] *Jeffrey Frankel,* "On the Mark: Reply," American Economic Review, Vol. 71, No. 3 (December, 1981): 1075 - 1082.

[7] See *Aida Der Hovannesian,* Risk and the Foreign Exchange Market, Claremont Graduate School, 1981 (unpublished Ph.D. dissertation), and *Waseem Khan,* The Monetary Approach to Exchange Rates: Theory and Empirical Evidence, Claremont Graduate School, 1981 (unpublished Ph.D. dissertation).

many of the other coefficients become insignificant or of the wrong sign for *Frankel's* model.

Why do the results from the monetary models not hold up robustly? One possibility is that the demand for money is not stable. As is discussed in section II, there is some evidence that this has been a problem, especially for monthly models. Taking into account the effects of risk and uncertainty, and portfolio balance considerations where capital mobility is not infinitely elastic, also appear to offer additional explanatory power.[8]

Two other factors seem to be of prime importance, however. One is that as is stressed in the asset market view adopted in the monetary approach, it is expectations which drive exchange rate behavior, and these can only very imperfectly be proxied by observable data. Second, contrary to the assumptions of the simple monetary approach, real factors do appear to have a major influence on exchange rate behavior. Changes in equilibrium real exchange rates have been a major determinant of exchange rate changes. Changing expectations of equilibrium current account relationships can lead to large changes in exchange rates, and deviations from PPP have not tended to be strongly self reversing as would be expected if exchange rate variations were dominated by poorly behaved speculation or interest rate induced exchange rate overshooting. For example, recent estimates by *Hooper* and *Morton*[9] support the argument made by *Willett* in the overview paper for this volume that the major cause of the substantial depreciation of the dollar during 1977 and 1978 was due to changing expectations about equilibrium real exchange rates. Their estimates suggest that about 80 percent of the dollar's decline over this period was due to real factors and about 20 percent to monetary factors.

It is inherently much more difficult to explain short run exchange rate dynamics than longer term trends. It is with respect to the latter that the monetary approach has its major explanatory power (a point acknowledged

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[8] On the inclusion of risk see the studies by *Makin,* "Exchange Rate Behavior Under Full Monetary Equilibrium: An Empirical Analysis," National Bureau of Economic Research Working Paper No. 647 (March 1981); and by *Der Hovanessian,* "Risk and the Foreign Exchange Market," op. cit., and on portfolio balance effects, see *Frankel,* "Monetary and Portfolio Balance Models of Exchange Rate Determination," in *J. Bhandari* and *B. Putnam* (eds.), The International Transmission of Economic Disturbances Under Flexible Exchange Rates (forthcoming), and *Peter Hooper* and *John Morton,* "Fluctuations in the Dollar; A Model of Nominal and Real Exchange Rate Determination," International Finance Discussion Paper No. 168 (October 1980), and references to the work by *Branson* and others cited there.

[9] See *Hooper* and *Morton,* "Fluctuations in the Dollar", and also *Rudiger Dornbusch,* "Exchange Rate Economics: Where Do We Stand?" Brookings Papers on Economic Activity, No. 1 (1980), pp. 143 - 194.

by most of its advocates).[10] For example, over the long run, we would expect a strong tendency for countries with higher interest rates to suffer from higher rates of inflation and have depreciating currencies. The truth of this proposition gives us little guidance to the relationships between short term fluctuations in interest rates and exchange rates, however. To improve our knowledge about such short-run dynamics we believe that the analysis should focus particularly on expectations formation both about monetary factors and about factors which influence exchanges independently of their effects on the demand and supply of money (i.e., which cause changes in equilibrium real exchange rates).

II. Evidence From Empirical Studies

In this section we compare and analyze the evidence on the effects on exchange rates of interest rates, inflation rates, real income and money supply variables available from the recently published empirical studies in the monetary approach to exchange rates and the extensions of this approach.

1. Interest Rates and Inflation Rates

As was noted in the introduction, one of the novel conclusions of the monetary approach to exchange rates was that contrary to conventional wisdom, high indirect rates (reflecting high inflation rather than high real rates) should be associated with a weak currency. A second innovative theoretical view developed by *Rudiger Dornbusch* argued that in contrast where wage and price adjustment was sluggish, an increase in interest would lead to currency appreciation, as in the conventional view, but that the magnitude of appreciation would be much greater as the initial appreciation would overshoot the longer run equilibrium level. The essential issue became the extent to which changes in short run interest rates reflected inflationary expectations or changes in real interest rates (Keynesian liquidity effects). The empirical relevance of these two views comes down essentially to the question of whether the coefficient on the interest rate differential in exchange rate models is positive or negative. (The monetary approach requires a positive coefficient since these models conventionally define the exchange rate as the price of foreign over domestic currency so that an exchange rate depreciation implies a positive change in the ex-

[10] See, for example, the comments by *John Bilson* in *Jacob Dreyer, Gottfried Haberler,* and *Thomas D. Willett* (eds.), The International Monetary System Under Stress (Washington, D.C.: American Enterprise Institute, 1982).

change rate.) As is summarized in Table 1, while proponents of each of these views were able to claim empirical studies in their support, there appears to be sufficient truth in both views for neither to win the day in terms of systematic empirical support.

In view of the mixed nature of these results two points are worth mentioning. Most of the monetary exchange rate equations introduce the domestic and foreign interest rates in differential form rather than separate explanatory variables. This has the unnecessary effect of constraining interest semielasticities to be equal across countries and, hence, may be a potential source of bias in the estimated coefficients. Moreover, the market determination of exchange rates, among other factors, is not always based upon interest differentials. One has to only read the newspaper to realize that commentators often have a strong tendency to focus on individual interest rates rather than the difference between them. Stories that the dollar rose on higher U.S. interest rates often fail to discuss what has happened to interest differentials.

Furthermore, it is interesting to note that the specific interest elasticity values implied by these studies are often significantly different than those obtained in domestic money demand studies. For example a benchmark interest rate of 10 % would imply interest elasticity values of 0.002, 0.65, and 0.005 in equations (2, 3, and 10) of Table 1. Studies by *Goldfeld*[11] and *Poole*[12] suggest short-term interest elasticities for the U.S. to be under 0.5 and between 2.5 - 2.7, respectively. Similarly, *Hamburger*[13] shows a short-run interest elasticity of 0.07 for Germany. In a more recent study, *Boughton*[14] indicates elasticity values of 0.06 and 0.15 for the U.S. and Germany, respectively.

In looking at the interest rate-exchange rate nexus, it is particularly important to recognize the distinction between short-run and long-run relationships. In looking at long-run trend relationships, it seems quite likely that the major influence on average interest rate differentials will be the

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[11] For a comprehensive study of changes in the demand for money and the implied interest elasticity estimates for the U.S., see *Stephen M. Goldfeld,* "The Case of the Missing Money," Brookings Papers on Economic Activity, No. 3 (1973), pp. 683 - 730.

[12] For a similar money demand study, see *William Poole,* "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model," Quarterly Journal of Economics, Vol. LXXXIV, No. 2, (May 1979), pp. 197 - 216.

[13] Also, see *Michael Hamburger,* "The Demand for Money in an Open Economy: Germany and the United Kingdom," Journal of Monetary Economies, Vol. 3, No. 1 (Jan. 1977); pp. 25 - 40.

[14] A detailed analysis of structural shifts in the demand for money across countries is provided in *James Boughton,* "Demand for Money in Major OECD Countries," OECD Economic Outlook, Occasional Studies (January 1979).

different national rates of inflation. Thus we would expect that countries with high average levels of interest rates would suffer depreciating currencies as the monetary approach predicts. On the other hand, short-run changes in interest rates appear to be importantly influenced by both changes in inflationary expectations and real (liquidity) factors. Thus it is not surprising that we find little consistency in the estimated short-run relationships between interest rates and exchange rates.

In a recent study, *Frankel*[15] proposed to empirically differentiate between the real and inflationary effects of interest rates on exchange rates by using a single equation exchange rate model. The difficulty with Frankel's analysis for this purpose is that he employs the long-term interest rate as a proxy for the expected rate of inflation in determining exchange rate overshooting. Since overshooting is a short-run phenomena which is likely to arise as a result of changes in short-run rather than long-run interest rates in excess of changes in short-run inflation rates, one should employ proxies for the short-run expected rate of inflation rather than the long-run expected rate of inflation in the empirical exchange rate equation.

We believe that this is a major reason why *Frankel's* results did not hold up when applied to other countries and time periods. However, attempts by *Khan* to use various proxies of short-run inflationary expectations did not achieve very good results.[16] We are inclined to attribute this primarily to the difficulty of developing good proxies for inflationary expectations and the considerable noise in any short-run exchange rate equation, rather than as disconforming the basic importance of this point.

2. *Exchange Rate Overshooting*

These results do bring into question the generality of *Frankel's* finding of interest rate induced exchange rate overshooting in the $-DM case.[17]

His results are also not robust with respect to time periods and econometric estimation techniques.[18] A recent study by *Keran* and *Zeldes* also failed to find evidence of overshooting for the dollar against the DM and three other

[15] *Jeffrey Frankel,* "On the Mark: Reply," op. cit.

[16] *Waseem Khan,* "Interest Rates and Exchange Rates," Claremont Working Papers, February 1981.

[17] See *Jeffrey Frankel,* "On the Mark." *Frankel* concluded that a 12% per annum increase in the U.S. money supply which would cause inflationary expectations to rise by 1% would tend to induce the DM/$ exchange rate to overshoot its long-run equilibrium value by a factor of 1.58%.

[18] See *Aida Der Hovanessian,* Risk and the Foreign Exchange Market, op. cit., and *Waseem Khan,* The Monetary Approach, op. cit.

major currencies.[19] They did find evidence for overshooting in the dollar-Swiss franc rate as has a recent paper by *Driskill.*[20] Thus we conclude that while the evidence to date does not rule out the possibility that there has been some interest rate induced exchange rate overshooting, this has not represented a general tendency and hence is unlikely to be a major explanation of observed exchange-rate volatility.

3. *The Real Income Variable*

Another novel feature emphasized by the monetary approach is that the growth of real income would lead to an increase in the demand for money and cause currency appreciation, rather than the currency depreciation due to increased imports which was emphasized in traditional analysis. It should be noted that a domestic boom can also cause appreciation in Keynesian models, if induced capital inflows exceed the deterioration in the current account.

The empirical evidence surveyed in Table 1 indicates that most of the coefficient estimates on the real income variable are quite unstable in magnitude and significance. However, they tend to maintain their correct sign for the monetary approach in a large majority of cases. More mixed results are found in the recent empirical work by *Harnack.*[21] He fails to detect a strong systematic tendency for exchange rates to either appreciate or depreciate.

Several reasons for the poor results on income variables have been noted in the literature. Again there may be differences between cyclical and secular relationships. Furthermore, *John Makin*[22] has argued that the income elasticity of money demand during the 1970s was considerably higher in Germany than that in the U.S., so that the possibility that a real income induced dollar appreciation at times was being significantly offset by a real income induced mark appreciation cannot be excluded. It is quite possible that this result could be reflected in an incorrect sign on the estimated real income coefficients.

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[19] See *Michael Keran* and *Stephen Zeldes,* "Effects of Monetary Disturbances on Exchange Rates, Inflation and Interest Rates," Economic Review of the Federal Reserve Bank of San Francisco (Spring 1980), pp. 7 - 29.

[20] *Robert Driskill,* "Exchange Rate Dynamics: An Empirical Investigation," Journal of Political Economy, Vol. 89, No. 2 (April 1981), pp. 357 - 371. *Driskill* concluded that the exchange rate overshoots its equilibrium value by a factor of two in the same quarter following the monetary expansion.

[21] *Joachim Harnack,* Floating Experience: Exchange Rate Determinats and Real Effects, Claremont Graduate School, 1982 (unpublished Ph. D. dissertation).

[22] See *John H. Makin,* "Exchange Rate Behavior Under Full Monetary Equilibrium."

Another point concerns the tendency to use only income differentials which constrains the income elasticities to be equal in both countries. If the two elasticities are not equal, and in fact as recent research shows that most of the time they are not,[23] the estimated coefficients will be biased – the direction of the bias depending upon the difference between the actual elasticities and the magnitude of the bias depending upon the difference between the actual and assumed elasticities.

4. *The Money Supply Variables and Stability of the Demand for Money*

In the monetary approach the exchange rate is defined as the relative price of two moneys. Thus the supply and demand for these moneys determines the equilibrium exchange rate. In the monetary exchange rate equation, changes in the money supply variables are assumed to generate proportionate changes in the exchange rate. Econometrically, this implies that the relative money supply coefficient is positive and significantly close to unity.

An examination of the empirical work in Table 1 indicates that while the money supply coefficients on the whole have behaved fairly closely to their hypothesized characteristics of being positive and significantly close to unity, the occasionally incorrect (negative) sign and statistical insignificance of some of the estimated coefficients substantially reduces their stability and robustness.

One of the likely causes of some of these difficulties are instabilities in the demand for money. There have been some notable shifts in demand for money functions in recent years, especially for $M1$ demand in the United States which has been used in many of the monetary approach equations.[24] There can be little question that recent financial innovations have generated a need for very careful attention to the aggregates used for both domestic and international monetary analysis.[25]

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[23] See, for example, *James Boughton,* "Demand for Money in Major OECD Countries," and *James Rasul* and *D. Sykes Wilford,* "Estimating Monetary Models of the Balance of Payments and Exchange Rates: A Bias," Southern Economic Journal, Vol. 47, No. 1 (July 1980), pp. 136 - 146.

[24] See, for example, *Boughton,* "Demand for Money," and references cited there. More recent research in this respect, in particular for the U.S. and German money demand functions that are quite commonly used in the empirical literature, shows that during the past decade the M 1 measure on the average has been significantly unstable when compared to the broader definitions of money demand. For details see *Aida Der Hovanessian,* "Risk and the Foreign Exchange Market."

[25] As *Michael Mussa* has pointed out, the definition of money which proves best for exchange rate analysis need not be the same as that which proves best for domestic analysis. He argues that it may be, for instance, that interest bearing

Recognizing the problems that velocity may increase over time because of financial innovations, *John Bilson* introduced a quadratic function of time as an additional explanatory variable in the exchange rate equation.[26] Econometrically, the technique is not very appealing for the time trend variable is not a good measure of why people demand different quantities of a currency or currencies at different times, and as an additional explanatory variable it has the tendency to adversely affect the estimated coefficients of other explanatory variables.

Recent attention has also been given to the potential importance of international shifts in the demand for money which would of course complicate the monetary approach analysis.

Moreover, as *Brittain*[27] has recently shown, relatively high levels of U.S. *M*1 velocity during the 1970s which induced shifts out of dollars and into marks in peoples' currency portfolios, preceeded successive dollar depreciations against the German currency. This evidence suggests that changes in the income velocity of money tend to carry strong implications for changes in the currency's external value.

III. Concluding Remarks

Our survey of the empirical evidence on the empirical studies of the monetary approach to exchange rates, suggests that as with domestic analysis, the statement that "money matters" has much more validity than its converse that "money doesn't matter". We also find strong evidence, however, against the proposition that "only money matters".[28] Again as

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deposits held by large corporations are of far more importance in determining the exchange rate rather than the currency and demand deposits held by the general public. *Michael Mussa,* "Empirical Regularities in the Behavior of Exchange Rates," p. 46.

[26] See *John Bilson,* "The Deutsche Mark/Dollar Rate," in *Karl Brunner* and *Allan Meltzer* (eds.), Policies for Employment, Prices and Exchange Rates (Carnegie-Rochester Conference Series in Public Policy, Vol. 11; Amsterdam, North Holland, 1979), pp. 59 - 99.

[27] *Bruce Brittain,* "International Currency Substitution and the Apparent Instability of Velocity in Some Western European Economies and the United States," Journal of Money, Credit, and Banking, Vol. 13, No. 2 (May 1981), pp. 135 - 155. See also *Roland Vaubel,* "West Germany's and Switzerland's Experience With Exchange Rate Flexibility," in *Jacob Dreyer, Gottfried Haberler,* and *Thomas D. Willett* (eds.), International Monetary Systems Under Stress (Washington, D.C.: American Enterprise Institute, 1982).

[28] Further negative results on the short-run predictive power of the monetary approach has been presented in the recent paper by *Richard Meese* and *Kenneth Rogoff,* "Empirical Exchange Rate Models of the Seventies: Are Any Fit to Survive?"

with the operation of domestic economies, we believe that the simple monetary approach becomes a closer approximation to reality, the longer is the time period in question. The failure to find highly robust short-run monetarist relationship for exchange rates does not undercut the importance of these propositions as guides for longer-term analysis, any more than the strong empirical content of these models with respect to longer-term trends assumes that these factors will dominate short-run relationships. The evidence is abundant that we face frequently real shocks in the foreign exchange market, and that equilibrium real exchange rates can change a great deal. Over the longer-run, however, a much greater proportion of the cummulative shocks which cause substantial upward or downward movements of exchange rates are likely to be monetary rather than real.

International Finance Discussion Paper No. 184 (June 1981). The authors discover that a random walk model explains better the recent experience with exchange rates and at the same time predicts better future exchange rates than any existing structural or time series model.

Table 1: **A Comparison of the Results of Various Monetary Exchange Rate Models**

Model	Const. Expected Signs	$\ln(m/m^*)$ +	$\ln(y/y^*)$ −	$(r-r^*)$ + M − K	$(\pi-\pi^*)$ +	T	T^2
1. Bilson (1978a) DM/£ rate 4/70 - 5/77	−1.3280			1.3853*[a] (2.792)		−0.0049* (−3.247)	
2. Bilson (1978b) DM/£ 1/72 - 4/76	−0.0136			0.0228[a] (0.016)			
3. Bilson (1979b) DM/$ 1/63 - 9/78	0.9285* (1.97)	$\sum_{i=1}^{13}$ 1.0269[i] (1.42)	$\sum_{i=1}^{13}$ −2.4749* (4.15)	$\sum_{i=1}^{13}$ 26.241*[a] (2.93)		−0.0025 −(0.22)	−0.001* −(2.12)
4. Khan DM/$ 1/74 - 12/79	−2.599 −(0.279)	−0.0035 −(0.022)	−0.2525 −(0.976)	−0.4067* −(6.466)		0.0003 (0.158)	−0.00002 (0.667)
5. Dornbusch (1978) DM/$ 3/74 - 5/78	1.24* (13.77)	1.00	−0.38 −(1.90)	0.14 (0.09)	9.12*[b] (2.08)		
6. Frankel (1979) DM/$ 7/74 - 2/78	1.39* (11.58)	0.97* (4.62)	−0.52* −(2.36)	−5.40* −(2.65)	29.40*[b] (8.83)		
7. Khan DM/$ 7/74 - 2/78	−3.37* −(16.85)	0.48 (1.66)	−0.413* −(2.46)	−0.451 −(0.48)	4.412[b] (1.12)		
8. Khan DM/$ 1/74 - 12/79	−11.5 −(1.03)	0.019 −(2.87)	−0.281 −(1.77)	0.623 (0.92)	0.059[b] (0.02)		
9. Frankel (1981) DM/$ 1/74 - 12/80	3.283* (3.22)	−0.770* −(2.87)		−0.698* −(2.13)			

Table 1 (continued)

Model	ln m +	ln m^* −	ln y −	ln y^* +	ln $(l + r)$ + M − K	ln $(l + r^*)$ − M + K	ln (π) +	ln (π^*) +
1. Bilson (1978a) DM/£ rate 4/70 - 5/77	1.0026*[g] (6.259)	− 0.9846*[h] (− 6.258)	− 0.9009* − (3.341)	1.0183* (3.623)				
2. Bilson (1978b) DM/£ 1/72 - 4/76	1.0013[g] (0.070)	− 1.0081[h] − (0.065)	− 1.0184 − (0.283)	0.9990 (0.308)				
3. Bilson (1979b) DM/$ 1/63 - 9/78								
4. Khan DM/$ 1/74 - 12/79								
5. Dornbusch (1978) DM/$ 3/74 - 5/78								
6. Frankel (1979) DM/$ 7/74 - 2/78								
7. Khan DM/$ 7/74 - 2/78								
8. Khan DM/$ 1/74 - 12/79								
9. Frankel (1981) DM/$ 1/74 - 12/80			− 0.382 − (1.411)	− 0.199 − (0.83)			3.485*[c] (2.940)	− 3.444*[c] (6.390)

Table 1 (continued)

Model	Const. Expected Signs	$\ln (m/m^*)$ +	$\ln (y/y^*)$ −	$(r - r^*)$ + M − K	$(\pi - \pi^*)$ +	T	T^2
10. Khan DM/$ 1/74 - 12/80	−40.06 −(2.207)	0.0766 (0.452)		−0.0498 −(0.250)			
11. Khan DM/$ 1/74 - 12/79	0.5963 (4.407)	−0.010 −(0.759)	0.1013 (0.4022)	−0.1410 −(0.8403)	−0.1369[c] −(0.8136)		
12. Hodrick (1978) $/£ 7/72 - 6/75	1.74* (4.97)	0.27* (2.70)	−0.66* −(4.40)	1.00* (2.94)			
13. Hodrick (1978) $/DM 4/73 - 9/75	7.85* (2.59)						
14. Kohlhagen (1979) DM/$ 3/73 - 12/75	5.866* (3.524)	0.663* (3.03)	1.611* (4.75)	−0.715*[a] −(2.608)	1.068*[d] (3.10)		
15. Driskill (1980) Swiss Fr./$ 73 - 77		2.37*[g] (5.73)			0.93*[e] (2.23)		
16. Keran & Zeldes (1980) DM/$ 1/75 - 12/78		3.09*[f] (2.37)					
17. Caves & Feige (1980) Can. $/U.S. $ 1970 - 1974		$\sum_{i=1}^{6}$ −0.632					

Table 1 (continued)

Model	ln m +	ln m^* −	ln y −	ln y^* +	ln $(l + r)$ + M − K	ln $(l + r^*)$ − M + K	ln (π) +	ln (π^*) +
10. Khan DM/$ 1/74 - 12/80			− 0.0581 − (0.375)	0.648* (2.541)			6.729[c] (0.631)	− 3.623[c] − (0.450)
11. Khan DM/$ 1/74 - 12/79								
12. Hodrick (1978) $/£ 7/72 - 6/75					1.93* (4.83)	− 0.83 − (1.73)		
13. Hodrick (1978) $/DM 4/73 - 9/75	1.52* (2.97)	− 1.39* − (2.47)	− 2.23* − (4.89)	0.073 (0.19)	2.53* (2.16)	1.93* (2.88)		
14. Kohlhagen (1979) DM/$ 3/73 - 12/75								
15. Driskill (1980) Swiss Fr./$ 73 - 77								
16. Keran & Zeldes (1980) DM/$ 1/75 - 12/78								
17. Caves & Feige (1980) Can. $/U.S. $ 1970 - 1974								

Table 1 (continued)

Notes:

t-statistics are in parentheses.
An asterisk on each variable represents a foreign country variable.
An asterisk on each figure indicates statistical significance at the 5 % level.

a: Forward premium is substituted for the interest differential.
b: Inflationary expectations are proxied by long term government bond yields.
c: Inflationary expectations are proxied by a twelve month moving average of CPI inflation.
d: The ratio of domestic to foreign wholesale price index is used.
e: The ratio of domestic to foreign consumer price index is used.
f: Logarithmic change in excess money supply regressed over logarithmic change in the exchange rate.
g: The German *M* 3 measure of money supply is used.
h: The British *M* 2 measure of money supply is used.
i: Money plus Quasi-money, lines 34 and 35 of the IMF's International Financial Statistics tape.

The index of industrial production to proxy real income and short-term interest rates are used in all studies.

The estimated equations in Table 1 refer to:

(1) *John Bilson,* "The Monetary Approach to the Exchange Rate: Some Empirical Evidence," I.M.F. Staff Papers, Vol. 25, No. 1 (March 1978), pp. 48 - 75.

(2) —, "Rational Expectations and the Exchange Rate," Ch. 5 in The Economics of Exchange Rates: Selected Studies, *Jacob A. Frenkel* and *Harry G. Johnson* (eds.), (Reading, Massachusetts, 1978), pp. 75 - 96.

(3) —, "The Deutsche Mark/Dollar Rate," in Policies for Employment Prices and Exchange Rates, *Karl Brunner* and *Allan Meltzer* (eds.), Carnegie-Rochester Conference Series in Public Policy, Vol. 11 (Amsterdam, North-Holland, 1979), pp. 59 - 99.

(4) *Waseem Khan,* "Tests of Alternative Monetary Models of the Exchange Rate," ch. 3 of The Monetary Approach to Exchange Rates: Theory and Empirical Evidence, unpublished Ph.D. thesis (Claremont, CA: Claremont Graduate School, 1981), pp. 32 - 55.

(5) *Rudiger Dornbusch,* "Monetary Policy under Exchange Rate Flexibility," in Managed Exchange Rate Flexibility, Conference Series No. 20 (Federal Reserve Bank of Boston, 1978), pp. 90 - 122.

(6) *Jeffrey Frankel,* "On the Mark: A Theory of Floating Exchange Rates based on Real Interest Differentials," American Economic Review, Vol. 69, No. 4 (September, 1979), pp. 610 - 621.

(7) and (8) *Waseem Khan,* "Interest Rates and Exchange Rates, Techniques and Methodology: A Critique and Some Evidence," Claremont Working Papers, Feb., 1981.

(9) *Jeffrey Frankel,* "On the Mark: Reply," American Economic Review, Vol. 71, No. 5 (December, 1981), pp. 1075 - 1082.

(10) and (11) *Waseem Khan,* The Monetary Approach to Exchange Rates: Theory and Empirical Evidence, unpublished Ph.D. Thesis (Claremont, CA: Claremont Graduate School, August, 1981).

(12) and (13) *Robert J. Hodrick,* "An Empirical Analysis of the Monetary Approach to the Determination of the Exchange Rate," Ch. 6 in The Economics of Exchange Rates: Selected Studies, *Jacob Frenkel* and *Harry G. Johnson* (eds.) (Reading, Massachusetts, 1978), pp. 97 - 116.

(14) *Steven W. Kohlhagen,* "The Identification of Destabilizing Foreign Exchange Speculation," Journal of International Economics, Vol. 9, No. 3 (August 1979), pp. 321 - 340.

(15) *Robert Driskill,* "Exchange Rate Dynamics: An Empirical Investigation," Journal of Political Economy, Vol. 89, No. 2, pp. 357 - 371.

(16) *Michael Keran* and *Stephen Zeldes,* "Effects of Monetary Disburbances on Exchange Rates, Inflation and Interest Rates," Economic Review of the Federal Reserve Bank of San Francisco (Spring, 1980), pp. 7 - 29.

(17) *D. W. Caves* and *E. L. Feige,* "Efficient Foreign Exchange Markets and the Monetary Approach to Exchange Rate Determination," American Economic Review, Vol. 70, No. 1 (March 1980), pp. 120 - 134.

Appendix A

Cross-Country Comparisons of Monetary Exchange Rate Models

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Introduction

During the initial stages of the monetary approach to the exchange rate, many investigators reported results that strongly supported the approach. However, in many cases the authors developed equations that aimed at capturing the behavior of a particular exchange rate but which were difficult to defend on theoretical grounds for the general case. The explanatory power of such equations might depend on, e.g., specific variables to capture the particular institutional setup, dummy variables, the time period selected, the data chosen to proxy the theoretical variables, or even the particular country chosen.

In order to throw some light on the relative explanatory power of the approaches developed in recent years to determine exchange rate behavior, the results for three basic equations which were tested against a common set of countries and over a common time period are presented.

* The views expressed represent the opinions of the authors and should not be interpreted as official views of the I.M.F.

Equations and Results

Each equation assumes a priori signs and magnitudes of its coefficients based on the theory behind each, which is indicated at the top of Tables 1 - 3. The equations were tested both bilaterally and multilaterally.[29] For bilateral testing, the foreign country was taken to be the most important testing partner of the country in question. For multilateral testing, weights were calculated for $n - 1$ countries based on their trade.[30]

The first two equations contain the relative income variable expressed as foreign over domestic income, which presents some notable features.[31] The R^2 statistics of these equations are high, ranging from .78 to .99, which seems to be primarily due to the relative income variable. The coefficient of this variable is in general near unity indicating that a monetarist framework (or a Keynesian framework with high capital mobility) is predominant: as domestic income increases relative to foreign income, i.e., as the ratio falls, the capital account improves faster than the current account deteriorates and the net gain in reserves appreciates the exchange rate. The results of the first equation show that the relative income is an important variable affecting the exchange rate. Its coefficient tends to unity, characteristic of a framework with high capital mobility. Relative prices also tend to unity, but their coefficients are negative, implying that as domestic prices rise relative to foreign prices, the exchange rate appreciates – which contradicts traditional theory. Finally, the interest rate differential influences the exchange rate only weakly. Its coefficients tend to be negative and close to zero.

The second equation, the standard monetary approach with relative money supplies substituting for relative prices, yields inconclusive results.[32] As mentioned before, the coefficient of the income variable supports the monetary approach, but the coefficient of the money variable does not. None of the coefficients is close to unity as called for by the theory; in fact, most are below .1. In the multilateral testing, the majority is even negative. The interest differential coefficients, however, support on the whole a monetarist relationship: an increase in domestic interest rates relative to those abroad depreciates the exchange rate. However, none of the coefficients is larger than .5 indicating that no overshooting occurs. Furthermore, the sign of the coefficient is different for different countries. The change in signs indicates that different relationships between interest and exchange rates exist in different countries: a negative sign indicates that the relationship is through the Keynesian

[29] For all equations, e_s and e_f are expressed as domestic currency units per unit of foreign currency. Furthermore, all coefficients are partial elasticities since the variables are expressed in logarithmic form.

[30] For a detailed description of this method, see *Joachim Harnack*, Floating Experience: Exchange Rate Determinants and Real Effects (unpublished Ph.D. dissertation, Claremont Graduate School, 1982), Ch. III, p. 10.

[31] Interpretation of the estimated coefficients requires caution as a positive sign here indicates support for the monetarist proposition that an increase in domestic income tends to appreciate the exchange rate via increasing the demand for domestic money. Alternatively a negative sign would indicate the Keynesian effects.

[32] Both this and the currency-substitution equation was tested with three different money measures, yielding only slightly different conclusions. Only the results with the narrowest money measure are presented here.

framework, indicating that the cause of the change in the nominal interest rates is in danger in the real interest rate, whereas a positive sign indicates that the relationship is through the monetary framework, with a change in inflationary expectations changing the nominal interest rates.

The currency substitution equation – identical to the standard monetary approach except that it omits the relative income variable – brings out better the explanatory power of the monetary and interest variables. By omitting the relative income variable, the R^2 statistics are significantly reduced, but the coefficients of the other two variables are increased. The money variable coefficients are quite significant and average .57 – much closer to unity than in the previous equation. But these results are still not statistically strong enough to support the monetary approach. The coefficients of the interest rate differential are still mainly positive, but are much more significant and larger than in the previous equation. The overall conclusion for this equation is that though it produces money variable coefficients that are higher than for the standard monetary approach, the relationship between money and the exchange rate is not strong enough to satisfy a priori expectations.

Summary and Conclusions

This appendix shows that although the results of many other studies strongly supported the monetary approach, the equations may not provide satisfactory results in the general case. To assure that the results from each equation are comparable, I use the same countries, time period, and data for each equation selected. The variable that emerges as the most significant and with the greatest explanatory power is the relative income variable. Its coefficients are overwhelmingly significant at the 99% level are near unity, and procedure R^2 statistics generally at .9 or above. However, this variable seems to distort the coefficients of the other variable present. Removing relative income, as in the currency substitution equation, yields coefficients closer to unity and more significant. On the whole, the signs of the coefficients show the predominance of the monetary framework. But the coefficient of the variable most crucial to the monetary approach, the relative money supply, proved mainly insignificant and much below the expected value of unity.

Table 1

Results of Equation 1

Equation: $\ln e_s = \alpha_0 + \alpha_1 \ln \left(\frac{y^{f,r}}{y^{d,r}}\right) + \alpha_2 (i^d - i^f) + \alpha_3 \ln \pi$

Expected sign: $\begin{matrix} -K \\ +M \end{matrix}$ $\begin{matrix} -K \\ +M \end{matrix}$ $+$

Country	(y^{fv}/y^{dv})	$(i^d - i^f)$	$\pi = \frac{Pd}{Pf}$	Durbin-Watson	Adjusted R^2
		A. Bilateral Results			
Canada	.669 (9.41)++	−.352 (1.43)	−.301 (.80)	1.72	.986
France	.945 (41.70)++	.474 (6.93)++	.014 (0.51)	2.31	.997
Germany	.945 (41.70)++	.474 (6.93)++	.014 (.51)	2.31	.997
Italy	1.064 (15.77)++	.185 (1.27)	−.176 (1.70)	1.78	.998
Japan	.928 (24.31)++	−.067 (.35)	.289 (3.87)++	1.79	.996
Netherlands	.700 (12.52)++	.031 (.73)	.081 (2.40)+	2.29	.929
Switzerland	−.022 (.24)	−.275 (.49)	−.243 (.29)	1.69	.868
United Kingdom	.638 (6.74)++	.842 (2.85)++	.219 (1.99)+	1.91	.970
United States					
		B. Multilateral Results			
Canada	.927 (9.14)++	−.034 (1.25)	.230 (.40)	1.30	.980
France	.593 (12.75)++	−.069 (4.96)++	−.164 (1.12)	2.30	.969
Germany	.759 (14.28)++	−.034 (.24)	−.497 (3.59)++	1.76	.908
Italy	.438 (8.22)++	−.026 (.35)	−.667 (7.38)++	1.43	.987
Japan	.884 (13.77)++	.008 (.28)	.110 (.62)	1.63	.986
Netherlands	.553 (6.41)++	−.004 (.98)	−.442 (1.30)	1.71	.976
Switzerland	.926 (17.33)++	−.082 (.38)	−.371 (1.97)	1.08	.934
United Kingdom	.382 (3.89)++	.085 (2.70)+	−.652 (5.39)++	1.87	.977
United States	.591 (9.97)++	−.010 (.38)	−.793 (9.92)++	1.63	.986

t-statistics in parentheses; + = significant at the 90 % level,
++ = significant at the 99 % level.

* *M* indicates expected monetarist sign.
K indicates expected Keynesian sign.

Table 2

Results of Equation 2

Equation: $\ln e = \alpha_0 + \alpha_1 \ln (Y^{r,f}/Y^{r,d}) + \alpha_2 \ln (M1^d/M1^f) + \alpha_3 (i^d - i^f)$

Expected Signs: $\begin{matrix} -K \\ +M \end{matrix}$ $\quad + \quad$ $\begin{matrix} -K \\ +M \end{matrix}$

Period: 1973 I to 1979 II

Country	$(Y^{r,f}/Y^{r,d})$	(Mi^d/Mi^f)	$(i^d - i^f)$	Durbin-Watson	Adjusted R^2
		A. Bilateral Results			
Canada	.683 (11.43)++	.051 (1.51)	.169 (.96)	2.09	.889
France	.881 (25.71)++	.135 (3.54)++	.063 (.74)	2.35	.988
Germany	.866 (24.57)++	.117 (3.50)++	.106 (1.53)	2.45	.989
Italy	.927 (39.96)++	.011 (.31)	.125 (1.66)	1.23	.992
Japan	.854 (10.64)++	.121 (1.80)+	−.040 (.25)	1.55	.957
Netherlands	.904 (21.18)++	.019 (.68)	.002 (.04)	1.17	.975
Switzerland	.917 (12.20)++	.022 (.41)	−.005 (.04)	1.7	.963
United Kingdom	.706 (10.77)++	.076 (1.51)	.239 (1.46)	1.75	.925
United States	.297 (11.43)++	.022 (1.51)	.074 (.96)	2.09	.889
		B. Multilateral Results			
Canada	.848 (10.79)++	.065 (1.19)	.084 (.33)	1.67	.883
France	.762 (12.63)++	.181 (3.08)++	.037 (.21)	1.66	.946
Germany	.703 (8.38)++	.021 (.23)	.116 (.78)	1.17	.881
Italy	.909 (56.20)++	−.139 (2.63)+	.325 (3.21)++	1.31	.995
Japan	.763 (5.29)++	.134 (1.24)	−.096 (.31)	1.42	.920
Netherlands	.619 (8.59)++	.005 (.17)	−.012 (.18)	1.41	.783
Switzerland	.852 (11.82)++	.075 (1.57)	−.146 (.69)	1.30	.935
United Kingdom	.806 (27.30)++	−.023 (.49)	.197 (.98)	1.71	.975
United States	1.018 (11.61)++	−.254 (6.43)++	.192 (1.21)	1.84	.950

t-statistics in parentheses; + = significant at the 90 % level;
++ = significant at the 99 % level.

Table 3

Results of Equation 3

Equation: $\ln e = \alpha_0 + \alpha_2 \ln (M\,1^d/M\,1^f) + \alpha_3 (i^d - i^f)$

Expected Signs $+$ $+ M$ $- K$

Period: 1973 I to 1979 II

Country	$(M\,1^d/M\,1^f)$	$(i^d - i^f)$	Durbin-Watson	Adjusted R^2
		A. Bilateral Results		
Canada	.187 (3.00)++	−.654 (1.77)	1.15	.281 (.718)
France	.920 (6.85)++	.222 (.69)	1.90	.767 (7.66)
Germany	.956 (13.13)++	.153 (.51)	1.93	.902 (.901)
Italy	.574 (4.32)++	.013 (.05)	1.34	.519 (.725)
Japan	.683 (7.49)++	.543 (1.44)	1.60	.779 (.868)
Netherlands	.437 (4.58)++	−.756 (3.28)++	1.53	.467 (.511)
Switzerland	.617 (7.86)++	−.356 (.86)	2.08	.714 (.981)
United Kingdom	.447 (5.05)++	.289 (.79)	2.01	.607 (.584)
United States	.081 (3.00)++	−.284 (1.77)	1.15	.281 (.718)
		B. Multilateral Results		
Canada	1.095 (14.28)++	.837 (3.84)++	2.21	.898
France	.543 (3.76)++	.608 (1.21)	2.06	.551
Germany	.637 (5.31)++	−.147 (.49)	1.48	.524
Italy	.498 (3.11)++	.305 (1.06)	1.28	.503
Japan	.629 (7.35)++	.424 (.98)	1.69	.796
Netherlands	.082 (1.55)	−.228 (1.82)+	1.97	.064
Switzerland	.490 (5.45)++	−.191 (.33)	2.20	.537
United Kingdom	.356 (4.28)++	.463 (1.28)	1.36	.582
United States	.516 (5.89)++	.228 (.57)	1.85	.617

t-statistics in parentheses; + = significant at the 90 % level;
++ = significant at the 99 % level.

Zusammenfassung

Der monetäre Ansatz der Wechselkurse: Ein Überblick über neuere empirische Untersuchungen

Während des vergangenen Jahrzehnts hat sich ein sehr starkes Interesse für den monetären Ansatz der Erklärung von Zahlungsbilanz und Wechselkursen entwickelt. Seit der Einführung flexibler Wechselkurse sind eine Reihe empirischer Untersuchungen über die monetäre Erklärung der Wechselkurse erarbeitet worden. Die meisten Untersuchungen der ersten Generation berichteten Ergebnisse, die den monetären Ansatz mit seiner „neuen" Hypothese begünstigten, daß hohe Zinssätze eher mit schwachen als mit starken Währungen zusammengehen und daß schnelles Wirtschaftswachstum häufiger mit Aufwertung als mit Abwertung verbunden ist. Neuere Forschung liefert allerdings weniger günstige Evidenz. Dieser Aufsatz bespricht kritisch empirische Arbeiten, die den monetären Ansatz verwenden und legt außerdem neue empirische Evidenz vor. Wir kommen zu dem Ergebnis, daß, obwohl das einfache Modell des monetären Ansatzes die Daten einiger Länder für einige Perioden ganz gut beschreibt, diese Beziehungen nicht systematisch gelten, weder für alle Länder noch für alle Perioden. Abgesehen von einigen technischen Fragen ökonometrischer Schätzung und der Modellspezifikation betonen wir, daß bei der Anwendung des monetären Ansatzes zwischen der kurzen und der langen Frist unterschieden werden muß. Wie bei makroökonomischen Modellen für geschlossene Volkswirtschaften scheinen die monetären Wechselkursmodelle große Aussagekraft im Hinblick auf längerfristige Trends zu haben, aber das Wirken realer Faktoren verringert ihre Aussagekraft für die kürzerfristige Analyse erheblich.

Summary

The Monetary Approach to Exchange Rates: A Review of Recent Empirical Studies

There has been tremendous interest over the past decade in the monetary approach to the balance of payments and exchange rates. Since the adoption of flexible exchange rates, a number of empirical studies of the monetary approach to exchange rates have been undertaken. Most of the first generation of the studies reported results favorable to the monetary approach with its "new" hypothesis that high interest rates would be associated with weak rather than strong currencies, and more rapid economic growth would be associated with appreciation rather than depreciation. Later research provides much less support, however. This paper critically reviews the published empirical studies applying the monetary approach and presents new empirical evidence. We conclude that while the simple monetary approach model fits the data quite well for some countries over some times periods, these relationships do not hold up systematically across countries and over time. In addition to a number of technical issues of econometric estimation and model specifications, we emphasize the need to distinquish between short-run and longer-run applications of the monetary approach. As with domestic macro models, the monetary exchange rate models appear to have a great deal of explanatory power with respect to longer-run trends, but the operation of real factors substantially reduces their explanatory power for short-run analysis.

Résumé

L'approche monétaire du taux de change: un compte-rendu des études empiriques récentes

Un intérêt énorme a été porté au cours des dernières dix années à l'approche monétaire de la balance des paiements et des taux de change. Une série d'études empiriques de l'approche monétaire des taux de change ont été entreprises depuis l'adoption des taux de change flexibles. La plupart des études de la première génération rapportèrent des résultats favorables à l'approche monétaire. Celle-ci contenait la «nouvelle» hypothèse que des taux d'intérêts élevés sont associés à de faibles plutôt qu'à de fortes monnaies et qu'une croissance économique plus rapide est associée à une appréciation plutôt qu'à une dépréciation. La dernière recherche est cependant moins soutenue. Cet article passe en revue de manière critique les études empiriques publiées sur l'approche monétaire et présente une nouvelle évidence empirique. Nous tirons la conclusion suivante: si le modèle simple de l'approche monétaire s'adapte assez bien aux données pour certains pays au cours de certaines périodes, ces relations ne valent pas systématiquement pour tous les pays et à n'importe quelle période de temps. En plus d'une série de résultats techniques d'estimation économétrique et de spécifications de modèle, nous soulignons la nécessite de distinguer les applications à court-terme et à long-terme de l'approche monétaire. Comme pour les macro-modèles nationaux, les modèles monétaires de taux de change paraissent avoir beaucoup de pouvoir explicatif en ce qui concerne les trends à long-terme. Mais, l'opération des facteurs réels perd considérablement de son pouvoir explicatif pour l'analyse de court-terme.