

ABSTRACT

This paper tests the hypothesis advanced particularly by McKinnon that the U.S. economy is strongly affected by the world supply of money and the U.S.-effective exchange rate while the domestic money supply is of minor importance. This currency substitution hypothesis is tested using monthly data for the floating exchange rate period 1971 - 1989. The empirical results give strong support to McKinnon's hypothesis.

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MCKINNON'S CURRENCY SUBSTITUTION HYPOTHESIS:  
SOME NEW EVIDENCE

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#### REFERENCES

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make this closed-economy view cur idea of monetary autonomy less obvious. Thus, it is not surprising that there have recently appeared several empirical analyses which try to assess the importance of foreign impulses. One way of explaining the growing importance of these impulses is to refer to the possibility of currency substitution (CS), which means that domestic residents hold foreign as well as domestic money balances. Specifically, multinational and investment corporations maintain money balances denominated in more than one currency. By doing so, they can arbitrage interest rate differentials and fluctuations in currency rates and thus reduce the financing costs associated with worldwide operations. In the case of high-inflation or hyperinflation countries/periods, foreign currency holding is probably also motivated by the need to have some asset which performs the traditional roles of money. Some authors, for instance Brittain (1981), have claimed that currency substitution can explain the apparent instability of velocity in a number of industrial countries. McKinnon (1982, p. 324) goes even further in arguing that "in general, growth in the world money supply is a better predictor of American price inflation than is U.S. money growth".

Still, there is no wide agreement on the empirical relevance of currency substitution. Thus, for instance, Joiner (1987) questions the practical importance of Brittain's (1981) findings. Coddington (1981), in turn, claims that it is of limited importance in macro modelling, but might have some implications for the estimation of money demand functions. The importance of currency substitution for the estimation of money demand functions, and more generally for monetary policy, has

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## 1 INTRODUCTION

Until recently it has been considered self-evident that nominal GNP and prices in the United States are mainly determined by domestic variables such as the money supply, the fiscal deficit etc. The proposition that foreign variables, including exchange rates, might play a significant role in this respect has not been taken very seriously, and even though it has been admitted that these variables have some minor effects, it has been assumed that floating exchange rates secure monetary autonomy. The developments in the 1980s surely make this closed-economy view cum idea of monetary autonomy less obvious. Thus, it is not surprising that there have recently appeared several empirical analyses which try to assess the importance of foreign impulses. One way of explaining the growing importance of these impulses is to refer to the possibility of currency substitution (CS), which means that domestic residents hold foreign as well as domestic money balances. Specifically, multinationals and investment corporations maintain money balances denominated in more than one currency. By doing so, they can arbitrage interest rate differentials and fluctuations in currency rates and thus reduce the financing costs associated with worldwide operations. In the case of high-inflation or hyperinflation countries/periods, foreign currency holding is probably also motivated by the need to have some asset which performs the traditional roles of money. Some authors, for instance Brittain (1981), have claimed that currency substitution can explain the apparent instability of velocity in a number of industrial countries. McKinnon (1982, p. 324) goes even further in arguing that "in general, growth in the world money supply is a better predictor of American price inflation than is U.S. money growth".

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been stressed by several other authors, starting from Frenkel (1977) and more recently by, e.g., Miles (1978), Bordo and Choudri (1982), Ortiz (1983), Fasano-Filho (1986), Marquez (1987a,b) and Canto and Nickelsburg (1987). Even though empirical evidence in this respect is somewhat mixed, it may be fair to conclude that at least some evidence of currency substitution has been found in all empirical studies.

Clearly, McKinnon (1982), in proposing that currency substitution makes an appropriately defined world money supply rather than national money supplies relevant for studying both global and national inflation, puts forward the most far-reaching hypothesis. The interesting point is that he also provides some empirical evidence, both in the form of stylized facts and estimation results, which all suggest that the above-mentioned hypothesis is not completely unwarranted.

As far as the econometric evidence is concerned, McKinnon (1984) exploits some simple nominal income (change rate) and inflation regression equations. To be a little bit more precise, he regresses U.S. nominal GNP and the wholesale price index by the (current and lagged) U.S. money supply, or alternatively by the (current and lagged) U.S. money supply, the "world money supply" and the effective U.S. exchange rate. The equations were fitted to annual data covering the years 1958 - 1983, and the results clearly supported McKinnon's hypothesis. Thus, for example, the "closed-economy model" including only the U.S. money supply was clearly outperformed by an "open economy" equation for the period 1972 - 1983, but not for the earlier period 1958 - 1971. McKinnon's results were later challenged by Goldstein and Haynes (1984), who used quarterly data and somewhat different estimating specifications. In their regressions the U.S. money supply variable clearly outperformed the world money supply variable. Both McKinnon (1984) and Goldstein and Haynes used some a priori restrictions in terms of the data transformations and the lag structure, which (together with the data) may explain the differences in results. Unfortunately, there seems to be no obvious and rigorous way of testing McKinnon's CS hypothesis. Thus, one has probably to apply some VAR model specification or to use some other more informal testing procedure(s).

In essence, the present study contains another test for McKinnon's CS hypothesis. The basic differences between our test procedures and McKinnon's are the following: we use monthly data instead of annual data, concentrate solely on the floating exchange rate period 1973M5 - 1989M12, base the testing on unrestricted dynamic form (and thus, in the first place, impose no a priori lag structure on the equation to be estimated), and, finally, we do not compare separate equations but make use of the encompassing principle in testing non-nested models, as proposed by Mizon and Richard (1986), and specify a composite equation containing both domestic and foreign variables.

More specifically, we use the following unrestricted dynamic VAR form as the point of departure:<sup>1</sup>

$$(1) \quad \Delta X_t = a_0 + \sum_{i=1}^k a_i \Delta X_{t-i} + \sum_{i=1}^k b_i \Delta M_{t-i}^{US} + \sum_{i=1}^k c_i \Delta M_{t-i}^{MW} + \sum_{i=1}^k d_i \Delta EX_{t-i} + u_t,$$

where  $X = \{Y, P\}$ , i.e. the model is estimated both in terms of  $\Delta Y_t$  and  $\Delta P_t$ , where  $Y =$  U.S. nominal output,  $P =$  the U.S. producer price index,  $M^{US} =$  the U.S. money supply (either M1 or M2),  $M^{MW} =$  the (rest of the) world money supply,  $EX =$  the U.S. effective exchange rate and  $u$  is the stochastic error term (see section 2 for further details of the data).<sup>2</sup> McKinnon's hypothesis implies that  $\sum_i c_i > 0$  and  $\sum_i d_i < 0$ . An extreme version of the hypothesis suggests also that  $\forall b_i = 0$ .

## 2 THE DATA

The following variables are used in this study:  $Y =$  nominal output =  $I \cdot P$ , where  $I =$  industrial production (total manufacturing),  $P =$  the producer price index,  $M^{US} =$  the U.S. money supply,  $M^{MW} =$  the rest of the OECD money supply (both M1 and M2 concepts are used here) and  $EX =$  the effective exchange rate. The latter variable is measured by the IMF (MERM) effective exchange rate index. A positive value of  $\Delta EX$  reflects a dollar appreciation - and vice versa.<sup>3</sup>

Most of the basic data are taken from OECD Main Economic Indicators. The data for MERM are taken from IMF International Financial Statistics. Though the data are derived from original tapes, they have been carefully checked and corrected using national data sources.

### 3 ESTIMATION RESULTS

Let us now turn to the estimation results which are presented in Tables 1 and 2. Estimation has been carried out using both OLS and Huber's robust M-estimator (for details of this estimator see Huber (1981)). This is motivated by the fact that the data contain some observations which can almost be classified as outliers. This conclusion is also reinforced by the relatively high values of the Jarque-Bera normality test statistic. The lag length  $k$  was set to four on the basis of the Schwartz Bayesian information criterion.

Basically, the results can be easily summarized. Thus, the U.S. domestic money growth variable is clearly outperformed by the world money growth variable. Indeed, given the composite model (1) we cannot reject the hypothesis that the coefficients of  $M^U$  are identically equal to zero. Moreover, the respective coefficients are even negative in some cases (with M1 and P). The world money supply variable behaves in a completely different way: both the coefficient estimates and the respective standard deviations suggest that nominal U.S. output and (producer) prices are strongly affected by the global money supply: the respective coefficients can be estimated very precisely and are in all cases of correct sign and of reasonable magnitude.

As far as the exchange rate variable is concerned, one can conclude that, given both  $M^U$  and  $M^W$ , it has an independent, although in some cases marginal, negative effect on  $Y$  and  $P$ . Thus, a dollar appreciation decreases nominal output and prices.  $EX$  has a direct effect on these variables via imports and exports; however, it may also be that it signals changes in asset portfolios and can thus be interpreted as some sort of leading indicator (see e.g. McKinnon (1984) for further discussion of this point).

The only real caveat with the estimation results is parameter instability. If the Chow stability test statistic is computed in terms of the beginning of the EMS period, the null hypothesis of parameter stability is rather clearly rejected. However, a clear difference in the parameter estimates could not be found when equation (1) was estimated from the respective subperiods.

Table 1. Estimation Results of Equation (1)

Y or P	$M^U$	$M^W$	EX	SEE %	DW	LMI	J-B	Chow	data
.571 (0.00)	.060 (13.74)	.460 (0.11)	-.087 (7.90)	1.015	1.985	38.18	1.80	0.16	M1,Y
.510 (0.00)	.559 (23.59)	.306 (0.03)	-.111 (8.42)	1.012	1.982	27.43	12.34	0.12	M2,Y
.564 (0.00)	-.037 (42.04)	.104 (0.00)	-.025 (3.35)	.691	1.924	5.10	0.00	0.02	M1,P
.534 (0.00)	.335 (53.38)	.182 (0.00)	-.035 (5.55)	.673	1.985	34.66	0.00	0.08	M2,P
.623 (0.00)	.089 (78.16)	.514 (1.07)	-.078 (53.37)	1.030	1.977	-	0.00	0.03	M1,Y
.538 (0.00)	.346 (52.91)	.350 (0.08)	-.011 (21.13)	1.018	1.948	-	0.41	0.06	M2,Y
.611 (0.00)	-.045 (-)	.208 (0.01)	-.027 (-)	.720	2.230	0.00	0.00	0.00	M1,P
.589 (0.00)	.289 (-)	.217 (0.00)	.052 (52.82)	.684	2.175	0.00	0.00	0.01	M2,P

The dependent variable is either  $Y$  or  $P$ . The reported numbers for each explanatory variable are sums of the coefficient estimates; numbers in parentheses are the marginal significance levels (in percentage terms) of F-test statistics for the hypothesis that these coefficients are identically equal to zero. The first four rows are OLS estimates and the second four rows Huber's robust M-estimates. SEE = the standard error of estimate, DW = the Durbin-Watson autocorrelation test statistic, J-B = the Jarque-Bera test statistic for normality of residuals, LMI = Godfrey's test statistic for first-order autocorrelation and Chow is Chow's stability test statistic for the period 1979M3 (the beginning of the EMS). The reported numbers for LMI, J-B and Chow are the marginal significance levels. In the case of robust estimation all statistics could not be computed.

Table 2. Granger-causality Test Statistics

predicted	Y	M <sup>US</sup>	M <sup>W</sup>	EX	data
Y	17.49	1.77	4.80	2.13	M1,Y
M <sup>US</sup>	1.82	6.43	0.26	0.51	M1,Y
M <sup>W</sup>	0.58	1.31	2.66	1.59	M1,Y
EX	1.12	1.13	0.60	3.30	M1,Y
Y	16.51	1.40	5.63	2.09	M2,Y
M <sup>US</sup>	0.49	30.38	0.37	2.34	M2,Y
M <sup>W</sup>	2.08	0.41	3.75	0.54	M2,Y
EX	0.68	2.10	0.65	3.86	M2,Y
P	12.92	0.98	10.54	2.67	M1,P
M <sup>US</sup>	1.77	6.51	0.21	0.60	M1,P
M <sup>W</sup>	0.71	1.32	2.36	1.47	M1,P
EX	0.43	0.80	0.56	3.73	M1,P
P	13.38	0.79	14.23	2.36	M2,P
M <sup>US</sup>	0.16	31.15	0.32	2.19	M2,P
M <sup>W</sup>	2.41	0.46	4.81	0.34	M2,P
EX	0.54	2.21	0.67	3.93	M2,P

Reported numbers are F-test statistics for the four lagged terms of each variable. The corresponding critical values are:  $F_{.10} = 1.97$ ,  $F_{.05} = 2.40$  and  $F_{.01} = 3.41$ .

Next, we extend our analysis by scrutinizing the causality structure between the four variables included in equation (1). The corresponding F-statistics (for four lagged terms of the respective variable) are reported in Table 2. These statistics indicate that M<sup>W</sup> does indeed cause Y and P while the opposite is generally not true. Only in the case of broad money can some signs of bidirectional causation between M and Y, and M and P be detected. The U.S. money supply appears to be largely exogenous, although the possibility of bidirectional causality between M<sup>US</sup> and EX cannot be completely ruled out. All in all, the test results are strikingly unambiguous. They are clearly consistent with McKinnon's CS hypothesis and they cannot be easily explained by any other traditional hypothesis.

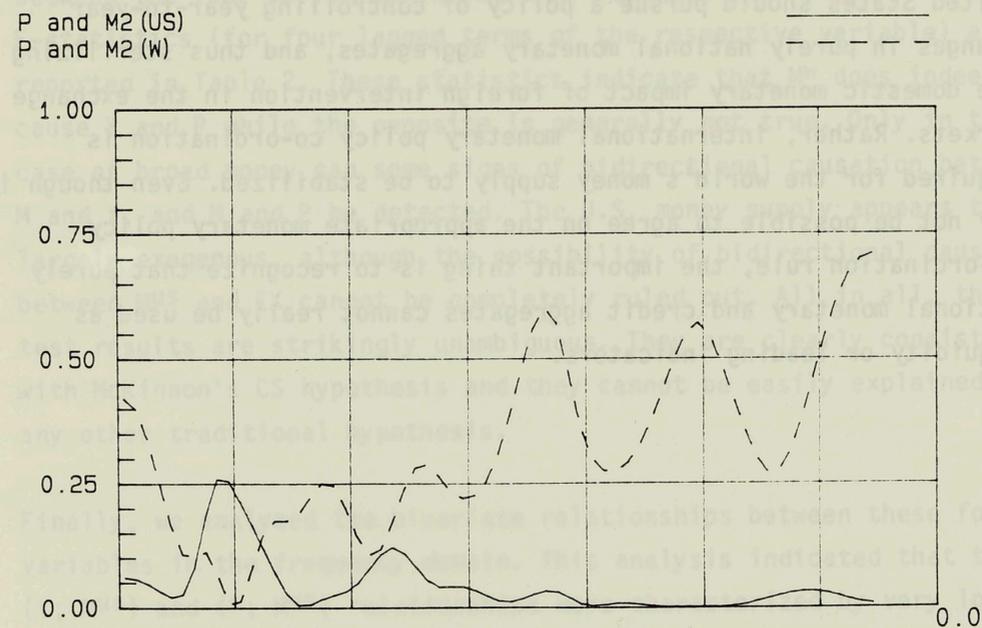
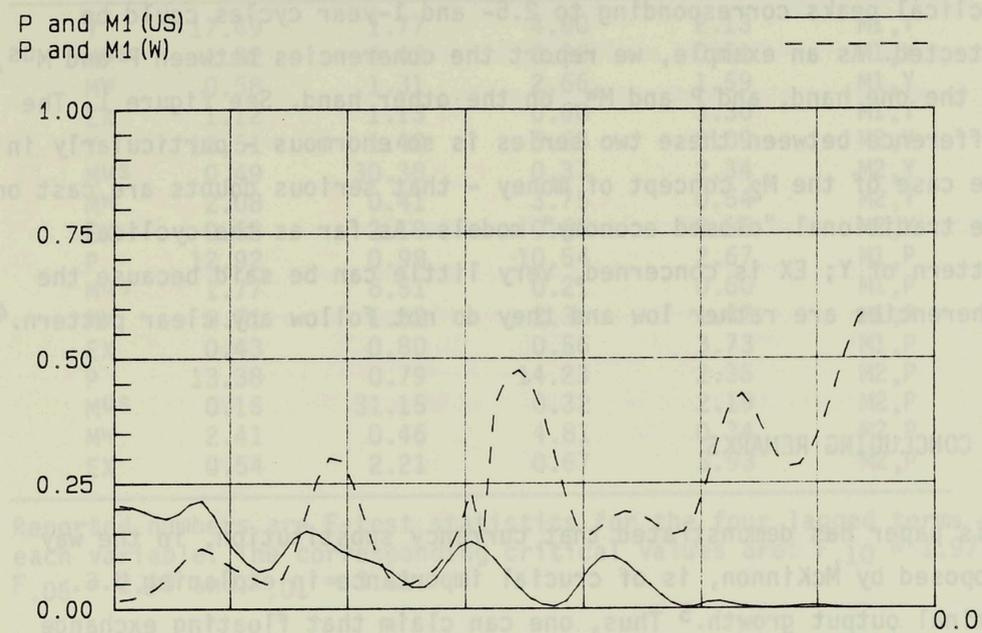
Finally, we analyzed the bivariate relationships between these four variables in the frequency domain. This analysis indicated that the (Y; M<sup>US</sup>) and (P; M<sup>US</sup>) relationships were characterized by very low coherencies for all frequencies - and in particular for high frequencies. In the case of (Y; M<sup>W</sup>) and (P; M<sup>W</sup>) the relationships were

completely different. Thus, the hypothesis that all coherencies are identically equal to zero could be rejected. This rejection was particularly clear with high frequency coherencies. Typically, cyclical peaks corresponding to 2.5- and 1-year cycles could be detected. As an example, we report the coherencies between P and M<sup>US</sup>, on the one hand, and P and M<sup>W</sup>, on the other hand. See figure 1. The difference between these two series is so enormous - particularly in the case of the M<sub>2</sub> concept of money - that serious doubts are cast on the traditional "closed economy" models. As far as the cyclical pattern of Y; EX is concerned, very little can be said because the coherencies are rather low and they do not follow any clear pattern.<sup>4</sup>

#### 4 CONCLUDING REMARKS

This paper has demonstrated that currency substitution, in the way proposed by McKinnon, is of crucial importance in explaining U.S. nominal output growth.<sup>5</sup> Thus, one can claim that floating exchange rates have not secured national monetary autonomy for all countries, not even for the United States. It is therefore hard to see that the United States should pursue a policy of controlling year-to-year changes in purely national monetary aggregates, and thus sterilizing the domestic monetary impact of foreign intervention in the exchange markets. Rather, international monetary policy co-ordination is required for the world's money supply to be stabilized. Even though it may not be possible to agree on the appropriate monetary policy co-ordination rule, the important thing is to recognize that purely national monetary and credit aggregates cannot really be used as liquidity or leading indicators.

FIGURE 1. Coherencies between P, M(US) and M(W)



## FOOTNOTES

- 1) Here we abstract from all problems of identifying the underlying structural model and defining the exact meaning of causation. See e.g. Jacobs et al. (1979) for more exact treatment of these problems. See also Pikkarainen and Virén (1989) for further discussion of interpreting the results from a model similar to (4). Before estimating the VAR model we analyzed the cointegration structure of the system using the standard two-step estimator. Practically no evidence of the existence of cointegrating vectors could be obtained, however.
- 2) We also introduced the domestic (ex post) real interest rate as an additional explanatory variable in (1) but dropped it because the explanatory power was extremely small.
- 3) We constructed an alternative proxy for EX by computing a weighted average effective exchange rate index (where the weights were relative GDP weights for 22 OECD countries in the same way as with MW). Results with this index were so close to those with the MERM index that they are not reported here (see Virén (1989) for details). Needless to say, a printout of the data and a detailed list of definitions and data sources are available upon request.
- 4) In testing the hypothesis of zero coherency the critical values (at the 5 and 10 per cent level of significance with the F distribution) would, given the Tukey-Hanning window of length 20, be  $\beta = .47$  and  $.42$ , respectively (see Koopmans (1974) for details of the test procedure). The data are expressed as first log. differences, the number of observations being 199.
- 5) The results for the United States were so impressive that we decided to apply the same framework for the European Community as well. Thus, we estimated equation (4) using monthly EC data for the EMS period 1979M3 - 1988M10. Specifically, the ECU/USD rate was used for EX. The results were to some extent analogous to those obtained for the United States. However, the relationships were generally weaker and the direction of causation could not be easily interpreted although the coefficients typically behaved according to McKinnon's hypothesis. For further details, see Virén (1989).

## REFERENCES

- BORDO, Michael and Esha CHOUDRI, "Currency Substitution and the Demand for Money: Some Evidence for Canada", *Journal of Money, Credit, and Banking*, 1982, 14: 48 - 57.
- BRITTAIN, Bruce, "International Currency Substitution and the Apparent Instability of Velocity in Some Western European Economies and in the United States", *Journal of Money, Credit, and Banking*, 1981, 13: 135 - 155.
- CANTO, V.A. and G. NICKELSBURG, "Currency Substitution: Theory and Evidence from Latin America", Kluwer Academic Publishers, Dordrecht, 1987.
- CUDDINGTON, John T., "Currency Substitution, Capital Mobility and Money Demand", *Journal of International Money and Finance*, 1983, 2: 112 - 133.
- FASANO-FILHO, Ugo, "Currency Substitution and the Demand for Money: the Argentine Case, 1960 - 1976", *Weltwirtschaftliches Archiv*, 1986, 122: 327 - 339.
- FRENKEL, Jacob, "The Forward Exchange Rate, Expectations, and the Demand for Money: The German Hyperinflation", *American Economic Review*, 1977, 67: 653 - 670.
- GOLDSTEIN, H.N. and S.E. HAYNES, "A Critical Appraisal of McKinnon's World Money Supply Hypothesis", *American Economic Review*, 1984: 74, 217 - 224.
- HUBER, Peter J., "Robust Statistics", Wiley, New York, 1981.
- JACOBS, Rodney; LEAMER, Edward E. and Michael P. WARD, "Difficulties with Testing for Causation", *Economic Inquiry*, 1979, 17: 401 - 413.
- JOINES, Douglas, "International Currency Substitution and the Income Velocity of Money", *Journal of International Money and Finance*, 1985, 4: 303 - 316.
- KOOPMANS, Lambert H., "The Spectral Analysis of Time Series", Academic Press, New York and London, 1974.
- MARQUEZ, Jaime, "Money Demand in Open Economies: A Divisia Application to the U.S. Case", in William A. BARNETT and Kenneth J. SINGLETON (eds.), *New Approaches to Monetary Economics*, Cambridge University Press, Cambridge, 1987a, 183 - 199.
- MARQUEZ, Jaime, "Money Demand in Open Economies. A Currency Substitution Model for Venezuela", *Journal of International Money and Finance*, 1987b, 6: 167 - 178.
- MCKINNON, Ronald I., "Currency Substitution and Instability in the World Dollar Standard", *American Economic Review*, 1982, 72: 320 - 333.

- MCKINNON, Ronald I., "An International Standard for Monetary Stabilization", Institute for International Economics, Washington D.C., 1984.
- MILES, Marc, "Currency Substitution, Flexible Exchange Rates, and Monetary Independence", *American Economic Review*, 1978, 68: 428 - 436.
- MIZON, Grayham and Jean-Francois RICHARD, "The Encompassing Principle and Its Application to Testing Non-Nested Hypotheses", *Econometrica*, 1986, 54: 657 - 678.
- ORTIZ, Guillermo, "Currency Substitution in Mexico", *Journal of Money, Credit, and Banking*, 1983, 15: 174 - 185.
- PIKKARAINEN, Pentti and Matti VIRÉN, "Granger Causality between Money, Output, Prices and Interest Rates: Some Cross-Country Evidence from the Period 1875 - 1984", *Weltwirtschaftliches Archiv*, 1989, 125: 74 - 82.
- VIRÉN, Matti, "How Does Domestic and Foreign Money Growth Affect the U.S. Economy?", Bank of Finland Discussion Papers 19/89, Helsinki, 1989.

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