

Briefing Notes in Economics

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Indexed with the Journal of Economic Literature

Issue No. 69, June/July 2006

<http://www.richmond.ac.uk/bne>

ISSN 0968-7017

Another Empirical Look at the Monetary Approach to Exchange-Rate Determination: The Case of G-7 Countries*

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This study tests the empirical validity of the monetary model of exchange-rate determination using quarterly data for the G-7 countries during the 1990s. Before estimating the empirical model, unit root and cointegration tests are conducted to diagnose the time series properties of the data. Since all the data series are found to be integrated of order one and the hypothesis of no cointegration is rejected, an error correction model is developed and estimated. The overall results lend only partial support to the monetary model of exchange-rate determination. **JEL: F30, F31.**

1. Introduction

The empirical validity of the monetary approach to the exchange rate has been a controversial issue for a long time. Empirical tests of the monetary model have produced dissimilar results depending on the time period under consideration as well as the currencies used. For example, empirical studies that have used 1920s data have produced results that support the validity of the theory (Frenkel (1976), Clements and

Frenkel (1980), Frenkel and Clements (1981), Ahking (1989)). On the other hand, studies based on data from the 1970s and 1980s such as those by Bilson (1978a, 1978b, 1979), Frenkel (1984), and Upadhyaya (1994) find mixed results on the validity of the monetary approach to exchange rate determination. MacDonald and Taylor (1994) tested the monetary model of the exchange rate between the sterling pound and the U.S. dollar utilizing a multivariate cointegration technique and

estimation of an error correction model. Their findings suggest that with an allowance made for complex short-run dynamics and with a careful interpretation, the monetary model still may be usefully applied.

With the exception of MacDonald and Taylor (1994) most of the studies mentioned above have used time series data without testing for their stationarity. With the help of recent developments in time series econometric analysis and recent data, this paper re-examines the empirical relevance of the monetary approach to exchange-rate determination by ensuring the stationarity of the data. Our empirical test involves data for the G-7 countries for the 1990s. In the next section, we explain the theoretical background and methodology. The estimation and empirical results are discussed in the following section. The final section reports the summary and conclusions.

2. Theoretical Background and Methodology

The monetary approach to exchange-rate determination emphasizes the fact that the foreign exchange market is a monetary phenomenon where monies are traded for monies. The monetary approach is a long run theory—it assumes prices adjust immediately to maintain full employment as well as purchasing power parity (exchange rates between two countries' currencies equal the ratio of the countries' price levels). It predicts that the exchange rate is fully determined in the long run by the relative money supplies and real money demands. Since money supplies are essentially controlled by central banks, the monetary approach emphasizes the

demand for money and its determinants. Changes in interest rates and output levels affect the exchange rate indirectly through their influence on money demand.

According to the monetary approach, the aggregate demand for money depends on the level of real income, prices and interest rates. As the economy grows and real income rises, the demand for money rises to finance rising transactions. If prices rise, the public will demand more money to cover economic transactions. Since the interest rate represents the opportunity cost of holding cash balances, lower interest rates induce people to hold more money. That is, when interest rates are low, people have less incentive to shift away from money balances, which pay no interest, to interest-bearing financial assets. It follows that as these determinants change in opposite directions, the demand for money decreases. The monetary approach emphasizes that under a system of market-determined exchange rates, movements in currency values play a primary role in restoring equilibrium between money demand and money supply. An increase in the money supply results in a depreciation of the exchange rate and conversely. An increase in money demand causes an appreciation of the exchange rate while a decrease in money demand does the opposite.

Based on the seminal paper by Frenkel (1976), which was later used by Clements and Frenkel (1980), Frenkel (1980), Woo (1985), and Ahking (1989), the following flexible-price monetary model is developed:

$$\log S = c + \log M - \log M^* + n^* \log Y^* - n \log Y + b(i - i^*) + u$$

where S is the spot exchange rate (home currency price of foreign currency), M denotes the domestic money supply, Y denotes domestic income, i stands for the long term domestic interest rate, u is the error term. The corresponding foreign variables are indicated by an asterisk (*).

The above equation makes a number of specific predictions regarding the long-run effects on the exchange rate of changes in money supplies, interest rates and output levels. Other things remaining constant, a permanent rise in the domestic money supply causes a proportional increase in the long-run domestic price level. Under purchasing power parity (PPP), the exchange rate rises in the long run in proportion to the increase in the money supply. Therefore, an increase in the domestic money supply causes a proportional long-run depreciation of the domestic currency. Conversely, a permanent increase in the foreign money supply causes a proportional increase in the foreign price level in the long run. Under PPP, this increase in the price level implies a proportional long-run appreciation of the domestic currency or a proportional depreciation of the foreign currency.

A rise in domestic output raises real domestic money demand and causes an excess demand for the domestic money stock. In order to increase their real money balances, domestic residents reduce their expenditures, which leads to a fall in the long-run domestic price level. According to PPP, this reduction in the price level causes an appreciation of the domestic currency. Similarly, a

rise in foreign output raises the real foreign demand for money and lowers the long-run foreign price level. As a result, PPP predicts that the domestic currency will depreciate.

Finally, a rise in the interest rate on domestic-currency-denominated assets lowers real domestic demand for money. The long-run domestic price level rises. Under PPP, the domestic currency must depreciate in proportion to the rise in the domestic price level. A rise in the interest rate on foreign-currency-denominated assets has the opposite long-run exchange rate effect. Since real foreign money demand falls, the foreign price level rises. Under PPP, the domestic currency must appreciate in proportion to the increase in the foreign price level.

Our analysis is based on quarterly data series for the G-7 countries. For Canada, the United Kingdom, France, Italy, Japan and the United States, we use data from the first quarter of 1991 to the fourth quarter of 1998. For Germany, we use data from the first quarter of 1992 to the fourth quarter of 1998. For the purpose of analysis, the United States is assumed to be the “foreign country.” Data for the G-7 countries have been obtained from various issues of the *International Financial Statistics* published by the International Monetary Fund.

3. Estimation and Empirical Results

Macroeconomic time series data are usually non-stationary (Nelson and Plosser, 1982). The use of non-stationary data produces spurious regression. Therefore, it is important to test the stationarity of the data series to

avoid spurious regression. To test the stationarity of the data, first an augmented Dickey-Fuller test (Nelson and Plosser, 1982) is conducted. This involves estimating the following regression and carrying out the unit root test:

$$\Delta X_t = \alpha + \rho t + \beta X_{t-i} + \sum_{i=1}^n \lambda_i \Delta X_{t-i} + \varepsilon_t$$

where X is the variable under consideration, Δ is the first difference operator, t is a time trend and ε is a random error term. If the null hypothesis that $\beta = 0$ is not rejected, the variable series contains a unit root and is non-stationary. The optimal lag length in the above equation is identified ensuring that the error term is a white noise. Second, in addition to the augmented Dickey-Fuller test, the Phillips-Perron test (Phillips, 1987; Phillips-Perron, 1988) is also conducted to ensure the stationarity of the data series. The Phillips-Perron test uses a non-parametric correction to deal with any correlation in error terms. The test results, reported in Table 1, indicate that all the data series are stationary in the first difference. Although the U.S. money supply ($\log M^*$) appears to be non-stationary in the first difference level with the standard unit root test (with constant and time trend), it is stationary when time trend and constant are not included in the test.

After establishing the stationarity of the data, Johansen's cointegration test (Johansen, 1988; Johansen and Juselius, 1990) is used to examine the long-run equilibrium relationship between the variables used in the model. This involves testing the cointegrating vectors. The test results are reported in

Table 2.

The cointegration test results in Table 2 suggest that the null hypothesis of no cointegration is rejected. Therefore, following Engle and Granger (1987), an error correction model is developed. This involves estimating the model in first difference form and adding an error correction term as another explanatory variable. The error correction representation of our first equation is as follows:

$$\Delta \log S = c + \Delta \log M - \Delta \log M^* + n * \Delta \log y^* - n \Delta \log y + b \Delta(i - i^*) + d EC_{-1}$$

The error correction term (EC_{-1}) in the above equation is the lagged values of the error terms that have been derived from our first equation. The estimated results of our third equation are reported in Table 3.

Although the estimations of our third equation seem fine in terms of the goodness of fit and the estimated F-values, the signs of the explanatory variables are not consistent across the G-7 countries. The coefficient of the domestic money supply carries an appropriate sign for the Canadian, Japanese, French and Italian foreign currency exchange rates, but is statistically significant only for the British pound and the French franc. The coefficient of the foreign money supply carries the right sign only for the Japanese yen and the British pound, and is statistically significant only for the Canadian dollar and the French franc. The coefficient of the foreign output carries the appropriate sign for the Canadian, Japanese, German and French currency exchange rates but is statistically significant only for the French franc. With regard to domestic

output, the coefficient carries the right sign only for the Canadian, French and German foreign currency exchange rates, and is statistically significant only for the Japanese yen. The coefficient of the interest rate differential carries the appropriate sign for the Canadian, British and French foreign currency exchange rates, and is statistically significant for the German, British and Italian foreign currency exchange rates. The error correction term carries the appropriate sign, which indicates that any deviation from equilibrium in the current period is corrected in the next period. We therefore conclude that while the signs of the coefficients of some variables are consistent with the monetary approach to the exchange rate, the overall results of our empirical analysis provide only limited support for the theory.

4. Summary and Conclusion

This paper has attempted to test the empirical validity of the monetary approach to the exchange rate using quarterly data for the G-7 countries during the 1990s. Unlike most past studies that have examined the empirical validity of the monetary approach, our analysis ensures the stationarity of the data series and uses more recent data. Before estimating the model, the time series properties of the data are diagnosed using unit root and cointegration tests. Since all the data series are found to be integrated of order one and the hypothesis of no cointegration is rejected, an error correction model is developed and estimated. The overall results of our estimation provide only partial support to the monetary approach.

The monetary approach assumes PPP—exchange rates between any two countries will adjust to reflect changes in the price levels of the two countries. However, in the long run, exchange rates are likely to be also affected by non-monetary factors such as trade policy, productivity and preferences for domestic versus foreign products. The exclusion of such factors may explain in part why the monetary model is unable to provide accurate predictions regarding exchange rates. In any event, there seems to be some support for the idea that when the most prominent changes are monetary in nature, empirical applications of the monetary approach to exchange rates may be more accurate and useful. That is, when the disturbances are primarily monetary in nature, exchange rates tend to be consistent with relative PPP in the long run.

It is also important to note that the period covered by our study was characterized by a financial crisis in several countries included in our study. In the aftermath of German reunification in 1990 and significant increase in interest rates by the Bundesbank to dampen inflation, several countries including France, Italy and the United Kingdom saw speculative attacks on their currencies. In September 1992, the European Monetary System (EMS) was rocked by an exchange rate crisis that compelled the U.K. to pull out of the EMS and cost central banks in member countries billions of dollars as they intervened in foreign exchange markets to prop up the EMS. A closer examination of the macroeconomic policies in the individual countries may provide additional insight and represents an area for future research.

Table 1: Unit Root Test

Country:	U.S.A.		Canada		Germany		U. K.		France		Italy		Japan	
Variable	ADF	PP												
log S	N/A		-4.80**	-6.09**	-3.39*	-4.58**	-4.57**	-6.11**	-4.04*	-5.09**	-4.58**	-4.75**	-4.04**	-4.12**
log y	-4.02**	-6.67**	-5.07**	-8.15**	-3.41*	-4.62**	-3.62**	-3.61**	-2.90	-5.09**	-4.76**	-3.59*	-3.76*	-5.76**
log M	-1.52	-2.12	-6.05**	-7.97**	-2.71	-4.67**	-4.25**	-5.96**	-4.27**	-4.73**	-4.48**	-6.49**	-3.35*	-6.68**
(i-i*)	N/A		-4.71**	-4.60**	-6.43**	-5.86**	-5.98**	-7.96**	-3.76**	-5.51**	-3.04	-5.14**	-6.43**	-5.65**

ADF and PP refer to the augmented Dickey-Fuller and Philipp-Perron tests. *, **, and *** indicate significant at 90%, 95% and 99% levels, respectively. N/A indicates not applicable.

Table 2: Johansen's Cointegration Test

Null Hypothesis Ho:	Canada	Germany	U. K.	France	Italy	Japan
r = 0	143.39**	193.64**	135.15**	163.09**	175.38**	156.39**
r ≤ 1	98.84**	123.20**	92.33**	117.29**	109.46**	109.78**
r ≤ 2	67.48**	81.69**	57.39	75.83**	70.04**	75.35**
r ≤ 3	37.83	50.20**	35.81	48.75**	39.62	44.82*
r ≤ 4	16.5	32.33**	20.03	26.49*	20.49	21.25
r ≤ 5	6.13	14.91*	9.66	7.55	6.42	8.75

** indicates significant at 99% level and * indicates significant at 5% level.

Table 3: Estimation of Equation (3); Dependent Variable $\Delta \log S$

Variable	Canada	Japan	Germany	U.K.	France	Italy
Constant	-0.006 (0.692)	-0.031 (1.107)	-0.006 (0.246)	0.035 (1.615)	-0.046 (2.550)**	0.001 (0.048)
$\Delta \log M^*$	0.549 (2.709)**	-0.996 (1.613)	0.225 (0.396)	-0.335 (0.761)	1.110 (2.147)**	0.924 (1.61)
$\Delta \log M$	0.236 (1.703)	0.249 (0.419)	-0.523 (0.674)	-2.073 (2.706)**	1.882 (2.935)**	0.154 (0.948)
$\Delta \log y^*$	1.085 (1.292)	3.338 (1.335)	1.690 (0.712)	-0.328 (0.186)	4.210 (1.903)*	-0.715 (0.239)
$\Delta \log y$	-0.450 (1.595)	1.851 (1.792)*	-0.500 (0.923)	0.652 (0.464)	-1.066 (0.722)	0.010 (0.442)
$\Delta (I-i^*)$	0.002 (0.243)	-0.013 (0.550)	-0.066 (3.19)***	0.032 (1.892)*	0.008 (0.491)	-0.023 (1.990)*
EC_{-I}	-0.575 (2.615)**	-0.679 (2.805)**	-0.481 (2.438)**	-0.798 (3.41)***	-0.608 (4.01)***	-0.566 (2.838)**
$Adj R^2$	0.333	0.511	0.385	0.569	0.446	0.282
DW	1.888	1.651	1.268	2.03	1.950	1.351
F -Stat	3.507	4.186	3.718	7.604	5.030	2.962

*** indicates significant at 99% level, ** indicates significant at 95% level and * indicates significant at 90% level.

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Book Review:

John F. Ermish. (2003) An Economic Analysis of the Family. Published by Princeton University Press, Princeton and Oxford. PP 224. ISBN 0-691-09667-8.

If the aim of the book, as pointed out by the author, is “to present the main elements of economic analysis of the family in an integrated way, providing

examples of empirical studies from a variety of international contexts to help bring theory to life”, then the book has more than successfully accomplished its purpose. Ermish, armed with micro economic foundation and econometric techniques, examines how the main theories explain family decision-making and how the predictions of these theories have been empirically tested. The book is comprehensive, well written and well structured. It also strikes the correct balance between academic rigour and intuition making it interesting to read.

The book starts with a useful panoramic view of the different chapters that also, in a clever way, includes key words in italics, definitions and concepts that are going to be used in the following chapters. For example, the first key word in the book is *individuals*. The family is not treated as a unified entity but the analysis recognises the individualistic behaviour of the members of the family. This introduction is very helpful for someone like me, an interested but non-expert on matters related to household formation.

Chapter 2 examines the behaviour of couples with children to gain main insights into intra household allocation of resources when parents do not cooperate with each other and when they do cooperate. Cooperation, sharing rules and bargaining leads into the issue of altruism which is analysed in the following chapter. Interestingly, (effective) altruism might fail to achieve efficient allocation or eliminate conflicts regarding allocation and distribution of welfare. Nothing ensures that once a child receives a gift from their parents, he (she) will not take actions that maximises his (her) own welfare even if

it reduces family welfare. Chapter 4 analyses 'home production', the parents' division of labour and the implications of their investment on children's human capital. In my view, these three chapters are core chapters and lay the foundations to understanding the more complex issues developed in the subsequent chapters.

Indeed, chapter 5 analyses transfers from parents to children that affect the earnings and income of children when adults via school attainment. It focuses on how outcomes depend on parents' resources and other aspects of the family like parents' preferences and education as well as the number of children. This leads to inspection of theories of fertility, the discussion of "child quality-child quantity" interaction and the cost of children in chapter 6. The analysis is extended to considering the effect of purchased childcare on fertility by weakening the link between women's wage and the cost of an additional child. But more relevant for developing countries, the analysis is also extended to examine the effects of child labour on fertility and child quality as well as the links between child mortality risk and fertility.

Up to now, the analysis considers stable married couples who decide how many children to have and their care. But nowadays, a substantial proportion of children are born outside marriage and there are high divorce rates so chapter 7 is devoted to the analysis of child bearing outside the marriage within the context of a marriage market model while chapter 8 focuses on divorce involving children. Women with poorer marriage prospects are more likely to raise a child without the father and

depending on the welfare system and on the resource contribution of the father, she might be better off than if she remains single and childless. In the case of divorce and custody of children by the mother, although resource transfers from the father affect the level of children expenditure, the allocation of children expenditure is not efficient because it does not take into account the effect of her choices on the welfare of the father. However, parents and children could be made better off if parents can settle in a cooperative agreement on resource allocation.

In contrast to chapters 2 to 8 that deal with the nuclear family, chapter 9 examines the role of extended family networks and non-altruistic family transfers as a response to imperfections in the capital markets. It also explores the interactions between transfers from parents and the labour effort of children. Chapter 10 analyses household formation decision when parents live with their middle-aged children i.e. multigenerational households. Finally, Chapter 11 explores how society influences and shapes the preferences of individuals.

It is worth noting that the underlying perspective adopted in the book is similar to the one taken on by Agénor and Montiel (Development Macroeconomics, 1999, Princeton University Press). The behaviour of economic agents in rich and poor countries are assumed to be alike in that they are consistent with rational optimising microeconomic principles but the circumstances (or the environment) in which these decisions are made are different and require careful consideration. Even though different

models are needed to capture these particular features, the standard analytical tools and the analysis presented in the book by Ermisch are pertinent for the study of family behaviour in developed and developing countries.

Given the nature of the book and although the book does not make excessive technical demands on the reader, the book is more suitable for social science researchers and policymakers trained in microeconomics and econometrics. This is a good book and I do not hesitate to recommend it to any social science researcher interested in family decision-making, family formation and dissolution and household formation.

Carmen A. Li

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Readers may be interested in the following news item:

New economics e-learning tool responds to universities' call for more interactive learning

A new interactive e-learning tool designed to help university students get to grips with economic analysis was formally unveiled earlier this summer. Academics and journalists gathered at Cass Business School on Tuesday 6 June, 2006 for London's first public demonstration of LiveEcon as part of an event to mark the release of a new report, *The Future of Economics Education*.

LiveEcon has been developed by The Enterprise Library, an independent provider of learning development tools which support the higher education sector. It currently focuses on the teaching and learning of economics and works with academics in the economics departments of some of the UK's top universities. The first volume of LiveEcon – Macroeconomics Principles, which covers the standard first year syllabus – is now available. A second volume, Macroeconomics Intermediate, will follow in due course.

Charles Jordan, Chief Executive of The Enterprise Library, said that LiveEcon had been developed to help bring the study of economics to life. "LiveEcon is not designed to replace textbooks – it is here to support the teaching and learning of economics and, above all, make it more dynamic and interactive," he said. LiveEcon's major strength lies in its 'U-Drive-It!' sections, Mr

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LiveEcon's authors include Chris Taylor, Chief Adviser at the Bank of England, Dr Jochen Runde, Reader in Economics at the Judge Business School, University of Cambridge, and Dr W David McCausland, Senior Lecturer in Economics at the University of Aberdeen. It has been extensively trialed at the University of Aberdeen and the Judge Business School.

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