AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Money

1979

UNIVERSITY OF CALIFORNIA
DAVIS

JUN 9 1980

Agricultural Economics Library

DEMAND FOR INTERNATIONAL MONEY 1962-77[1]

by

K. Alec Chrystal*, Nigel D. Wilson** and Phillip Quinn***

Working Paper Series
No. 140

Note: The Working Papers of the Department of Economics, University of California, Davis, are preliminary materials circulated to invite discussion and critical comment. These papers may be freely circulated but to protect their tentative character they are not to be quoted without the permission of the author.

November 1979

Department of Economics
University of California
Davis, California

1. This research was financed by a grant from the UK Social Science Research Council.

* University of Essex, Visiting University of California, Davis.

** Graduate student, M.I.T.

*** Trent Polytechnic.

DEMAND FOR INTERNATIONAL MONEY 1962-77

Some recently published work by one of the present authors (Chrystal 1977) purported to establish a pattern of interrelationship between the demand for external balances of four major currencies. The data originally used covered, roughly speaking, the decade of the 1960's. It might reasonably be suggested that this choice of time period was fortunate in that it was characterized by both convertibility between major currencies and by the widespread existence of fixed exchange rates. The situation both before and since has been of a very different complexion. In particular, the perturbations in the international monetary system over the 1970's have been so severe that it would be difficult to invent a more rigorous test of the original model than to apply it to recent data. Accordingly, the present paper does just that, mutatis mutandis.

The results we have obtained seem to us to demonstrate that the model used does capture certain of the economic relationships involved. Indeed, in many respects, the estimates are better than those originally obtained. There remain, of course, many problems and uncertainties, but it is hoped that this work increases knoweldge in a neglected area. Some of the policy implications of the approach adopted are pointed out in Chrystal (1978). In what follows Section I will outline the approach and derive the estimating equations, and Section II will discuss the results.

Section I

The intellectual origin of the present work is connected to the relatively recent attempts to extend monetary theory to the international economy. One aspect of this is the 'monetary approach' to the balance of payments and exchange rates, which has dominated open economy macroeconomics during recent years. The latter approach, however, still relies for its results upon analysis of 'domestic' demand for money and so is not concerned with the international economy per se. We are, rather, interested in the demand for what Swoboda (1968) called 'vehicle currencies.' This demand arises from the medium of exchange role played by a small number of specific currencies (especially the dollar) in the international economy, as distinct from their role within the domestic economy of the country of issue. We are not concerned with external currency holdings which arise for purely speculative purposes, or what has come to be known as 'currency substitution' (Calvo and Rodriguez, 1977, Girton and Roper, 1976) though we do allow for speculation amongst the group of currencies considered. As to terminology, we prefer 'international money' to 'vehicle currency' since the medium of exchange function has always been a dominant characteristic of money, and the international economy presents no difference of principle.

Recent evidence on the invoicing pattern of foreign trade (Grassman, 1973, 1976, and Page, 1977) has required a reformulation of the nature of international transactions demand (Chrystal, 1978, McKinnon, 1979) in comparison to Swoboda's thesis. It has been revealed that international trade in manufactured goods between convertible currency countries is dominantly invoiced in the currency of the exporter and to a lesser extent the importer, but hardly at all in third party currencies. However, there are a number of powerful reasons for believing that the international economy will continue to require working balances of international moneys and that these requirements will in some way be related to the level of trading activity in goods. Firstly, there is a wide range of trade, particularly in primary commodities, but also in manufactured goods for countries in convertible currencies, which is almost entirely invoiced in international money. Secondly, international moneys act as the media of exchange in currency markets themselves, thus diminishing the number of cross-markets necessary. Thirdly, credit raised in international markets is typically most easily available in denominations of international moneys. And, finally, what evidence is available

(Swoboda, 1969) indicates that transactions costs in international moneys are considerably lower than in other currencies. This latter feature alone could provide a rationale for retaining working balances in international money, even if ultimate payment were always to be made in local currency. The fact that the banker countries are, on the whole, the major trading nations reinforces this point.

We proceed by assuming the existence of a small set of currencies which are more or less close substitutes for each other in the role of international money. In practice there are taken to be four (sterling, dollar, deutschemark and French franc). Each yields to the holder both a financial return in the form of an interest rate and a flow of 'transactions' or 'liquidity' services. The latter are valuable in the sense that a holder is prepared to trade off financial return. A 'typical' holder is considered to arrange a portfolio of exogenously given total value in such a way as to maximize the expected utility of that portfolio. Utility is considered to be derived from the flow of financial return and from the valuable services which positive amounts of each currency yield. The financial returns and service flows on each currency are assumed to be uncertain but all are drawn from a normally distributed population with a given variance. The utility function is assumed to be of the form

$$U = a - ce^{-bY} \qquad a,b,c > 0 \qquad (1)$$

where Y is the real income from the portfolio. Since Y is a linear function of the financial yields and service flows, it will also be normally distributed with mean $\bar{Y}$ and variance σ_y^2. The expected value of utility is

$$E(U) = a - c \exp(-b\bar{Y} + \frac{b^2}{2}\sigma_y^2) \qquad (2)$$

Thus, maximizing $\bar{Y} - \frac{b}{2}\sigma_y^2$ is equivalent to maximizing E(U). Let a and r be the i dimensional vectors of actual service flows and financial yields respectively. The actual yields will equal their expected values plus an error.

$$a = \hat{a} + u_a \qquad E(u_a) = 0$$
$$r = \hat{r} + u_r \qquad E(u_r) = 0 \tag{3}$$

Let x be the i dimensional vector of currencies held. The actual income from assets x is

$$Y = (\hat{a} + u_a)'x + (\hat{r} + u_r)'x$$
$$E(Y) = \bar{Y} = \hat{a}'x + \hat{r}'x \tag{4}$$

The variance of Y is

$$\sigma_y^2 = E((u'_a x + u'_r x)^2)$$
$$= x'E(u_a u'_a + u_r u'_r + u_a u'_r + u_r u'_a)x$$

It is assumed that $E(u_a u'_r) = E(u_r u'_a) = 0$, that is that the financial yield is independent of the service flow. So

$$E(u_a u'_a + u_r u'_r + u_a u'_r + u_r u'_a) = E(u_a u'_a + u_r u'_r)$$

Define $\Sigma = E(u_a u'_a + u_r u'_r)$; this is an $i \times i$ symmetric non-negative definite matrix[1], and it is assumed to be positive definite. So

$$\sigma_y^2 = x' \Sigma x \tag{5}$$

The problem then is to maximize

$$\hat{a}'x + \hat{r}'x - \frac{b}{2}x' \Sigma x \qquad \text{s.t. } i'x = W$$

where i is an i dimenstional unit vector, and x is the choice vector. Form the Lagrangian

$$V = \hat{a}'x + \hat{r}'x - \frac{b}{2}x' \Sigma x - \lambda(i'x - W) \tag{6}$$

The first order conditions for a maximum are

$$\frac{\partial V}{\partial x} = \hat{a} + \hat{r} - b \Sigma x - \lambda i = 0 \tag{7}$$

$$\frac{\partial V}{\partial \lambda} = -(i'x - W) = 0 \tag{8}$$

The second order condition for a maximum is that the lending principle minors of

$$\begin{bmatrix} -b\Sigma & i \\ i' & 0 \end{bmatrix}$$

should alternate in sign starting negative. This is assured since Σ is positive definite. The first order conditions may be rewritten

$$\begin{bmatrix} x \\ \lambda \end{bmatrix} = \begin{bmatrix} b\Sigma & i \\ i' & 0 \end{bmatrix}^{-1} \begin{bmatrix} \hat{a} + \hat{r} \\ W \end{bmatrix} \qquad (9)$$

from which

$$x = \frac{1}{b}\left[\Sigma^{-1} - \frac{\Sigma^{-1} i\ i' \Sigma^{-1}}{i' \Sigma^{-1} i}\right]\left[\hat{a} + \hat{r}\right] + \left[\frac{\Sigma^{-1} i}{i' \Sigma^{-1} i}\right] W \qquad (10)$$

Since the variances are taken as parametric, this may be rewritten:

$$x = A\hat{a} + A\hat{r} + hW \qquad (11)$$

where the A matrix is symmetric with row and column sums adding to zero and the elements of h add to unity. Also since Σ is positive definite

$$\frac{dx_i}{d\hat{a}_i} \text{ and } \frac{dx_i}{d\hat{r}_i}$$

are positive for all i.

Equation (11) is our basic model. It remains for us to give the critical variables $\hat{a}$ and $\hat{r}$ empirical form and to report our estimation results.

Section II

With regard to the liquidity services of the currencies, a, we retain the assumption used in earlier work. This has been extensively discussed elsewhere (Chrystal 1975, 1977). It is that the services of each currency can be related to the importance of the country of issue in world trade. Thus

$$\hat{a} = Vt \qquad (12)$$

where V is an i × i diagonal matrix of parameters, and t is a vector of export values from the respective countries to the typical holder. So our model now becomes

$$x = AVt + A\hat{r} + hW \qquad (13)$$

The expected financial return on each currency, r, is easier to define but more difficult to tie down in practice. The typical holder is presumed to use the dollar as numeraire, so, expressing exchange rates in currency units per dollar, the financial return on the i^{th} currency is:

$$\frac{SR_t^i}{SR_{t+1}^i}(1 + r_t^i) - 1 \qquad (14)$$

where SR_t^i and SR_{t+1}^i are the spot rates at the beginning and end of the period and r_t^i is the expected coupon yield in local currency over the period. The latter is assumed to be that ruling at the beginning of the period, but the value of SR_{t+1}^i is much more problematic. In Chrystal (1977) a satisfactory assumption seemed to be that the expected exchange rate change over the period was a random variable with zero mean. In that case (14) reduces to r_t^i. This was a reasonable assumption for a period of fixed exchange rates but is not realistic in a period of greatly fluctuating rates such as have been experienced since 1971.

The rational expectations and efficient markets approach might suggest two possible methods. One is to assume that expectations are correctly formed subject to a random error with mean zero. Here one would use what the exchange rate actually turned out to be, ex post. This assumption does not work well for the data period because there are too many abrupt administered changes which could not have been fully anticipated. Frenkel (1976) has suggested that the forward exchange rate could be used as it reflects all information available at the time expectations are formed. The problem with this in the present context is that forward discounts typically reflect interest differentials so that the resultant financial yields would be highly colinear.

We have had some success using an instrument for the expected spot rate. Frenkel demonstrates the efficiency of the forward market by regressing the current spot rate on the lagged forward rate. We take this one step further by, instead of using the actual forward rate, taking the predicted value of the spot rate from the estimated equation. This predicted value is then used in place of SR^i_{t+1} in (14). Aggregation over all holders now proceeds as in Chrystal (1977, p. 842).

Estimation of all parameters in (13) requires non-linear methods. These are not reported in the present paper. Rather, we estimate the parameters of the linear system

$$x = Bt + Ar + hW \tag{15}$$

where it is assumed that the restrictions applicable to A also apply to B.

Table I reports the results obtained using the local interest rates unadjusted for exchange rate changes.[2] The positive feature of these results is that the trade structure effects (except the franc) are extremely well determined and have the correct sign pattern. Also the R^2 is high in every case considering that there is no intercept and all coefficients are restricted. The interest rates work acceptably well for the deutschemark and franc, but there is a wrong sign on the dollar. Inspection of the exchange rate series shows that the sterling/dollar exchange rate moves fairly smoothly whereas the deutschemark and franc tend to move in more irregular jumps. This latter feature is probably due to the EEC snake arrangements.

We found by trial and error that it is best to retain the unadjusted interest rates for the deutschemark and franc but to adjust the sterling return by the predicted spot rate obtained as described above. The results of doing this are presented in Table

II. The sign pattern on the interest rates is dramatically improved, the dollar equation obviously being particularly sensitive to the definition of sterling yield chosen. The other positive features of the results are broadly retained and in Table II the F ratio test[3] on the restrictions is acceptable at the 95% level, whereas it is not acceptable in Table I. It is clear that the overall goodness of fit is now vastly superior to the results obtained using data only from the 1960's, despite (or perhaps because of) the strong variations in the data occurring subsequently.

The final results we present relate to the portfolio dynamics. We utilize a generalized partial adjustment structure which is equivalent to the method proposed by Brainard and Tobin (1968). If equation (13) now determines the desired portfolio, x^*_t, but the actual is only partially adjusted towards this, then:

$$x_t - x_{t-1} = M(x^*_t - x_{t-1}) \qquad (16)$$

Substituting into (13) we obtain:

$$x_t = MAVt_t + MAr_t + MhW_t + (I-M)\, x_{t-1} \qquad (17)$$

where M is a 4 × 4 matrix of adjustment parameter, and I is an identity matrix. The elements of M must add to unity in each column, and the elements of I-M must add to zero in each column to preserve portfolio consistency. The effect of modelling this way is to add all the lagged dependent variables to each equation. All parameters are identified but to estimate them directly requires the application of non-linear techniques. The application of the linear methods used above to (17) does, however, provide a direct estimate of the I-M matrix. This is presented in Table III.

The last 4 × 4 block of coefficients is the estimate of I-M. It is clear from this that adjustment dynamics are very important. The own lagged dependent variable is particularly important in each case. We might also investigate the I-M marix to check if the adjustment process is stable. Conlisk (1973) has proposed a quick check for stability which is based on the matrix norm of I-M being less than unity. There are three possible matrix norms. First the square root of the sum of the squared elements. Second the maximum sum of the absolute value of the elements of each row, and finally, the same for each column. Our I-M matrix fails by all of these and so presents an a priori case of instability. This is confirmed by the eigenvalues since at least one of these has a real part in excess of unity (1.153).

The final problem worth mentioning is the behaviour of the errors. The Durbin-Watson statistic is not appropriate for this method of estimation. It is clear, however, both from inspection and from the Box-Pierce Chi-squared statistic that the results reported in Tables I and II have residuals which are far from random. As would be expected, the problem is greatly reduced by the introduction of lagged dependent variables. The Box-Pierce statistic is acceptable in each equation in Table III. However, it is well known (see Doran and Griffiths, 1978) that partial adjustment processes are prone to disguised autocorrelation which can only be avoided by more complex estimation techniques. So reservations about these results should be borne in mind for this reason.

Summary and Conclusion

We have considerably extended the data period first used in Chrystal (1977) to include a period of major shocks as well as floating exchange rates. It has been demonstrated that the model fits even better to the extended data period than it did before. The major new problem that we have had to deal with is proxying exchange rate expectations. This we have done for sterling by taking the predicted value of the spot rate resulting from regressing the spot rate on the lagged forward rate. Other currencies, however, seem to be closer to administered rates.

As a result of this work, there would seem to be little doubt that systematic interrelationships between external balances of major currencies do exist and that we have identified some of them successfully.

TABLE I

Basic Linear Model

Equation	UKTBR	USTBR	German CMR	French CMR	UK Exports	US Exports	German Exports	French Exports	Total Stock	R^2
Sterling	655 (.97)	446 (.63)	-432 (-1.25)	-669 (-2.81)	1.32 (6.2)	-1.14 (-8.59)	-.48 (-5.13)	.3 (3.6)	.33 (19.3)	.96
Dollar	446 (.63)	-646 (-.64)	348 (.85)	-148 (-.4)	-1.14 (-8.59)	.99 (6.2)	.23 (2.6)	-.08 (-1.21)	.62 (40.8)	.99
D.M.	-432 (-1.25)	348 (.85)	294 (1.4)	-210 (-1.45)	-.48 (-5.13)	.23 (2.6)	.38 (4.3)	-.13 (-1.94)	.02 (2.58)	.97
Franc	-669 (-2.81)	-148 (-.4)	-210 (-1.45)	1027 (3.51)	.3 (3.6)	-.08 (1.21)	-.13 (-1.94)	-.09 (-.9)	.03 (4.9)	.93

Notes: Variables measured in current dollar values; t-statistics shown in parentheses.

Number of observations 58, Period 1962iv to 1977i.

TBR = 3 month Treasury Bill Rate
CMR = 3 month Call Money Rate
Total Stock = Sum of dependent variables

(Interest rates and exports; source: I.M.F.)

Dollar = U.S. short-term liquid liabilities to foreigners. Source: Federal Reserve.
Sterling = Exchange reserves in sterling plus banking and money market liabilities in sterling. Source: Bank of England.
D.M. = Short-term liabilities of German banks to foreigners. Source: Deutschebundesbank.
Franc = External public debt plus foreign deposits with Bank of France. Source: Institut National.

TABLE II

Basic Model with Alternative Sterling Yield

Equation	UK Yield	USTBR	German CMR	French CMR	UK Exports	US Exports	German Exports	French Exports	Total Stock	R^2
Sterling	559 (1.18)	-406 (-1.11)	19 (.05)	-202 (-1.2)	1.21 (7.92)	-1.08 (-10.15)	-.49 (-3.87)	.36 (3.72)	.32 (18.3)	.97
Dollar	-406 (1.11)	2222 (3.35)	-1109 (-2.46)	-707 (-1.8)	-1.08 (-10.15)	.62 (3.82)	.59 (4.26)	-.13 (-1.71)	.63 (44.8)	.99
D.M.	19 (.05)	-1109 (-2.46)	1105 (2.45)	-15 (-.06)	-.49 (-3.87)	.59 (4.26)	.03 (1.66)	-.13 (-1.23)	.01 (2.5)	.96
Franc	-202 (-1.2)	-707 (-1.8)	-15 (-.06)	924 (2.37)	.36 (-3.72)	-.13 (-1.71)	-.13 (-1.23)	-.1 (-.5)	.04 (5.52)	.92

F ratio test for acceptability of restrictions $F(12, 141) = 1.94$ acceptable at 95% level.

UK Yield = UKTBR adjusted by predicted exchange rate change (see text).

TABLE III

Partial Adjustment

Equation	INTEREST RATES UK	US	German	French	EXPORTS UK	US	German	French	Total Stock	LAG 1	LAG 2	LAG 3	LAG 4	R^2
Sterling	-33 (-.19)	-1699 (-3.46)	889 (3.54)	630 (1.43)	.63 (2.42)	-.14 (-1.49)	-.22 (-1.71)	.19 (.97)	.18 (4.34)	.75 (11.85)	-.13 (-3.25)	-.38 (-2.9)	-.02 (-.06)	.99
Dollar	-182 (-.78)	975 (1.46)	-968 (-2.82)	357 (.59)	-.72 (-2.02)	.26 (2.01)	.08 (.44)	-.26 (-1.0)	.74 (15.4)	-.48 (-5.5)	.16 (2.97)	.11 (.62)	-1.19 (-3.55)	.99
D.M.	231 (1.48)	662 (1.46)	100 (.43)	-1346 (-3.32)	.16 (.66)	-.12 (-1.41)	2.6 (2.18)	-.04 (-.22)	.08 (2.52)	-.24 (-4.05)	-.03 (-.77)	.27 (2.22)	.45 (1.98)	.99
Franc	-16 (-.23)	62 (.31)	-22 (-.21)	359 (1.96)	-.07 (-.63)	.004 (.1)	-.12 (-2.14)	.12 (1.42)	.02 (1.3)	-.03 (-1.25)	-.004 (-.2)	-.0005 (-.009)	.76 (7.4)	.99

LAG 1, etc. = Lagged dependent variable of equation 1, etc.

FOOTNOTES

1. See Cramer (1946), p. 263.

2. Estimation is conducted on the University of Essex TSP programme using Zellner-Theil Seemingly Unrelated Least Squares with cross equation restrictions. Notice also that the sterling data series differs from that used in Chrystal (1977).

3. See Theil (1971), p. 314.

REFERENCES

Brainard, W. and Tobin, J. (1968) "Pitfalls in Financial Model Building," American Economic Review, May, pp. 99-122.

Calvo, G. A. and C. A. Rodriguez, (1977), "A Model of Exchange Rate Determination under Currency Substitution and Rational Expectations," Journal of Political Economy 85 (June), pp. 617-625.

Chrystal, K. A. (1975), "Demand for International Media of Exchange," University of Essex Ph.D. thesis.

Chrystal, K. A. (1977), "Demand for International Media of Exchange," American Economic Review, December, pp. 840-850.

Chrystal, K. A. (1978), "International Money and the Future of the SDR," Princeton Essays in International Finance, No. 128, June.

Conlisk, J. (1973), "Quick Stability Checks and Matrix Norms," Economica, Vol. 50, pp. 402-409.

Cramer, H. (1946). Mathematical Method of Statistics.

Doran, H. E. and Griffiths, W. E. (1978), "Inconsistency of the OLS Estimator of the Partial Adjustment-Adaptive Expectations Model," Journal of Econometrics, April, pp. 133-147.

Frenkel, J. A. (1976), "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence," Scandinavian Journal of Economics, June.

Girton, L. and D. Roper, (1976), "Theory and Implications of Currency Substitution," FRD Discussion Paper.

Grassman, S. (1973), "Exchange Reserves and the Financial Structure of Foreign Trade," Saxon House.

Grassman, S. (1976), "Currency Distribution and Forward Cover in Foreign Trade," Journal of International Economics, May, pp. 215-221.

McKinnon, R. I. (1979). Money in international Exchange: The Convertible Currency System, Oxford University Press.

Page, S. A. B. (1977), "Currency of Invoicing in Merchandise Trade," National Institute Economic Review, August, pp. 77-80.

Swoboda, A. K. (1968), "The Euro-Dollar Market: An Interpretation," Princeton Essays in International Finance, No. 64.

Swoboda, A. K. (1969), "Vehicle Currencies and the Foreign Exchange Market: The Case of the Dollar," in R. Z. Aliber (ed.), The International Market for Foreign Exchange, Praeger.