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MONEY-INCOME RELATIONSHIPS BETWEEN THREE ERM COUNTRIES

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This paper investigates the monetary interdependence and the money-income relationship between countries under a pegged and a floating exchange rate system during the same time period (1979-1997). The relationship is tested between three ERM countries, France, Germany and Holland, and also between these countries and the United States. The ERM countries have a pegged exchange rate between themselves, and the rate between these countries and the United States is freely floating. The empirical tests are conducted by means of the Johansen multivariate cointegration method and the error correction model. Among the ERM countries, international transmission of monetary policy is found in almost all directions. This may provide evidence against the theory of German domination of the EMU. In the second set of tests, the United States money is found to affect all three European incomes but not vice versa.

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I. Introduction

One of the main differences between monetarist and Keynesian economics is provided by the money-income relationship theories. Monetarists believe there is only one source of income fluctuations, which is a change in the

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money supply. Their solution to reducing income fluctuations is a rule providing a constant growth of money supply. Keynesians , by contrast, believe that there are other sources for the income fluctuations, such as fiscal policy, net exports, supply shocks, etc. Keynesians doubt that controlling the money supply will reduce fluctuations in income. Friedman and Kuttner (1992) indicate that money supply or its growth can be a successful monetary policy tool only if the fluctuations in money over time predictably correspond to fluctuations in income or whatever economic activity the central bank wants to influence.[1] Lucas (1972), Fisher (1977) and Taylor (1980) show that a money-income relationship is due to the inability of economic agents to discriminate perfectly in the short run between real and nominal sources of price shocks. The magnitude of the money-income relationship depends on the relative sizes of the two types of shocks, and the authorities do not have the capacity to exploit this relationship in order to influence the level of output.[2]

Mills and Wood (1978) indicate that the exchange rate regime plays an important role in the money-income relationship.[3] This paper investigates the significance of the exchange rate regime in the money-income relationship. Based on the monetary approach to balance-of-payment analysis, monetary authorities in non-reserve countries (countries whose currencies are not held as international reserves by other countries) can fully control domestic money supply only under a completely freely floating exchange rate regime. Under a

[1] Friedman (1990) includes a survey of papers that investigate the proper requirements of the money-income relationship that may warrant money as a successful monetary policy tool.

[2] Bernanke (1986) presents two other explanations for the money-income relationship. The first approach focuses on financial market imperfections rather than real nominal confusion as the source of the relationship. The second approach takes the view that money is passive and that it is correlated with output only because economic agents increase their demand for transaction services when output or expected future output is high.

[3] Fleming (1962), Mundell (1963) and Hamada (1974) provide detailed theoretical analysis of the interdependence of monetary policies during different exchange rate regimes.

pegged (or fixed) exchange rate system, the monetary authorities' control of money supply is limited by the extent to which they are willing to allow their exchange rate to change or their willingness to change their stock of international reserves. Otherwise, the authorities can neither offset a monetary shock from abroad nor affect nominal income by their own monetary actions. On the other hand, under a pegged (and fixed) exchange rate, monetary authorities in reserve countries can influence domestic money supply and the money supply of non-reserve countries. When exchange rates are freely floated, they can only influence their money supply. Thus, effects of the domestic monetary policy on domestic income may depend upon the exchange rate regime.[4]

This paper investigates the monetary interdependence by testing the money-income relationship between countries under both a pegged and a floating exchange rate system during the same time period. All empirical tests are conducted by means of the multivariate cointegration test and the constrained error correction models. Many of the previous empirical studies have focussed on the short-run relationships connecting the growth rate of money to the growth rate of income.[5] Friedman and Kuttner (1992) state that in some situations, especially the conduct of monetary policy in the multi-year context, the long-run relationship between the level of money and the level of income is of very important. A test of cointegration between nominal money and nominal income is then appropriate. Friedman and Kuttner further indicate that if cointegration describes a valid relationship between money and income, then money supply is a proper intermediate target of monetary policy if the ultimate policy objective is to influence the level of income.

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[4] Rivera-Batiz and Rivera-Batiz (1994) provide a detailed analysis of the effectiveness of the domestic monetary policy under a fixed and a flexible exchange rate regime with perfect capital mobility.

[5] Cagan (1989) includes a list of citations that use the Granger-Sims style VAR causality tests in the money-income relationship. These citations are not provided here in order to save space.

The investigation in this paper is conducted between France, Germany and Holland during the exchange rate mechanism (ERM) period (1979-1997). Further tests are also conducted between the stated three European countries and the United States during the same period. Exchange rates between the three European currencies are pegged under the ERM agreement but against the United States dollar they are freely floating. According to Fountas and Pappagapitos (1997) an increase in the importance of the monetary policy among the ERM countries would indicate that monetary policy co-ordination has been successful in stabilizing domestic economies and, hence the transition to European Monetary Union would not deprive policy makers of an important policy tool. Under the ERM set up, this paper has two empirically oriented objectives. First, to test for the effect (size and direction) of one country's money supply on another country's nominal income under two different exchange rate regimes.[6] This paper directly applies the money-income relationship to investigate the interdependence of the monetary policy under conditions of ERM.[7] Second, this paper tests for the so-called, "German dominance" of the European monetary union (EMU). A number of studies contend that Germany has dominated the EMU. If these studies are correct then German domination of the system implies two things: first, Germany should not react to other ERM members' monetary policy, and; second, each ERM country reacts only to the German monetary policy changes and not to any other ERM country's policy, or to the rest of the world.

[6] Mills and Holmes (1999) also study the independence and interdependence of monetary policies for six European countries during two different exchange rate regimes. Mills and Holmes study the fixed rate period of Bretton Woods and the pegged rate period of ERM. They conduct their investigation by studying common trends and cycles between the industrial production indices. Their study does not include the US.

[7] Bayoumi (1992) claims that after the induction of the ERM the effects of demand and supply shocks on ERM countries were longer and more similar.

II. Money-Income Relationship between Countries

According to Helliwell and Maxwell (1974) the international effects of any country's monetary policy may be transmitted by some or all of the economic links between countries. This is especially true if the two countries have close economic ties. Helliwell and Maxwell further show that international transmission of monetary policy from a large economy to a small economy is more feasible during a pegged or fixed exchange rate regime.[8] The ERM countries provide an ideal condition for the study of money-income relationships between large and small countries with pegged exchange rates. Friedman and Schwartz (1982) provide a simple model that checks for the effects of one country's changes in the money supply on the nominal income of some other country. Comparing a small economy country and a large economy country, Friedman and Schwartz show that the large country's money supply may influence the smaller country's money supply through the balance-of-payment surpluses or deficits between the two countries. According to Friedman and Schwartz the main question is whether the changes in the large country's money supply influences the smaller country beyond its money supply. Friedman and Schwartz (1982, footnote #12, pp. 321) start with the following statistical relationship:

$$Y_t^* = \alpha_1 M_t^* + \alpha_2 M_t + \alpha_3 V_t \qquad (1)$$

where Y_t^* is the log of the nominal income in the non-reserve small country, M_t^* is the log of the nominal money supply in the small country, M_t is the log of nominal money supply in the large reserve country and V_t is the velocity of

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[8] Helliwell and Maxwell (1974) show that during the floating period the United States monetary policy has the least amount of influence on the Canadian economy. During the fixed rate period, the Canadian economy was heavily affected by the United States monetary policy. In contrast, the Canadian monetary policy has no effect on the United States economy during any exchange rate regime.

money in the large country. Changes in nominal income (Y_t^*) may happen in other ways than through changes in the other country's money supply (M_t). The velocity of money is added to allow a way for these subtle effects. Velocity can be defined as

$$V_t = Y_t - M_t \tag{2}$$

After substituting equation 2 into 1, equation 1 can be re-written as,

$$Y_t^* = \alpha_1 M_t^* + (\alpha_2 - \alpha_3) M_t + \alpha_3 Y_t \tag{3}$$

The coefficient α_3 measures the additional connection between the two countries over and above the effect operating through the money supply. In this paper, equation 3 is estimated and analysed for the countries stated above. To our knowledge no other study applies equation 3 to investigate money-income relationships during any exchange rate regime. In equation 3 the large country's nominal money supply (M_t) and the nominal income (Y_t) are converted to the currency of the small country by means of the appropriate exchange rate. For example, a test to check whether German money supply (M_t) influences French income (Y_t^*), the German money supply and income (Y_t) are converted to French francs by using the mark per francs exchange rate.

III. The ERM and German Dominance

The European Monetary System's (EMS) exchange rate mechanism (ERM) establishes a set of exchange rate pegs among the European Economic Community (EEC) currencies. There are also some fixed margins (target zones) around the pegs, inside which the values for these currencies must be kept.[9]

[9] In a true sense the ERM is not entirely a fixed rate system.

Over the years the target zones have been changed more than once and as stated earlier the monetary authorities' control of money supply is limited by the extent to which they are willing to allow their exchange rate to change. To determine the exchange rate peg between two currencies, the community fixes the value of the currencies relative to the European Currency Unit (ECU). The main objectives of the ERM are to reduce exchange rate volatility and to reduce inflation in European Union countries (Gibson, 1996).

By examining the co-movement between interest rates, Koedijk and Kool (1992), Hafer and Kutan (1994) and Katsimbris and Miller (1995) conclude that European Union monetary policies are fairly interdependent but that there is some scope for independent policy. Hall et al. (1992), Koedijk and Kool (1992), Caporale and Pittis (1993) and Thom (1995) reach similar conclusions by studying inflation convergence. Mills and Holmes (1999) also reach a similar conclusion by studying common trends and cycles among European industrial production prices. This paper extends the current literature by providing a study of monetary interdependence between ERM countries by investigating the money-income relationship using equation 3.

Giavazzi and Giovannini (1989), Fratianni and Von Hagen (1990) and Melitz (1988, 1990) have shown that the ERM has effectively worked as a Deutschmark zone. These studies point to the evidence of intervention within the system. By and large the burden of intervention fell on countries other than Germany. Further, these studies also claim that at times of expected realignments, German interest rates (unlike other EMS countries) were unaffected; that is, they did not tend to decrease in order to offset the expected appreciation of the mark. The final piece of evidence shows that inflation in initially high inflation ERM countries converges to German levels. In other words, the German inflation rate did not rise but inflation in the other countries showed a distinct tendency to converge on the German levels. But Hafer and Kutan (1994), Katsimbris and Miller (1995) and Mills and Holmes (1999) find very little evidence of German domination. Fratianni and Von Hagen (1990) indicate that German dominance of the system implies that (i) Germany should not react to other ERM members' monetary policy, and (ii) each

ERM country reacts only to the German monetary policy changes and not to any other ERM country's policy, or to the rest of the world. If Germany does dominate the European Union then in this paper the French and Dutch nominal income should be affected by the German money supply and not vice versa. Also, they should not affect each other's income. Similarly, they should not be affected by the United States (a non-ERM country) money supply. As stated above, the money-income relationship between these ERM countries and the United States is also investigated. The currencies of the ERM countries are freely floating against the United States dollar. Use of the United States provides the opportunity to study the same money-income relationship between a large and a small country under a floating exchange rate system. Theoretically, there should be no transmission of monetary policy effect from the United States to the ERM countries.

The United States is considered to be a reserve country, that is, the United States dollar is held as international reserves by other countries. Among the ERM the German mark is also held as a part of international reserves. The United States is the largest economy among the four countries and Germany is the largest economy among the three ERM countries under consideration. This paper thus investigates the international transmission of the monetary policy effects between a larger reserve country and a smaller non-reserve country during a pegged exchange rate system and a freely floating rate system.

IV. The Data

As stated above the empirical tests are conducted using data from France, Germany, Holland and the United States.[10] Quarterly data from the fourth quarter of 1979 to the fourth quarter of 1997 are applied. Nominal GDP presents the nominal income for all countries. The narrow definition of nominal money, M1, presents the nominal money supply for all countries. All data are

[10] Lack of proper quarterly income and/or money data prevented us from using the remaining ERM countries.

obtained from *Datastream*. Since cointegration tests require a certain stochastic structure of the time series involved, the first step in the estimation procedure is to determine if the variables are integrated of the order one or zero, i.e. stationary or nonstationary in levels. For our purposes the variables should be nonstationary in levels. Three different tests are applied in this paper, the augmented Dickey-Fuller (ADF), the Phillips-Perron (PP), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. All series are found to be nonstationary in levels and stationary after first difference, that is, all series contain one root. These results are not presented due to lack of space and the large number of series, but they are available on request.[11]

V. Cointegration Results and Long-Run Coefficients

A system of nonstationary variables can, however, share common stochastic trend(s), i.e. be cointegrated. The main idea behind cointegration is a specification of models that includes beliefs about the movement of variables relative to each other in the long-run. In other words, individual variables, such as the ones in equation 3 may drift apart in the short-run, but in the long-run they are constrained.

The cointegration tests in this paper are conducted by means of the method developed by Johansen (1988). This procedure provides more robust results than other cointegration methods especially when more than two variables are involved (Gonzalo 1994). This procedure ensures that coefficients estimates are symmetrically distributed and the median is unbiased, and the hypothesis tests may be conducted using the standard asymptotic chi-squared tests. The Johansen method applies the maximum likelihood procedure to determine the presence of cointegration vectors in nonstationary time series.

[11] The large number of series resulted from the conversion of the same money and income into different currencies. For example the United States money and income had to be converted into currencies of the three ERM countries, thus providing three United States money series and three income series.

This method detects the number of cointegrating vectors and allows for tests of hypotheses regarding elements of the cointegrating vector. The Johansen maximum likelihood approach sets up the nonstationary series as a vector autoregressive (VAR):

$$\Delta X_t = C + \sum_{i=1}^{K} \tau_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t \qquad (4)$$

where X_t is a vector of nonstationary (in levels) variables and C is a constant term. The information on the coefficient matrix between the levels of the series Π is decomposed as $\Pi = \gamma\, \delta'$ where the relevant elements of the γ matrix are the adjustment coefficients and the δ matrix contains the cointegrating vectors. Johansen and Juselius (1990) provide two different tests, the trace test and maximum eigenvalue test, to determine the number of cointegrating vectors. If a nonzero vector(s) is indicated by these tests, a stationary long-run relationship is implied.[12] According to Dickey et al. (1991) cointegration vectors are obtained from the reduced form of a system where all the variables are assumed to be jointly endogenous. Thus, cointegrating vectors cannot be interpreted as representing structural changes. However, cointegrating vectors may be due to constraints that an economic structure imposes on the long-run relationship between the jointly endogenous variables.[13] Osterwald-Lenum (1992) provides the appropriate critical values required for these tests.

A. Tests between the ERM Countries

Table 1 presents the results from the cointegration tests using the ERM

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[12] If more than one significant vector is found this implies that more than one stationary long-run relationship exists between the stated variables. The cointegration test results are stronger and more robust when there is more than one significant vector (Johansen and Juselius 1990, and Dickey et al.1991).

[13] Johasen and Juselius (1990) and Dickey et al. (1991) provide a detailed analysis of the Johansen multivariate cointegration tests.

countries data. Three tests are conducted: between Holland and France, Holland and Germany and finally between France and Germany. The number of lags applied in the VAR is based on the evidence provided by both the Akaike information criterion (AIC) and the likelihood ratio test. In all tests four lags are applied in the VAR. In all three cases both the trace test and the eigenvalue test indicate one significant vector at the 5% level or above. In other words, results show a long-run stationary equilibrium relationship between the four stated variables in all cases. The diagnostic tests fail to show significant serial correlation. Results indicate the presence of nonnormal residuals but as indicated by Gonzalo (1994), the performance of the Johansen method is still robust even when the errors are nonnormal.

The estimated cointegrating vectors are given economic meaning by normalizing on the nominal income of the smaller country (in the relationship). In tests involving Holland, the vector is normalized on the Dutch income and in the test between France and Germany, it is normalized on the French income. These normalized vectors are shown in table 2. Using the chi-square test, all variables are tested for significance as indicated by Johansen and Juselius (1990). All variables are found to be significant except for the French money in the French-German test. Domestic money supply (M_t^*) imposes a (significant) positive effect in the Dutch-French relationship and a negative effect in the Dutch-German relationship. Foreign income (Y_t) imposes a significant negative effect in all three relationships. Results thus show that changes in domestic nominal income may happen in ways other than through changes in the other's country money supply. The coefficient (α_2 - α_3) on the foreign money supply (M_t) is found to be positive and significant in all cases. Restriction tests based on the chi-square test are applied to check for the significance of the direct effect (α_2) of foreign money supply. The foreign money supply coefficient is found to be significant in only one case, that is for French money on Dutch income.[14]

[14] In the test between Germany and the United States it is interesting to see if a large country's monetary policy affects another relatively large country's income during a free floating exchange rate era.

Table 1. Cointegration Test between the ERM Countries

Holland-France			
Vectors	Trace Test	Maximum Eigen	Eigenvalue
r = 0	48.28[b]	32.44[a]	0.3794
r ≤ 1	14.84	12.13	0.1633
r ≤ 2	3.71	3.27	0.0470
r ≤ 3	0.44	0.44	0.0064

Lags in VAR = 4, Trace correlation = 0.663,
Autocorrelation LM (1) $\chi^2(16) = 23.56$, Normality $\chi^2(8) = 18.13^*$.

Holland-Germany			
Vectors	Trace test	Maximum Eigen	Eigenvalue
r = 0	49.47[b]	31.57[b]	0.3714
r ≤ 1	17.90	10.30	0.1460
r ≤ 2	7.60	7.10	0.0992
r ≤ 3	0.49	0.49	0.0072

Lags in VAR = 4, Trace correlation = 0.348,
Autocorrelation LM (1) $\chi^2(16)= 16.86$, Normality $\chi^2(8) = 67.82^*$.

Table 1. (Continued) Cointegration Test between the ERM Countries

France-Germany			
Vectors	Trace Test	Maximum Eigen	Eigenvalue
r = 0	57.14[a]	36.96[a]	0.4193
r ≤ 1	20.18	12.54	0.1684
r ≤ 2	7.64	7.60	0.1057
r ≤ 3	0.05	0.05	0.0007

Lags in VAR = 4, Trace correlation = 0.475,
Autocorrelation LM (1) $\chi^2(16)$= 15.64, Normality $\chi^2(8)$ = 37.36*.

Notes: a, b & c imply significance at the 1%, 5% & 10% level, respectively. *imply rejection of the null at the 5% level.

Table 2. Normalized Equations between the ERM Countries

Holland-France		Holland-Germany		France-Germany	
Variables	Coefficients	Variables	Coefficients	Variables	Coefficients
Hy	1.000[a]	Hy	1.000[b]	Fy	1.000[c]
	(7.53)		(3.86)		(2.69)
Hm	0.935[a]	Hm	-0.286[c]	Fm	0.088
	(6.99)		(3.21)		(0.02)
Fm	0.175[c]	Gm	1.888[a]	Gm	1.815[a]
	(2.96)		(12.13)		(14.45)
Fy	-0.797[b]	Gy	-1.646[a]	Gy	-2.196[a]
	(4.91		(7.72)		(10.41)

Notes: a, b and c imply significance at the 1%, 5% and 10% level, respectively. Chi-squares statistics in the parentheses. Hy = Dutch income, Hm = Dutch money, Fy = French income, Fm = French money, Gy = German income and Gm = German money.

B. Tests between the ERM Countries and the United States

Table 3 show the results from the cointegration tests between the ERM countries and the United States.[15] The lags in the VAR are again based on the AIC and likelihood ratio test evidence. Two lags are used in the French-United States relationship and four lags in the other two tests. In two relationships both the trace test and the eigenvalue test indicate one nonzero vector. In the relationship using the Dutch data, only the trace test indicates one nonzero vector at the 10% level.[16] The diagnostic tests are again satisfactory.

Table 4 presents the normalized equations. These vectors are normalized on the European country income. The domestic money supplies are positive and significant in the cases of Holland and Germany. It is negative and significant for France. The United States income imposes a significant and negative effect on the Dutch and the German incomes, but the opposite is true for France. Once again results show that changes in income may be due to factors other than another country's change in the money supply. In comparison the German income imposes a negative effect on the French income (table 2) while the United States effect is positive. The two coefficients in absolute value are quite close to each other. Both German and the United States incomes affect the Dutch income inversely and in absolute value Germany imposes a larger affect. French income also imposes a negative effect on the Dutch income but with the smallest magnitude (table 2). The coefficient (α_2 - α_3) on the United States money supply is positive in the Dutch and German tests and negative in the French test. In all cases it is significant. In the case of Holland, the German money coefficient is larger

[15] The trace test tends to be more powerful than the maximum eigenvalue test when the eigenvalues are evenly distributed (Kasa 1992, p. 102). Further, according to Cheung and Lai (1993), the trace test shows more robustness to both skewness and excess kurtosis in the residuals than the maximum eigenvalue test.

[16] See Engle and Granger (1987), Miller and Russek (1990) and Miller (1991) for detailed discussions of the error correction modelling strategy based upon the information provided by cointegrated variables.

Table 3. Cointegration Test between ERM Countries and the United States

Holland-United States			
Vectors	Trace Test	Maximum Eigen	Eigenvalue
r = 0	46.46[c]	24.11	0.2985
r ≤ 1	22.35	13.93	0.1852
r ≤ 2	8.42	6.01	0.0846
r ≤ 3	2.42	2.42	0.0349

Lags in VAR = 4, Trace correlation = 0.464,
Autocorrelation LM (1) $\chi^2(16) = 24.26$, Normality $\chi^2(8) = 13.04$.

France-United States			
Vectors	Trace Test	Maximum Eigen	Eigenvalue
r = 0	63.50[a]	37.26[c]	0.4128
r ≤ 1	26.24	15.94	0.2036
r ≤ 2	10.30	8.54	0.1148
r ≤ 3	1.76	1.76	0.0248

Lags in VAR = 2, Trace correlation = 0.407,
Autocorrelation LM (1) $\chi^2(16) = 8.56$, Normality $\chi^2(8) = 23.53^*$.

Table 3. (Continued) Cointegration Test between ERM Countries and the United States

Germany-United States			
Vectors	Trace Test	Maximum Eigen	Eigenvalue
r = 0	48.17[b]	30.01[b]	0.3568
r ≤ 1	18.16	10.88	0.1479
r ≤ 2	7.28	7.26	0.1013
r ≤ 3	0.02	0.02	0.0003

Lags in VAR = 4, Trace correlation = 0.343,
Autocorrelation LM (1) $\chi^2(16) = 20.23$, Normality $\chi^2(8) = 49.24^*$.

See notes at the end of table 1.

than the United States or the French coefficient. For France, the absolute value of the United States coefficient is larger than the German. The significance of the direct effect of the United States money supply is checked by means of the chi-square restriction test. Once again only in one case, the German test, do the results show a significant effect.

VI. Error-Correction Models

Cointegration also implies that the transitory components of the series can be given a dynamic error correction representation, i.e. a constrained error correction model can be applied that captures the short-run dynamic adjustment of cointegrated variables.[17] According to Miller and Russek (1990)

[17] See Engle and Granger (1987), Miller and Russek (1990) and Miller (1991) for detailed discussions of the error correction modelling strategy based upon the information provided by cointegrated variables.

Table 4. Normalized Equations between the ERM Countries and the United States

Holland-US		France-US		Germany-US	
Variables	Coefficients	Variables	Coefficients	Variables	Coefficients
Hy	1.000[c]	Fy	1.000[a]	Gy	1.000[a]
	(3.51)		(7.61)		(13.17)
Hm	0.647[c]	Fm	-1.993[a]	Gm	0.847[a]
	(3.66)		(7.61)		(16.09)
Um	0.886[a]	Um	-2.750[b]	Um	0.374[a]
	(10.02)		(6.30)		(16.29)
Uy	-0.983[a]	Uy	2.403[c]	Uy	-0.494[a]
	(8.83)		(3.04)		(18.13)

Notes: a, b and c imply significance at the 1%, 5% and 10% level, respectively. Chi-squares statistics in the parentheses. Hy = Dutch income, Hm = Dutch money, Fy = French income, Fm = French money, Gy = German income, Gm = German money, Uy = United States income and Um = United States money.

the constrained error correction model allows for a causal linkage between two or more variables stemming from a common trend or equilibrium relationship.[18] If two variables A and B are cointegrated (share a common trend), then the current change in A is partly the result of A moving into alignment with the trend value of B. Such causality may not be detected by the standard Granger causality test provided by Granger (1969), which only

[18] Granger (1969, p. 428) defines causality as a situation in which a variable A is causing another variable B if we are better able to predict B using all available information rather than if the information not including A had been used. A feedback is said to occur if both A and B are causing each other.

examines whether past changes in a variable help to explain current changes in other variables. As indicated by Miller and Russek (1990) as long as A and B are cointegrated, causality must exist in at least one direction. In the present context the following error correction representation is implied:

$$\Delta Y^*_t = \delta_0 + A(L)\Delta Y^*_{t-i} + B(L)\Delta M^*_{t-i} + C(L)\Delta M_{t-i} + D(L)\Delta Y_{t-i} + \qquad (5)$$

$$+ \theta_1 \mu_{t-1} + \varepsilon_t$$

where ΔY_t, ΔM_t, ΔM^*_t and ΔY^*_t are the once differenced stationary large country income, money supply, small country income and money supply series respectively, A(L), B(L), C(L) and D(L) are polynomials in the lag operator, and μ_{t-1} is the lagged value of the error correction term from the cointegration equation.[19] Within a constrained error correction model causality may arise from two sources (Granger, 1988). Based on equation 5, lack of causality from M_t, M^*_t and Y_t to Y^*_t is rejected not only if the coefficients on the variables are significant, but also if the coefficient on $\mu_{t-1}(\theta_1)$ is significant. Short-run dynamics in the model are captured by the lagged differences, and conventional tests of causality may be based on the significance of these terms.

The error correction term represents the potential effects of departures from the long-run equilibria. The size and significance of the error term coefficient (θ_1) in equation 5 shows the tendency of nominal income (Y_t^*) to restore equilibrium. In other words the coefficient represents the speed of adjustment of the small country nominal income (Y_t^*) towards the long-run equilibrium. Thus, income (Y_t^*) will adjust fully to any persistent change in the other three variables eventually restoring the equilibrium relationship in levels represented by equation 3. If this coefficient is insignificant then the

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[19] The error correction term μ_t is defined as,

$$\mu_t = Y_t^* - \bar{\alpha}_1 M_t^* - (\bar{\alpha}_2 - \bar{\alpha}_3) M_t - \alpha_3 Y_t$$

where $\bar{\alpha}_1$, $\bar{\alpha}_2$, and $\bar{\alpha}_3$ are estimated values of α_1, α_2, and α_3.

dependent variable does not adjust to correct departures from equilibrium. Interpretation of the error correction estimation depends upon whether nominal income is exogenous or endogenous.[20] If income is endogenous, then the error correction equation represents the endogenous response of nominal income growth rate to adjustment in the economy. Our results show all variables to be endogenous. Equation 5 is also tested with the once differenced small country money supply, large country money supply and income as the dependent variables. In this manner causality in all directions and speed of adjustment toward long run equilibrium for each variable may be investigated.[21]

Given the so called "German dominance of EMU" and pegged ERM rates there should be no causality from Dutch and French money to the German income but German money should cause income of the other two ERM countries. Given the free floating exchange rates between the United States and the three European countries, there should be no causality between money of one country and income of another. And if some evidence of causality is found it should be from the United States (large country) money to the income of the European countries (small country) only.

Tables 5 to 10 show the error correction test results. The lag structure in the error correction model is determined by the Akaike's FPE criterion.[22] Possible combinations of one to four lags are examined and the lag structure that minimizes the FPE is chosen. If more than one lag of the variables is applied then joint significance of all lags are conducted by means of

[20] In these models a variable is econometrically exogenous if only the lagged changes in the dependent variable provide explanatory power.

[21] With the cointegration vector normalized on the small country nominal income in the equation which models the nominal income as the dependent variable, the associated element of θ represents the speed of adjustment directly. In the remaining equations, the corresponding elements of θ represent the ratio of the speed of adjustment of the relevant variables to the value of its associated coefficients in the cointegrating relationship.

[22] Thornton and Batten (1985) compare several criteria for lag-length selection. They find Akaike's FPE criterion to perform the best based on standard, classical, hypothesis-testing norms.

the F-test. If all lags are jointly found to be significant this indicates causality from the independent variable to the dependent variable. Diagnostic statistics of the regression are provided below the error correction results.[23]

A. Results from the ERM Countries

Tables 5 to 7 present the test results for the three European countries: Holland-France (table 5), Holland-Germany (table 6) and France-Germany (table 7). In the Holland-France test (table 5) the lagged error correction term (μ_{t-1}) is significant in all four equations. As stated earlier if the error coefficient is insignificant then the dependent variable does not adjust to correct departures from the equilibrium. The size of the error correction term in the Dutch income equation (-0.014) indicates that 1.4% of the adjustment of nominal Dutch income towards the long-run equilibrium takes place per quarter. The significance of the error term indicates causality from all four independent variables to the Dutch income. As stated above in the remaining three equations the error term is also found to be significant. Thus, along with Dutch income, the Dutch money supply and the income and money supply of France are also caused by all variables. In the case of Holland and France, results show feedback effect between all four variables. The fastest speed of adjustment is provided by the French income, 4.65% ($\theta\alpha_3$) per quarter. In the Dutch income besides the lagged error correction term the F-test indicates joint significance of all lagged Dutch money, and the F-test also shows the lagged French income to be significant. Similarly, in the French income test along with the error term the lagged Dutch income and one time lagged French income are significant. These results may provide some evidence against the German dominance theory. In all four equations the diagnostic statistics are quite satisfactory.

[23] As the referee pointed out the error correction regressions may be affected by omitted variables. If regressions are estimated without relevant variable(s) then it is very possible that the estimated coefficient(s) may be biased.

Table 5. Holland-France Error Correction Results

	Dep. variable ΔHy_t	Dep. variable ΔHm_t	Dep. variable ΔFm_t	Dep. variable ΔFy_t
Constant	0.1785[c]	-0.4136[c]	1.2666[a]	0.6645[a]
	(1.844)	(-1.800)	(3.838)	(4.018)
μ_{t-1}	-0.014[c]	0.0406[c]	-0.1124[a]	-0.0584[a]
	(-1.672)	(1.900)	(-3.820)	(-3.949)
ΔHy_{t-1}	-0.051	0.3700	-0.3433	-0.3258[c]
	(-0.466)	(1.342)	(-1.257)	(-1.710)
ΔHm_{t-1}	-0.0713[c]	-0.1264	-0.0341	-0.0039
	(-1.903)	(-1.360)	(-0.302)	(-0.070)
ΔHm_{t-2}	-0.0707[b]	-0.2432[a]	---	---
	(-2.175)	(-2.953)		
F-test	5.425**	5.834**	---	---
ΔFm_{t-1}	-0.0216	-0.1902[b]	-0.3694[a]	-0.0078
	(-0.662)	(-2.423)	(-3.949)	(-0.163)
ΔFm_{t-2}	-0.032	0.5006[a]	-0.2900[a]	0.0359
	(-0.914)	(6.079)	(-3.074)	(0.660)
ΔFm_{t-3}	---	---	-0.3532[a]	---
			(-3.532)	
ΔFm_{t-4}	---	---	0.5994[a]	---
			(6.226)	
F-test	0.745	4.481**	2.060	0.0949
ΔFy_{t-1}	0.1246[c]	-0.1660	0.0028	0.3105[a]
	(1.766)	(-1.000)	(0.014)	(2.675)
ΔFy_{t-2}	-0.3003[a]	---	0.5497[a]	---
	(-4.450)		(3.008)	
F-test	4.551*	---	4.748**	---
R^2	0.235	0.727	0.8607	0.4469

Table 5. (Continued) Holland-France Error Correction Results

	Dep. variable ΔHy_t	Dep. variable ΔHm_t	Dep. variable ΔFm_t	Dep. variable ΔFy_t
SEE	0.0085	0.0217	0.0209	0.0203
SSR	0.0048	0.0291	0.0254	0.0151
Box-Ljung Q(17)	24.727	11.028	15.567	12.698

Notes: a, b and c imply significance at the 1%, 5% and 10% leve,l respectively. t statistics in parentheses. ***, ** and * imply rejection of the null at 1%, 5% and 10% level, respectively. SEE = Standard error of regression, SSR = Squared sum of residuals.

Table 6. Holland-Germany Error Correction Results

	Dep. variable ΔHy_t	Dep. variable ΔHm_t	Dep. variable ΔGm_t	Dep. variable ΔGy_t
Constant	0.4808[b]	-1.1898[c]	-2.0610[a]	-0.6490[c]
	(2.138)	(-1.757)	(-3.848)	(-1.673)
μ_{t-1}	-0.0386[b]	0.1015[c]	0.1710[a]	-0.0538[c]
	(-2.086)	(1.822)	(3.887)	(-1.687)
ΔHy_{t-1}	-0.0671	0.4820	-0.1528	0.1730
	(-0.539)	(1.358)	(-0.517)	(0.944)
ΔHy_{t-2}	-0.0774	---	---	---
	(-0.610)			
F-test	0.6308	---	---	---
ΔHm_{t-1}	0.0094	-0.7133[a]	-0.0649	-0.0630
	(0.318)	(-7.179)	(-0.928)	(-1.483)
ΔHm_{t-2}	---	-0.5554[a]	---	---
		(-4.871)		

Table 6. (Continued) Holland-Germany Error Correction Results

	Dep. variable ΔHy_t	Dep. variable ΔHm_t	Dep. variable ΔGm_t	Dep. variable ΔGy_t
ΔHm_{t-3}	---	-0.5860[a]	---	---
		(-5.302)		
F-test	---	58.729***	---	---
ΔGm_{t-1}	-0.0525	0.6408[a]	0.2184	0.1184
	(-0.792)	(3.410)	(1.413)	(1.241)
ΔGm_{t-2}	---	---	0.0917	---
			(0.788)	
F-test	---	---	2.463	---
ΔGy_{t-1}	0.1411	-0.9784[a]	-0.4430[c]	-0.2184
	(1.288)	(-3.009)	(-1.716)	(-1.370)
ΔGy_{t-2}	---	---	---	-0.0212
				(-0.183)
ΔGy_{t-3}	---	---	---	0.1036
				(0.895)
ΔGy_{t-4}	---	---	---	0.3809[a]
				(3.225)
F-test	---	---	---	0.929
R^2	-0.0087	0.5615	0.1304	0.1620
SEE	0.0098	0.0276	0.0233	0.0142
SSR	0.0060	0.0466	0.0342	0.0119
Box-Ljung Q(17)	15.00	23.048	8.260	13.600

Notes: a, b and c imply significance at the 1%, 5% and 10% level, respectively. t statistics in parentheses. ***, ** and * imply rejection of the null at 1%, 5% and 10% level, respectively. SEE = Standard error of regression, SSR = Squared sum of residuals.

Table 7. France-Germany Error Correction Results

	Dep. variable ΔFy_t	Dep. variable ΔFm_t	Dep. variable ΔGm_t	Dep. variable ΔGy_t
Constant	0.3353[a]	0.5330[b]	-0.4401[c]	0.0350
	(4.951)	(2.431)	(-1.892)	(0.183)
μ_{t-1}	-0.0388[a]	-0.0618[b]	0.0551[b]	-0.0025
	(-4.880)	(-2.387)	(2.015)	(-0.112)
ΔFy_{t-1}	0.1870	-0.1992	-0.5246	-0.6225[b]
	(1.592)	(-0.634)	(-1.258)	(-2.043)
ΔFm_{t-1}	0.0148	-0.2486[a]	0.0872	0.0055
	(0.595)	(-2.736)	(1.347)	(0.117)
ΔFm_{t-2}	0.0193	-0.1995[b]	---	---
	(0.791)	(-2.172)		
ΔFm_{t-3}	---	-0.2424[b]	---	---
		(-2.530)		
ΔFm_{t-4}	---	0.7054[a]	---	---
		(7.467)		
F-test	0.5705	0.0021	---	---
ΔGm_{t-1}	-0.0607	-0.0640	0.0686	-0.0331
	(-1.613)	(-0.486)	(0.396)	(-0.245)
ΔGm_{t-2}	---	---	0.0245	---
			(0.210)	
F-test	---	---	0.1708	---
ΔGy_{t-1}	0.1283[c]	0.0391	-0.1402	0.1039
	(1.827)	(0.221)	(-0.560)	(0.573)
ΔGy_{t-2}	---	---	---	0.0920
				(0.759)
ΔGy_{t-3}	---	---	---	0.3004[b]
				(2.508)
F-test	---	---	---	4.285**

Table 7. (Continued) France-Germany Error Correction Results

	Dep. variable ΔFy_t	Dep. variable ΔFm_t	Dep. variable ΔGm_t	Dep. variable ΔGy_t
R^2	0.5300	0.8820	0.1687	0.1990
SEE	0.0070	0.0180	0.0259	0.0187
SSR	0.0036	0.0192	0.0442	0.0215
Box-Ljung Q(17)	19.401	19.443	13.974	22.147

Notes: a, b and c imply significance at the 1%, 5% and 10% level, respectively. t statistics in parentheses. ***, ** and * imply rejection of the null at 1%, 5% and 10% level, respectively. SEE = Standard error of regression, SSR = Squared sum of residuals.

A similar result is found between Holland and Germany (table 6). In all four equations the error correction term is significant. Once again significance of the error term in all four equations indicates causality between all four variables. The adjustment rate of the Dutch income towards the long-run in this relationship is 3.86% per quarter. The Dutch income speed of adjustment is faster in the Holland-German relationship than in the Holland-French relationship. The fastest speed is provided by the German money at 32.30% per quarter. Besides the error term no other variable is significant in the Dutch and the German income equations. Causality from Dutch money to German income provides evidence against the German dominance theory and also against the lack of small country monetary effect on a larger country's income. The diagnostic tests are again satisfactory.

Table 7 presents the French-German results. The error term is insignificant only in the German income equation. Thus, all four variables cause the money supply of France and Germany and the income of France. The fastest rate of adjustment is shown by the French income, 3.88% per quarter. In the French income equation, German income is significant along with the error term. In the case of the German income, the French income is significant and the F-test indicates joint significance of all lagged German income. There is no indication of any causality from the French money supply to the German income.

What do the European results show and imply? Given the pegged exchange rate and the standard theory, we expected monetary policy of the large country to affect the income of the smaller country. Results show that the German money affects both the Dutch and the French incomes. Between the Dutch and French tests, once again results show a larger country's (France) money supply affecting the income of a smaller country (Holland). But results also indicate some evidence of a smaller country's money supply affecting the larger country's income. The Dutch money supply influences both the French and the German income. The Dutch money influencing German income also provides some evidence against the German dominance theory, though the French-German results provide some evidence for the dominance theory. Most of these significant causality results are indicated by significance of the error correction term. Transmission of monetary policy across borders implies lack of control of domestic monetary policy by the domestic central bank. The ERM results indicates transmission of monetary policy between countries thus indicating lack of control of domestic monetary policy by domestic authorities.

B. Results between the ERM Countries and the United States

Test results between the ERM countries and the United States are presented in tables 8 to 10: Holland-United States (table 8), France-United States (table 9) and Germany-United States (table 10). In the Dutch tests, the error correction term is insignificant in three of the equations. Only in the Dutch money supply equation is the error correction term significant at the 5% level. The speed of adjustment of Dutch money is about 5% per quarter. In the Dutch income equation the United States income is significant and all lags of the United States money are jointly significant. Results show causality from the United States money and income to the Dutch income. In the United States money equation, non of the Dutch variables are significant. Results show only a

Table 8. Holland-United States Error Correction Results

	Dep. variable ΔHy_t	Dep. variable ΔHm_t	Dep. variable ΔUm_t	Dep. variable ΔUy_t
Constant	0.0666	-0.8270	0.6917	1.6511
	(0.285)	(-1.358)	(0.544)	(1.333)
μ_{t-1}	-0.0049	0.0760[b]	-0.0606	-0.1490
	(-0.233)	(2.385)	(-0.529)	(-1.333)
ΔHy_{t-1}	-0.089	0.2010	-0.3535	0.1999
	(0.727)	(0.628)	(-0.511)	(0.309)
ΔHy_{t-2}	---	-0.2253	---	1.1374[c]
		(-0.693)		(-1.711)
F-test	---	0.1245	---	1.835
ΔHm_{t-1}	0.0006	-0.2273[b]	-0.2212	-0.2038
	(0.020)	(-2.134)	(-1.451)	(-1.149)
ΔHm_{t-2}	---	-0.1195	---	0.2077
		(-1.117)		(1.257)
ΔHm_{t-3}	---	-0.1603	---	---
		(-1.550)		
ΔHm_{t-4}	---	0.5956[a]	---	---
		(6.101)		
F-test	---	0.0685	---	0.0002
ΔUm_{t-1}	-0.1311[c]	0.1180	1.1808[a]	0.7502[c]
	(-1.674)	(0.608)	(2.829)	(1.902)
ΔUm_{t-2}	-0.0511[b]	---	---	---
	(-2.287)			
F-test	6.053**	---	---	---
ΔUy_{t-1}	0.1546[c]	-0.0626	0.9233[c]	-0.4940
	(1.826)	(-0.292)	(-1.987)	(-1.128)
R^2	0.0840	0.6780	0.1870	0.1424
SEE	0.0090	0.0273	0.0530	0.0488

Table 8. (Continued) Holland-United States Error Correction Results

	Dep. variable ΔHy_t	Dep. variable ΔHm_t	Dep. variable ΔUm_t	Dep. variable ΔUy_t
SSR	0.0050	0.0327	0.1825	0.1477
Box-Ljung Q(17)	23.092	16.929	14.811	8.679

Notes: a, b and c imply significance at the 1%, 5% and 10% level, respectively. t statistics in parentheses. ***, ** and * imply rejection of the null at 1%, 5% and 10% level, respectively. SEE = Standard error of regression, SSR = Squared sum of residuals.

Table 9. France-United States Error Correction Results

	Dep. variable ΔFy_t	Dep. variable ΔFm_t	Dep. variable ΔUm_t	Dep. variable ΔUy_t
Constant	0.2216[a]	0.3154[c]	-0.3881	-0.3823
	(3.953)	(1.883)	(-1.218)	(-1.300)
μ_{t-1}	-0.0065[a]	-0.0093[c]	0.0121	0.0119
	(-3.870)	(-1.855)	(1.262)	(1.343)
ΔFy_{t-1}	0.1993	-0.1386	0.3647	0.4812
	(1.565)	(-0.435)	(0.444)	(0.616)
ΔFy_{t-2}	-0.0347	---	---	---
	(-0.275)			
F-test	1.0359	---	---	---
ΔFm_{t-1}	0.0101	-0.2391[b]	-0.0643	-0.0243
	(0.551)	(-2.476)	(-0.529)	(-0.211)
ΔFm_{t-2}	---	-0.1999[c]	---	---
		(-1.964)		
ΔFm_{t-3}	---	-0.2522[b]	---	---
		(-2.407)		

Table 9. (Continued) France-United States Error Correction Results

	Dep. variable ΔFy_t	Dep. variable ΔFm_t	Dep. variable ΔUm_t	Dep. variable ΔUy_t
ΔFm_{t-4}	---	0.6864[a]	---	---
		(6.556)		
F-test	---	0.0002	---	---
ΔUm_{t-1}	-0.0843	-0.2128	1.3888[a]	0.6737[c]
	(-1.400)	(-1.370)	(3.382)	(1.800)
ΔUm_{t-2}	---	---	-0.0748	---
			(-0.075)	
F-test	---	---	11.312***	---
ΔUy_{t-1}	0.0885	0.1986	-1.0170[b]	-0.413
	(1.308)	(1.136)	(-2.402)	(-0.983)
R^2	0.4817	0.8790	0.2140	0.1150
SEE	0.0076	0.0183	0.0502	0.0480
SSR	0.0037	0.0198	0.1519	0.1527
Box-Ljung Q(17)	15.543	15.856	13.094	11.980

Notes: a, b and c imply significance at the 1%, 5% and 10% level, respectively. t statistics in parentheses. ***, ** and * imply rejection of the null at 1%, 5% and 10% level, respectively. SEE = Standard error of regression, SSR = Squared sum of residuals.

Table 10. Germany-United States Error Correction Results

	Dep. variable ΔGy_t	Dep. variable ΔGm_t	Dep. variable ΔUm_t	Dep. variable ΔUy_t
Constant	-0.4017[b]	-0.6284[b]	-0.0839	0.3275
	(-2.248)	(-2.402)	(-0.143)	(0.593)

Table 10. (Continued) Germany-United States Error Correction Results

	Dep. variable ΔGy_t	Dep. variable ΔGm_t	Dep. variable ΔUm_t	Dep. variable ΔUy_t
μ_{t-1}	-0.1434[b]	0.2241[b]	0.0364	-0.1052
	(-2.309)	(2.473)	(0.180)	(-0.550)
ΔGy_{t-1}	-0.1951	-0.4837[c]	0.1966	0.2658
	(-1.134)	(-1.815)	(0.328)	(0.471)
ΔGy_{t-2}	-0.0178	---	---	---
	(-0.137)			
F-test	0.9177	---	---	---
ΔGm_{t-1}	0.1222	0.1977	-0.8076[b]	-0.7743[b]
	(1.224)	(1.274)	(-2.234)	(-2.367)
ΔGm_{t-2}	---	---	0.0716	0.0244
			(0.266)	(0.097)
F-test	---	---	2.380	3.033*
ΔUm_{t-1}	-0.0368	0.0891	1.2756[a]	0.8552[b]
	(-0.307)	(0.481)	(2.940)	(2.170)
ΔUm_{t-2}	---	---	0.0709	---
			(0.627)	
F-test	---	---	10.593***	---
ΔUy_{t-1}	0.0588	-0.0002	-1.0264[b]	-0.6115
	(0.447)	(-0.001)	(-2.192)	(-1.400)
R^2	0.0269	0.1203	0.2449	0.1525
SEE	0.0148	0.0227	0.0504	0.0478
SSR	0.0135	0.0336	0.1577	0.1437
Box-Ljung Q(17)	22.966	13.774	13.960	12.983

Notes: a, b and c imply significance at the 1%, 5% and 10% level, respectively. t statistics in parentheses. ***, ** and * imply rejection of the null at 1%, 5% and 10% level, respectively. SEE = Standard error of regression, SSR = Squared sum of residuals.

causality from the United States variables to the United States money. The United States income is only affected by the United States money. Thus, we find no evidence of Holland affecting the United States income or money supply. The diagnostic statistics are again satisfactory.

In the French tests (table 9), the error correction term is significant in the two French equations, but no other variable is significant. The speed of adjustment in both cases is very low: 0.65% per quarter for income and 1.85% per quarter for money. In the case of the United States money, only the United States variables impose an influence. Similarly the United States income is only caused by the United States money supply. No influence of France on the United States variables is found. This result is similar to the Dutch results (table 8) reported above.

Testing the relationship between Germany and the United States (table 10) results obtained are somewhat similar to the French results. The error terms are again significant only in the German equations. Besides the error term only the lagged German income is significant in the German income equation. The adjustment speed is higher than in case of France: 14.34% per quarter for income and 18.98% per quarter for money. The United States money supply is only influenced by the United States variables. No evidence is found of any German influence. In the case of the United States income, a more significant effect of United States money rather than German money is found. The F-test indicates jointly significant lagged German money at a low and weak 10% level. Thus, very little evidence is found of German money causing the United States income. Ample evidence is found of causality from the United States to Germany.

Results from the United States tests provide substantial evidence of causality from the United States money to the ERM countries income. Given that the exchange rate between the United States and these countries is freely floating, evidence of international transmission of monetary policy is quite surprising. Very little and weak evidence is found of the causality from the ERM countries to the United States. These results do back the theory that large reserve centre country's monetary policy affect the smaller non-reserve country's income and not vice versa. The United States monetary policy influence on the Dutch and French incomes may also provide evidence against the German dominance theory.

VII. Conclusion and Implications

This paper investigates monetary interdependence (or independence) by means of the money-income relationship between countries under a pegged exchange rate and a freely floating exchange rate system during the same time period. Tests are conducted between three European countries involved in the exchange rate mechanism (ERM): France, Germany and Holland. Further tests are conducted between these three countries and the United States (a non-ERM country), based on the ERM exchange rate between the three European countries being pegged while the rates between these countries and the United States is freely floating. The empirical tests are conducted using quarterly data from 1979 to 1997 and the Johansen multivariate cointegration method. Nominal M1 represents the money supply and nominal GDP represents the income for all countries. The theoretical model applied includes nominal money supply and nominal income from two countries. Six cointegration tests are conducted by pairing off two countries at a time. All six cases indicate a stationary long-run equilibrium relationship.

A constrained error correction model based on the cointegration tests is further conducted to investigate the direction of the causality between domestic income and foreign money. Between the ERM countries causality from foreign money to domestic money is found in all cases except from France to Germany. Dutch money influencing German income and bidirectional causality between Dutch and French variables provides evidence against the 'German dominance' theory. Based on this theory no other ERM country's money supply should affect German income or each other. Using the United States, results provide ample evidence of causality from the United States to the ERM countries and very little and weak evidence in the other direction. This may also provide evidence against the German dominance theory. But given that the exchange rates between the United States dollar and the currencies of these European countries are freely floating, strong evidence of strong causality from the United States money to the income of these countries is quite surprising. The United States results do support the theory that the large reserve centre country affects the smaller nonreserve centre countries.

Results presented provide evidence for and against several money-income theories. Results show the large country's (United States) monetary policy affecting smaller country's (Holland, France and Germany) income during flexible exchange rate regimes but not vice versa. Thus, evidence is provided against independent monetary policy of a smaller country during the flexible exchange rate regime but not against the independence of a large country's monetary policy. Results also show that the size of a country may not make a difference during a pegged exchange rate regime. International transmission of monetary policy in both directions is found between a small country (Holland) and a large country (Germany) during the ERM era.

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