Foreign Exchange Rate Determination: Basic Theories and International Evidence

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I. Introduction

Because of the high degree of volatility in the foreign exchange rate under the current floating exchange rate system, and the rising trade deficits in the United States,the determination of the foreign exchange rate has become once again an important topic in economic theory. There are five major theories on the exchange rate determination: The purchasing power parity theory (absolute and relative), the interest rate parity theory (covered and uncovered, nominal and real), the monetary theory (absolute and relative), the portfolio balance theory, and the trade balance theory (elasticity approach).

The major purpose of this paper is to test some of the above basic theories for several industrial countries with recent data. In the following Section II, some of the previous empirical studies are briefly reviewed. In section III and IV, the two parity theories, monetary, portfolio balance, and trade balance models are explained. In section V, possible reasons for deviations of the empirical data from the basic theories are discussed. The sources of the data and methodology are explained in section VI. The empirical results are presented in sections VII and VIII. In the final section IX, a summary and conclusions are provided.

II. Review of the Previous Studies

There are a large number of studies on the determination of exchange rate. In this paper, we will review only a few.[1] In a recent paper, using the

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1) Since there is a vast amount of literature on the determination of foreign exchange rate, it is impossible to review all. Some of the selected articles are listed in the reference section. For review of the theories and empirical studies, see Bergstrand (1983), Levi (1983), and

daily data for the period 1976-82, Tandon and Simaan (1985) found that the dollar value (15 country weighted average index) was positively correlated with the unexpected inflation rate in the measurement period and in the announcement period. However, as the nominal interest rate rises, the dollar value depreciated. They argue that the above results support the so-called "dynamic asset market theory", developed by Dornbusch (1976, 1980, 1983, 1985), Mussa (1982), and Bhadari (1983).[2] But, their R^2 values were at most 0.022 for the daily data. Using monthly data for the period 1971-83 for 43 countries, Adler and Lehmann (1983) found that deviations from the purchasing power parity follow the martingale process.

Booth-Duggan-Koveos (1985) found no contemporaneous correlation between exchange rate and inflation for 10 industrial countries, when monthly data for 1973-83 are used. However, when time lags were introduced, some correlation coefficients were significant. Using the Canadian daily data, Doukas (1985) found that only unanticipated money supply announcements affect the exchange rate immediately after the announcements. However, his R^2 values were no greater than 0.0782 for the daily data for the period 1974-78.

Using the Canadian quarterly data for the period 1971-1980, Backus (1984) tests the purchasing power parity theory, the monetary models of Frenkel (1976), Bilson (1978, 1979), and Hodrick (1978), the monetary

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Dornbusch (1980, 1985), Backus (1984) and Pippenger (1986).

For the purchasing power parity theory, see Richardson (1978), Kravis and Lipsey (1978), Genberg (1978), Thygesen (1978), Hodgson and Phelps (1975), Folks and Stransel (1975), Roll (1979), Pippenger (1982, 1986), Rogalski and Vinso (1977), Clements and Frenkel (1980), Krugman (1978), Adler and Lehmann (1983), Booth, Duggan and Koveos (1985). The modern version of the purchasing power parity theory was developed by Cassel (1916).

For the interest rate parity theory, see Officer and Willett (1970), Frenkel and Levich (1975), Levi (1977, 1983), Aliber (1973), Dooley and Isard (1980), Frankel (1979), Frenkel (1973, 1975, 1977), Batten and Thornton (1984). The modern version of the interest rate parity theory was developed by Keynes (1924).

For monetary models, see Dornbusch (1976, 1978, 1980), Frenkel (1976, 1981), Hodrick (1978), Bilson (1978), Girton and Roper (1977), Driskill (1981), Clements and Frenkel (1980).

For the portfolio balance model, see Branson (1976), Branson, Halttunen and Masson (1977, 1979), Tobin and Macedo (1980), Fischer (1980), Frenkel and Rodriguez (1975, 1982).

For the trade balance model, see Alexander (1959), Houthakker and Magee (1969), and Ford (1982).

2) The asset market theory of exchange rate argues that if the actual inflation rate is greater than the equilibrium exchange rate, then the transactions demand for money increases, and the nominal interest rate rises. As a result, capital inflow increases, and exchange rate appreciates. But, over time, forward premium on foreign exchange rate increases, and the exchange rate depreciates.

models with sticky prices of Dornbusch (1976), Frankel (1979, 1981), and Driskill (1981), and the portfolio balance models of Branson (1976), Branson and Halttnunen and Masson (1977, 1979), Tobin (1969), Tobin and Macedo (1980), Kouri (1976), Dornbusch and Fischer (1980), and concludes that all models are rejected by the tests, and that the exchange rate is very close to a random walk.

In older studies, Frenkel (1981), Richardson (1978), Kravis and Lipsey (1978), and Genberg (1978) were unable to find supporting evidence for the purchasing power parity theory. However, Hodgson and Rhelps (1975), Folks and Stansell (1975) found significant correlation between exchange rate and inflation rate when time lags were introduced. But, Rogalski and Vinso (1977) found significant instantaneous relationships between inflation and changes in exchange rates, but were unable to find any significant correlation for the lagged variables. They used monthly data for the period 1920-24 for 7 industrial countries. They argue that their results are consistent with the efficient market hypothesis which states that all past information is reflected on the current exchange rate, and thus past data such as inflation rate are not useful to predict current foreign exchange rate (Roll, 1979). Using quarterly data for the period 1973-79, Dornbusch (1980) found the monetary models insignificant for dollar/Mark exchange rate.

As to the interest rate parity theory, using monthly data for the period 1962-64, Branson (1969) found significant correlations between the forward rate of change and the interest rate differential for U.K. and Canada. However, Cumby and Obstfeld (1981), using weekly data for the period 1970-80, rejected the interest rate parity model for Canada, France, Germany, Netherlands, Switzerland, and U.K.

Many other studies are concerned with the behavior of the deviations of foreign exchange rate from the interest rate parity. Clendenning (1970), Frenkel and Levich (1975) found the deviations are too small to make extra profit from interest rate arbitrage. However, in a later study, Frenkel and Levich (1977) found some opportunities for excess profits from exchange arbitrage net of transaction costs. Poole (1967), Burt, Kaen and Booth (1977) found some significant serial correlations, which do not support the random walk hypothesis in the exchange market. However, these studies do not provide any information on the significance of interest rate parity theory in explaining the variations in the exchange rate.

Compared with the above and many other previous studies, this paper has the following features.

First, it tests primarily the basic theories in their pure forms without any time lags and without including any other independent variables. Second, this study uses annual data for the period 1962-84, that covers both the fixed and the floating exchange rate systems. Since the parity theories are essentially long-run equilibrium theories, annual data may be sometimes more appropriate than monthly or quarterly data. Since many empirical studies used daily, monthly and quarterly data without much success, annual data are tested in this paper. Adler and Lehmann (1983) state that a long-term hypothesis cannot be legitimately tested using monthly data. But disadvantage is that annual time series are shorter (p. 1476).

III. Purchasing Power Parity and Interest Rate Parity Theories

Before we discuss the empirical results of this study, it should be useful to review some of the basic theories on the exchange rate determination. The most popular traditional theories are the purchasing power parity theory and the interest rate parity theory. These theories are summarized in the following equations:

$$E = p/p^* \quad (3\text{-}1)$$

$$dE/E = (p - p^*) \quad (3\text{-}2)$$

$$dE^*/E = (i - i^*) \quad (3\text{-}3)$$

$$i - p = i^* - p^* \quad (3\text{-}4)$$

where

- E = foreign exchange in country A's currency per U.S. dollar.
- P = the price level in country A, namely, Korea, Japan, U.K., France, Germany, Canada. = P (A)
- P^* = the price level in country B (the U.S.) = P (B)
- dE/E = the percentage rate of change in foreign exchange rate (%)
- dE^*/E = the expected rate of change in foreign exchange rate (%)
- p, p^* = inflation rates (%) in countries A and B (U.S.)
- i, i^* = nominal interest rates (%) in countries A and B (U.S.)
- $i-p$ = r = real interest rate (%)

The variables with asterisk (*) denote for country B, or the U.S. Equation (3-1) represents the absolute purchasing power parity theory (APPP), which states that the equilibrium exchange rate should be equal to the price ratio of the two countries. To support the theory, when exchange rate is regressed on the price ratio, if the prices are expressed in terms of each country's currency unit, the coefficient of the Price ratio (p/p^*) should be equal to one, and the constant intercept should be equal to Zero. However, if the two prices are measured in price indexes, the coefficient of the price ratio need not be qual to 1.0.

Equation (3-2) is the relative purchasing power parity theory (RPPP), which is derived from Equation (3-1). Rewriting Equation (3-1) in terms of natural logarithms,

$$\ln E = \ln P - \ln P^* \qquad (3\text{-}5)$$

Differentiating with respect to time t,

$$\frac{1}{E}\frac{dE}{dt} = \frac{1}{p}\frac{dP}{dt} - \frac{1}{P^*}\frac{dP^*}{dt} \qquad (3\text{-}6)$$

If t = 1, we obtain Equation (3-2).

An alternative derivation may be shown. Equation (3-1) may be rewritten as

$$E_{t-1}(1 + dE/E) = [P_{t-1}(1 + p)] / [P^*_{t-1}(1+p^*)] \qquad (3\text{-}7)$$

Since $E_{t-1} = P_{t-1}/P^*_{t-1}$, solving for dE/E, we obtain

$$dE/E = \frac{1}{(1+p^*)}(p - p^*) \qquad (3\text{-}8)$$

If p* is negligible in $1/(1 + p^*)$, Equation (3-8) reduces to Equation (3-2). It states that the rate of change in foreign exchange rate (dE/E) is equal to the inflation differential of the two countries. If the inflation rate is higher in country A than in country B, country B's currency value, i.e., the exchange rate will increase. To support the theory, again the constant intercept will be equal to zero, and the coefficient of the inflation differential (p-p*) should be equal to 1.0.

Equation (3-3) is the covered interest rate parity theory. If states that the expected forward rate of change in foreign exchange rate is equal to the nominal interest rate differential. That is, if country A has a higher interest rate, its currency will depreciate, and vice versa. Therefore, dE*/E and i-i* are positively correlated. This proposition is apparently inconsistent with the idea that if country A has a higher interest rate than country B, investors in country B will wish to purchase more bonds in country A, and thus the demand for country A's currency will increase and the price of country A's currency will rise. This means that currency A should appreciate when interest rate differential increases for country A. However, according to the covered interest rate parity theory, this is true if the forward premium does not increase in the exchange market.

The covered interest rate parity theory is derived from the following equilibrium condition:

$$(1 + i^*) = (1 + i)\,E/F \qquad (3\text{-}9)$$

where i and i* are the nominal interest rates in countries A and B respectively, and F = the forward exchange rate, or the future expected exchange rate at the time the foreign bond is redeemed. If an investor purchases a bond in country B with a dollar, his wealth at the end of the year will be equal to $(1+i^*)$. If he purchases a bond in country A, his wealth will be equal to $E(1+i)$ at the end of the year in the value of currency A. At that future time, if the exchange rate is F, the value of the wealth will be $E(1+i)/F$ in terms of currency B. As long as $(1+i)E/F$ is greater than $(1+i^*)$, the demand for foreign bond will continue. Capital outflow is ceased when the quilibrium condition (3-9) is reached.

Euation (3-4) is the so called Fisher open condition which states that real interest rates should be equal across the countries. This theory also assumes that there is free international trade (Samuelson, 1966), and there is no risk difference between the two capital markets. Otherwise, including the risk premium, Equation (4) should be rewritten as

$$(i-p) = (i^*-p^*) + K \qquad (3\text{-}10)$$

where K = the risk premium, when country A has a higher risk. Assume that Equation (3-4) is true, then it follows that

$$p-p^* = i-i^* \qquad (3\text{-}11)$$

Thus, in equilibrium

$$dE/E = dE^*/E \qquad (3\text{-}12)$$

Equation (3-12) states that the actual rate of change in exchange rate dE/E should be equal to the "expected" rate of change, dE^*/E in equilibrium in the Fisherian open economy.

IV. Monetary, Portfolio Balance, and Trade Balance Theories

The monetary models may be derived from the purchasing power parity model using the quantity theory of money:[3]

3) The monetary models may be derived in another way: See Backus (1984) and Bilson (1979):
In terms of natural logs, the absolute purchasing power parity theory is

$$E = P-P^* \qquad (a)$$

The demand for money in logs is

$$M-P = aY-bi \qquad (b)$$

$$M^*-P^* = aY^*-bi^* \qquad (c)$$

All variables are ejxpressed in logs except for i and i*. Variables with * are for country B and

$$P = MV / Y \tag{4-1}$$

where P = the price level, M = the supply of money, V = velocity of money, Y = the real GNP. Substituting Equation (4-1) in Equation (3-1), we obtain

$$E = (MV/Y) / (MV/Y)^* \tag{4-2}$$

If we assume V and Y are constant as is the case for the rigid quantity theory of money, we obtain

$$E = a\, M / M^* \tag{4-3}$$

where $(V/Y) / (V/Y)^* = a$.

Alternatively, we may rewrite Equation (4-2) in natural logarithms:

$$\ln E = (\ln M - \ln M^*) \quad (\ln Y - \ln Y^*) + (\ln V - \ln V^*) \tag{4-4}$$

If we assume that the velocity is a function of the rate of interest, Equation (4-4) may be rewritten as

$$\ln E = (\ln M - \ln M^*) - (\ln Y - \ln Y^*) + f(i - i^*) \tag{4-5}$$

To obtain the rate of change in exchange rate, by differentiating Equation (4-4) with respect to time t, and letting t = 1, we may derive Equation (4-6):

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variables without it is for country A.

Substituting P and P* in (b) and (c) in (a),

$$E = (M - M^*) - a(Y - Y^*) + b(i - i^*) \tag{d}$$

$$= M' - aY' + bi' \tag{e}$$

Some monetary models drop the last interest rate differential term on the ground that country A's interest rate (i) should not be presumed as exogenous variable. According to the interest rate parity theory,

$$E^* - E = i - i^* \tag{f}$$

Thus,

$$i = E^* - E + i^* \tag{g}$$

Substitutin (g) in (d)

$$E = M' - aY' + b(E^* - E) \tag{h}$$

Solving for E*

$$E^* = -(1/b)M' + (a/b)Y' + [1 + b)/b]E \tag{i}$$

Solving the above stochastic differential equation, Bilson (1979) shows without proof:

$$E = (1 + b)^{-1} \sum_{i=0}^{X} [(1 + b)/b]^{-j} E(M' - aY')(t + j)$$

where $E(M' - aY')(t + j)$ is the expected value (E) of $M' - aY'$ for period $t + j$. See Backus (1984, pp. 826-827).

$$dE/E = (m - m^*) - (y - y^*) + (v - v^*) \quad (4\text{-}6)$$

where $m = dM/M$, $y = dY/Y$, and $v = dV/V$. If velocity is constant, the last term will drop out. If we assume $v = v(i)$, Equation (4-6) may be rewritten as

$$dE/E = (m - m^*) - (y - y^*) + g(i - i^*) \quad (4\text{-}7)$$

To support the monetary model, the rate of change in exchange rate should be positively correlated with the monetary growth differential, and the interest rate differential, and negatively correlated with the real GNP growth differential.

If the two velocities are the same for the two countries, the last term in Equation (4-4) will drop out, and we have

$$\ln E = (\ln M - \ln M^*) - (\ln Y - \ln Y^*) \quad (4\text{-}8)$$

Also, Equation (4-6) will take the form

$$dE/E = (m - m^*) - (y - y^*) \quad (4\text{-}9)$$

The portfolio balance models are well summarized in Backus (1984). We will review only one simple basic portfolio balance model.[4] The total

4) Backus (1984) gives the following sumary of the portfolio balance model: The total financial wealth of an investor in country A is equal to

$$W = M + B + EF$$

The three demand functions are

$$M = M(i, i^* + E^*, Y, W)$$
$$B = B(i, i^* + E^*, Y, W)$$
$$EF = F(i, i^* + E^*, Y, W)$$

where W = total financial wealth, M = domestic money stock, i = domestic short term interest rate, i^* = foreign short term interest rate, E^* = expected exchange rate, Y = real incme, B = domestic bond, F = the foreign bond, i.e., the net foreign asset position and the stock of foreign-denominated claims. e = foreign exchange rate. Thus, EF = the foreign bond value converted into domestic currency. Except the interest rates, i and i^*, all variables are measured in natural logarithms. The three equations determine the two endogenous variables, i and E. One equation is redundant in the three equilibrium equations. In the above portfolio balance model, we note that another important financial asset, equity stock is ignored.

$$S = S(i, i^* + E^*, r, r^* + E^*, Y, W)$$
$$ET = T(i, i^* + E^*, r, r^* + E^*, Y, W)$$

where S = domestic equity stock, T = net foreign stock, ET = net foreign stock in domestic currency, r = the rate of return on domestic euqity stock, r^* = the rate of return on foreign equity stock. If the above two equations are added to the previous three demand equations, we will have 5 equation (4 independent equations) for the 3 endogenous variables, i, E, and r. The system would be overidentified. The domestic equity stock S could be regarded as an endogenous variable to be exactly identified.

wealth of an investor consists of three types of assets: money stock, domestic bond, and foreign bond. Each asset demand is a function of domestic and foreign interest rates, expected rate of change in exchange rate, real income and the total wealth. In the three demand equations, the endogenous variables are the domestic interest rate and the exchange rate. Solving for the exchange rate, the reduced form is given as a function of the exogenous variables:

$$E = E\,(M,\ B,\ B^*,\ i^* + E^*,\ Y) \tag{4-10}$$

where E = exchange rate, M = money supply, B = domestic bond, B^* = foreign bond, i^* = foreign interest rate, E^* = expected exchange rate, Y = real income. The variables are expressed in logarithms except for the interest rates. M and $i^* + E$ are expected to have positive signs, and all other variables are expected to have negative signs.

Finally, the trade balance model may be interpreted as a dynamic model of exchange rate. The equilibrium exchange rate is determined by the supply of and the demand for the foreign currencies. The major reason for the demand for foreign exchange is to finance imports of goods and services, and the major source of the supply of foreign exchange is the revenue from exports. When imports and exports of goods and services are not balanced for a given period, there is either excess demand for or excess supply of foreign exchange. The greater the excess demand for foreign exchange, the greater will be the rate of depreciation of the currency. This situation may be expressed as

$$dE/E = f\,[\,(M - X)\,/\,X\,] \tag{4-11}$$

where M = imports of goods and services, X = exports. Thus, $(M-X)/X$ is a measure of excess demand for foreign exchange. It should be positively correlated to the rate of depreciation, dE/E. Equation (4-11) is further explained later in section VII using Figure 2.

V. Possible Deviations from the Basic Theories

As we have seen before, most previous empirical studies found large deviations of the actual data from the purchasing power parity and interest rate parity as well as monetary and portfolio balance theories. As possible reasons for such deviations, the following factors are often cited: (1) transportation cost of goods and services, (2) tax (tariff on imports and taxes on interest income), (3) import and export control, (4) foreign exchange control (direct and indirect), (5) price control, (6) interest rate control, (7) country risk differences (political, economic and business), (8) control on capital movement, (9) investor's geographical preferences, etc.

We may show that some of the above factors are significant, but others are not significant for the basic parity models. First, we may introduce the transportation (transaction) cost and tax variables in the foreign trade. The absolute purchasing power parity equation (3-1) may be rewritten as

$$E = \frac{(1+t)}{(1+t^*)} \cdot \frac{P}{P^*} \tag{5-1}$$

where t = tax rate on domestic goods in country A, t* = tax rate on imports from country B, or the trade barrier cost, including transportation cost, import tariffs, and shipping insurance cost. In general, $t < t^*$. E = the price of the foreign currency (U.S. dollar) in country A's currency unit.

In spite of the trade barrier costs (transportation, transaction costs tariff and insurance costs), the relative purchasing power parity equation can remain the same as Equation (3-2), if t and t* are constant.[5)]

$$dE/E = (p - p^*) \tag{5-2}$$

As to the interest rate parity theory, there are three major criticisms. First, taxes on interest income are ignored. If we introduce differential tax rates on interest income in the two countries. The interest rate parity equation (3-9) can be rewritten as

$$[1 + i^*(1 - t^*)] = [1 + i(1-t)]\ E/F \tag{5-3}$$

where t* = tax rate on interest income earned in country B, imposed by countries A and B, t = tax rate on interest income earned in country A, imposed by countries A and B. Solving Equation (5-3), we obtain

$$dE^*/E = \frac{1}{[1+i^*(1-t^*)]}\,[i(1-t) - i^*(1-t^*)] \tag{5-4}$$

where (F-E)/E = dE*/E.

If the real after tax interest rates should be equal across the countries, the Fisher open condition (3-4) may be rewritten as

$$[i(1-t) - p] = [i^*(1-t^*) - p^*] \tag{5-5}$$

If the inflation rate and the tax rates are negligible, Equations (5-4) and (5-5) will be reduced to Equations (3-3) and (3-4).

The second criticism is that interest rate parity equation (3-3) assumes

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5) As before, rewrite Equation (5-1) in natural logarithms, and differentiate with respect to time t:

$$\ln E = \ln(1+t) + \ln P - \ln(1+t^*) - \ln p^*$$

Since tax rates t and t* are constant,

$$\frac{1}{E}\cdot\frac{dE}{dt} = \frac{1}{P}\cdot\frac{dp}{dt} - \frac{1}{p^*}\cdot\frac{dp^*}{dt}$$

that there is no risk difference in the two capital markets. If country B has a higher risk (political, economic and business) than in country B, the nominal interest rate should be higher in country A than in country B. If we introduce the risk premium K, the equilibrium condition (3-5) should be rewritten as

$$(1+i^*+K) = (1+i)\ E/F \tag{5-6}$$

where K = the risk premium required for country B's investor's point of view. From Equation (5-6), we can derive the following condition:

$$dE^*/E = \frac{1}{(1+i^*+k)}\ [\, i-(i^*+K)\,] \tag{5-7}$$

The third criticisms is that the covered interest rate parity theory assumes that there are no adjustment lags in the international capital movements and changes in the the forward rate. There are at least two types of time lags in the process. One is the lag between the changes in interest rates and actual capital movement, and the other is the time lag between the actual capital movement and the time when the forward premium in the exchange rate rises. Thus, the interest rate parity theory assumes that capital movements and the change in the forward rate immediately take place after the change in the interest rate differential. If some capital movements are not covered in the forward or futures market, the interest rate differential and the rate of change in "spot" exchange rate can be negatively correlated, since the increases in the demand for foreign exchange will merely appreciate the country's currency where interest rate is higher. In such a case, the actual rate of change in exchange rate should have the following relation:

$$dE/E = a-b(i-i^*) \tag{5-8}$$

where dE/E = the actual rate of change in exchange rate.

VI. The Data and Methodology

In testing the above theories there are several problems. First, using the annual data for the period of recent fluctuating exchange rate system, 1973-84, the major problem is that the period of observation is too small. For this reason, we extended the observation period to cover the period of fixed exchange rate system, 1962-72. In other words, about half (11 years) of the entire observation period consists the fixed exchange rate system, and the remaining half (12 years) consists of the fluctuating exchange rate system. Since the two periods are "heterogenous", we can use the Gujarati's (1982, pp. 295-299) dummy variable method. For instance, the absolute purchasing power parity equation (3-1) is

$$E = a + b(P/P^*) + e \tag{7-1}$$

By the method of Gujarati's dummy variables, it can be tested in the following equation:

$$E = a + b(P/P^*) + (D + dD(P/P^*) + e \tag{7-2}$$

where D is the dummy variable. The term c D is the differential intercept, an d D is the differential slope. For the period of fixed exchange rate system, 1962-72, the dummy variable 1 is assigned, and for the period of fluctuating exchange rate system, the dummy variable 0 is assigned. This method does not require the Chow test, and has the advantage of losing no degrees of freedom. Also, it should be noted that the fixed exchange rate system does not imply that the exchange rates are indeed fixed without any fluctuations. (See Table 1). Indeed, in empirical results, the dummy variables were not significant. Thus, we will show only the equations without dummy variables in Table 2-20.

The second problem in the empirical test is concerned with the data. All the data used in this paper are taken from IMF, *International Financial Statistics, Yearbook*, 1985. For the exchange rate, we have used the market rate (series rf). For the price index, we have tested both the consumer price index (series 64) and the wholesale price index (series 63). The results were very similar, but we will show the results with WPI only, since WPI produced very slightly better R^2 values.

As to the interest rates, the bond equivalent rates were used since no other uniform series were available: U.K. (series 60cs), France (series 61), Germany (series 61), Canada (series 61a) and the U.S. (series 60cs). For Korea, only the discount rate (series 60) was available. For Japan, also the discount rate (series 60) was used since other interest rates were not available for the early years of the observation period.[6]

For the money supply, series 34 (currency + demand deposit) is used. For the real income, GDP or GNP was used due to the availability: Korea (GDP, series 99bp), Japan (GNP, series 99ar), U.K. (GDP, series 99bp), France (GDP, series 99br), Germany (GNP, series 99ar), Canada (GNP, series 99ar), and the U.S. (GNP, series 99ar). The real incomes are measured all in 1980 constant prices of each country's currencies.

6) Using the daily data for the period 1975-83, Batten and Thornton (1984) found that the U.S. dollar value (weighted average exchange rate) was positively correlated with unexpected increase in discount rate. But R^2 values were less than 0.105.

VII. Empirical Results (1)

The repression results are summarized in Table 2-17. It may be useful to summarize each model and then discuss the empirical results.

(1) Purchasing power parity theory:

$$E = a + b(P/P^*) + e \qquad (7\text{-}1,\ \text{Table } 2)$$

$$\ln E = \ln a + b \ln (P/P^*) + e \qquad (7\text{-}2,\ \text{Table } 3)$$

$$dE/E = a + b(p - p^*) + e \qquad (7\text{-}3,\ \text{Table } 4)$$

where e = the error term. All other variables were defined before. For the sake of easy typing, all the coefficients, a, b, c. . . are used without subscripts.

The absolute purchasing power parity theory states that the exchange rate should be equal to the price ratio of the two countries. To support the theory, the slope coefficient *b* should be positive and significant in Equation (7-1). If the price ratio is measured in terms of monetary units, the coefficient of *b* should be equal to 1.0 However, when the prices are measured in terms of indexes, *b* should be any positive constant. In such a case, the intercept constant *a* can be also any significant or insignificant constant. In Table 2, the price ratio is positive and significant in all equations. The intercept constant is significant for only for Canada. These results are consistent with the absolute purchasing power parity theory.

Equation (7-2) is the absolute purchasing power parity theory in terms of natural logarithms. In Table 3, the intercept constants and the slope coefficients are all significant. The R^2 value are between 0.8662 and 0.9820. In effect, the absolute purchasing power parity theory is strongly supported by the annual data.

Equations (7-3) is the relative purchasing power parity theory. It states that the rate of change in exchange rate should be equal to the inflation rate differential in the two countries. To support the theory, the constant intercept should be equal to zero, and the slope coefficient should be equal to 1.0. In Table 4, the intercept constants are not significant. Except for U.K., the slope coefficients are all positive and significant ranging from 0.7972 and 1.2965, which are not significantly different from 1.0 The R^2 values are between 0.2798 and 0.5413, which are significantly lower than for the absolute purchasing power parity theory. However, the results are consistent with the relative purchasing power parity theory except for U.K.

(2) Nominal Interest Rate Parity Theory:

$$dE/E = a + b(i - i^*) + e \qquad (7\text{-}4,\ \text{Table } 5)$$

$$dE/E = a + b(i - i^*)_{t-1} + e \qquad (7\text{-}5,\ \text{Table } 6)$$

The interest rate parity theory states that the "expected" forward rate of change in exchange rate should be equal to the nominal interest rate differential in the two countries. Thus, in Equations (7-4) and (7-5), the dependent variables should be dE*/E instead of the actual rate of change in exchange rate, dE/E. However, we have not used dE*/E for the following three reasons. First, there is no satisfactory measure of the expected rate of change in exchange rate. Second, as we have seen before, according to the Fisher open condition, in equilibrium, the expected rate of exchange in exchange rate should be equal to the actual rate of change in exchange rate. Third, instead of the expected rate, when the actual rate of change in exchange rate is used, Equation (7-4) may be regarded as the "spot" interest rate parity theory, since the forward rate or the futures rate is not necessarily equal to the realized exchange rate.[7)]

In Table 5, the interest rate differential is significant only for Germany and Canada. But, for Germany, the coefficient has a negative sign, which is inconsistent with the interest rate parity theory. For Canada, the interest rate differential coefficient is 1.0401, which is not statistically different from 1.0, and this result is exactly consistent with the interest rate parity theory.

To examine for possible time lags, dE/E is regressed on one-year lagged interest rate differential. The results are shown in Table 6. They are very similar to those in Table 5. That is, only for Canada, the interest rate differential is positively correlated to the actual rate of change in exchange rate. For Germany, it is negatively correlated. We will discuss more in detail about the above results with regard to the real interest rate parity theory later in section VIII.

(3) Inflation-Interest Rate Model:

$$dE/E = a + b(p - p^*) + \quad (i - i^*) + e \qquad (7\text{-}6,\ \text{Table } 7)$$

The purchasing power parity theory is based primarily on the commodity arbitrage theory, and the interest rate parity theory is based on the bond arbitrage theory. Thus, the demand for and the supply of foreign exchange primarily depend upon commodity and security prices, and the rate of change in exchange rate should depend upon both inflation and interest rate differentials. To support the above theory, both inflation rate differential and interest rate differential should be significant, though the

7) Frankel (1980) found the forward rate did not pass the rationality test. levich (1979) found the forecast error of the forward rate was unbiased, but R was only 0.10. He concludes that the forward rate is a very poor predictor of the future exchange rate. Agmon (1981) found R values between 0.05 and 0.346, using the data for the period 1973-77 for Germany, U.K., and Switzerland.

sizes of the regression coefficients are not relevant. In Table 7, only the inflation rate differential is significant for all countries, and the interest rate differential is not significant. The above results do not support the inflation-interest rate model.

VIII. Empirical Results (2)

(4) Monetary Models:

$$E = a + b(M/M^*) + e \qquad (7\text{-}7,\ \text{Table } 8)$$

$$\ln E = \ln a + b \ln(M/M^*) + e \qquad (7\text{-}8,\ \text{Table } 9)$$

$$\ln E = \ln a + b \ln(M/M^*) - c \ln(Y/Y^*) + e \qquad (7\text{-}9,\ \text{Table } 10)$$

$$\ln E = \ln a + b \ln(M/M^*) - c \ln(Y/Y^*) + d(i - i^*) + e \qquad (7\text{-}10,\ \text{Table } 11)$$

$$dE/E = a + b(m - m^*) + e \qquad (7\text{-}11,\ \text{Table } 12)$$

$$dE/E = a + b(m - m^*) - c(y - y^*) + e \qquad (7\text{-}12,\ \text{Table } 13)$$

$$dE/E = a + b(m - m^*) - c(y - y^*) + d(i - i^*) + e \qquad (7\text{-}13,\ \text{Table } 14)$$

Six monetary models are tested in this paper. Equations (7-7)-(7-10) are the absolute monetary models. The constant intercept a may or may not be significant, but the slope coefficients, b and d should have significant positive signs, and c should have a negative sign, as specified in the above equations.

In Table 8, the monetary ratio has significant correct positive signs only for Korea and U.K. For Japan, France and Germany, the money supply ratio has significant wrong negative signs. For Canada, the positive sign is not significant. In the logarithmic results in Table 9, the money supply ratio has significant correct positive signs for Korea and U.K., but has significant wrong negative signs for Japan and Germany. In Table 10, the income ratio is added to the monetary ratio. The income ratio is negative and significant only for Canada. The monetary ratio is positive and significant only for U.K. These results do not support the monetary model. In Table 11, the interest rate differentia is added to the monetary ratio and the income ratio. The signs of the coefficients are mixed, but generally the regression results do not support the monetary model.

Equations (7-11)-(7-13) are the relative monetary models to explain the variations of the rate of change in exchange rate. In Table 12, the monetary growth rate differential is not significant. In Table 13-14, the monetary growth rate differential and interest rate differential are not significant. The income growth rate differential is significant only for Canada, but it has a wrong negative sign. In effect, none of the regression equations supports the relative monetary model.

(5) Trade balance model:

$$dE/E = a + b\,[(M-X)/X] + e \qquad (7\text{-}14,\ \text{Table 15})$$

If the supply of and the demand for foreign currencies are related only to exports and imports, at an equilibrium exchange rate, imports should be equal to exports. However, in disequilibrium, if imports are greater than exports, exchange rate will depreciate. The greater the excess demand for foreign currencies, the greater will be the rate of depreciation. The excess demand gap is measured in terms of (M-X)/X, where M = imports, X = exports.

The above model is explained in Figure 1. The supply of foreign currencies ($) is a function of exchange rate and exports, and the demand for foreign currencies ($) is a function of exchange rate E_1, the demand for the dollar is E_1B, the supply of the dollar is E_1A, and the excess demand for the dollar is AB. The greater the excess demand gap, the greater will be the rate of depreciation, dE/E. The regression results are presented results are presented in Table 15. We note that the regression equation is significant only for France, and not for Korea, Japan, U.K., Germany and Canada.

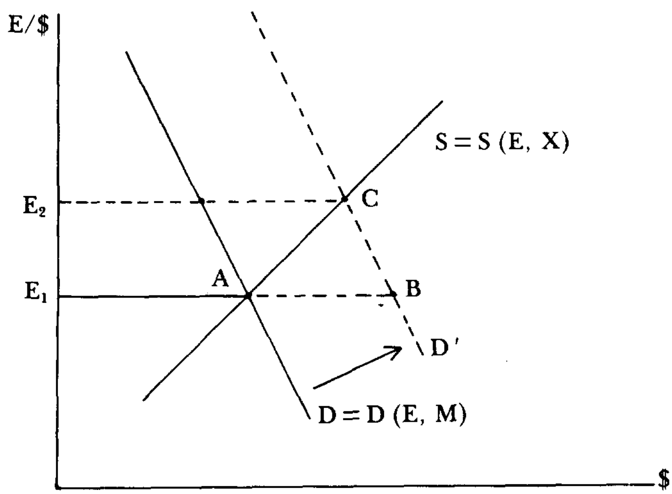

Figure 1. Trade Balance Theory

(6) Real interest rate equality theory (Fisher open condition):

(a) $r = a + b r^* + e$ (7-15, Table 16)

(b) $dE/E = a + b(p - p^*) + e$ (7-16, Table 17)

$dE/E = a + b(i - i^*) + e$ (7-17, Table 17)

$r = a + br^* + e$ (7-18, Table 17)

Though the Fisher open condition is not directly related to the determination of foreign exchange rate, it is relevant to examine the relationship between the relative purchasing power parity theory and the interest rate parity theory. As briefly discussed in section III, If the Fisher open condition should hold, two important conclusions would result. First, in equilibrium, the actual rate of change in exchange rate dE/E should be equal to the expected (or forward) rate of change in exchange rate dE^*/E. Second, it should support the factor equalization theorem in real terms (Samuelson, 1966).

In Table 16, the real interest rate of each country is regressed on the U.S. real interest rate. The U.S. real interest rate is significant and has positive signs for all countries. The coefficients are not statistically different from 1.0, as the real interest rate equality theory predicts, for Korea, Japan, U.K., and Canada. However, for France and Germany the coefficients are significantly less than 1.0. In effect, the above results show that there are strong relationships between each country's real interest rate and the U.S. real interest rate.[8)]

The joint model of Equations (7-16)-(7-18) is estimated by the method of seemingly unrelated regression, since the error terms may be correlated between the three equations.[9)] The inflation rate differential is still significant at the 5% level for all six countries. However, the nominal interest rate differential is significant only for France, Germany and Canada. It has a negative sign for Germany. The positive sign for France is significantly greater than 1.0. The coefficient for Canada is 0.9611, which is not significantly different from 1.0. In the real interest rate equations, all the coefficients are positive and significant. In effect, only for the Canada, the relative purchasing power model, the nominal interest rate parity model, and the Fisher open condition are jointly supported.

8) Mishkin (1984) rejects the real interest rate equality theory by a joint test, using quarterly data for the period 1967-69, for U.S., Canada, U.K., France, Germany, the Netherlands, and Switzerland.

9) For seemingly related regression method, see Pindyck and Rubinfeld (1981, pp. 323-24, 331-34).

(7) Real interest rate parity model (Real interest rate plus risk premium parity hypothesis):

(a) $dE/E = a + b(r - r^*) + e$ (7-19, Table 18)

(b) $i = a + bi^* + e$ (7-20, Table 19)

(c) $dE/E = a + b(p - p^*) + e$ (7-21, Table 20)

$dE/E = a + b(r - r^*) + e$ (7-22, Table 20)

$i = a + bi^* + e$ (7-23, Table 20)

In Table 5, 6 and 17, we have seen that the nominal interest rate parity models are fully supported only for Canada, and rejected for other 5 countries. The following reasons may be listed for the poor performance of the nominal interest rate parity model: (1) Country risk differences are ignored, (2) tax rate differences are ignored, (3) interest rate data are heterogenous, (4) some other important variables might have been ignored in the model, (5) the expected rate of change in exchange rate should have been used instead of the actual rate of change, (6) the nominal interest rate parity model has some specification errors.

To see if an alternative model can improve the interest rate parity model, what may be called the real interest rate parity model is tested in Equations (7-19)-(7-23). In the nominal interest rate parity model, the nominal interest rate is the objective of the arbitrage operation, and inflation factor is implicitly assumed to be taken care of by the forward premium exchange rate.

However, in an uncovered interest rate arbitrage operation, the real

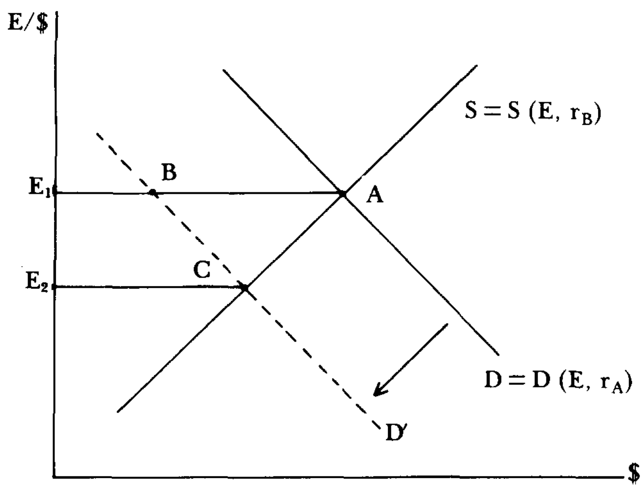

Figure 2. Real Interest Rate Parity Theory

interest rate differential may be the significant target. This model is explained in Figure 2. Assume that in country A, the supply of foreign currencies ($) is a function of the dollar price (exchange rate) and the real interest rate in country B (the U.S.). The demand for the dollar is a function of exchange rate and the real interest rate of country A. Assume that in country A, the initial equilibrium is at point A, where the real interest rates are equal between the two countries. If the real interest rises in country A, the demand for the dollar falls, since investors in country A will want to purchase country A's bonds instead of U.S. bonds. The demand curve D shifts to D's, and the excess supply of the dollar is AB. The greater the real interest rate differential (r-r*), the greater will be the excess supply of the dollar, and the greater will be the rate of depreciation of the dollar. Thus, the real interest rate differential (r-r*) will be negatively correlated to rate of change in spot exchange rate, dE/E.[10)]

In the above model, we can further introduce the risk premium. The equilibrium condition for the two capital markets in the absence of foreign exchange would be

$$(1 + r^* + K) = (1 + r) \tag{7-24}$$

where K = the risk premium. Thus, in the presence of foreign exchange and in disequilibrium, the rate of change in exchange rate can be expressed as a function of the real interest rate differential and the risk premium.

$$\begin{aligned} dE/E &= [r-(r^*+K)] \\ &= K-(r-r^*) \\ &= a-b(r-r^*) \end{aligned} \tag{7-25}$$

where a = K, b = 1.0. Equation (7-25) is equal to (7-19). When dE/E is regressed on the real interest rate differential, the intercept would represent the risk premium. If $a > 0$, country A has a higher risk, and if $a < 0$, country B has higher risk.

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10) In Frankel (1979) model, the nominal interest rate differential is negatively correlated with the rate of change in exchange rate. His "real interest rate differential model" is given by:

$$e = (m-m^*) - a(y-y^*) - b(i-i^*) + c(p-p^*)$$

where e = the log of the spot exchange rate, m = long of money supply, y = log of output, p = log of price level, i = log of interest rate, a,b,c = coefficient, * denotes foreign country variables. (p.613)

Using monthly data for the period 1974-78 for Mark/dollar rate, Frankel argues that the regression results are consistent with his hypothesis that *b* has a negative sign. However, when annual data are used, in my study, for Korea, Japan, U.K., France, Germany, and Canada, the results were consistent with only the purchasing power parity theory for all six countries, and inconsistent with Frankel and other hypotheses.

Given Equations (7-25) and the relative purchasing power parity model, Equation (7-3), we may combine the two to obtain the relationship between the nominal interest rates in the two countries. Since Equations (7-3) and (7-25) are equal with regard to the rate of change in exchange rate, we have

$$(p-p^*) = a-b(r-r^*)$$

$$= a-b[(i-p)-(i^*-p^*)]$$

$$i = [a/b-(p-p^*)(b-1)/b] + i^* \qquad (7\text{-}26)$$

When $b=1$, Equation (7-26) reduces to (7-23), i.e.,

$$i = a + i^* \qquad (7\text{-}27)$$

As stated before, *a* represents the risk premium. If $a > 0$, country A has a higher risk than country B, and vice versa. If $a=0$, the two countries would have an equal risk.

In Table 18, the rate of change in exchange rate (the dollar price in country A's currency, dE/E) is regressed on the real interest rate differential. We note that the real interest rate differential is negative and significant for Korea, Japan, U.K., France, and Germany, but not for Canada. The coefficients are all statistically not different from 1.0 except for Germany. The intercept constant that represents the risk premium is positive and significant for Korea, U.K. and Germany. The above results are generally consistent with the real interest rate (plus risk premium) parity hypothesis.

In Table 19, the regression results for Equation (7-20) are shown. The nominal interest rate of each country is regressed on the U.S. nominal interest rate. The slope coefficients are significant for U.K., France, Germany, and Canada, and they are statistically not different from 1.0, except for Germany. The slope coefficients are not significant for Korea and Japan for which the discount rates are used instead of the market bond rates. Thus, the above results are also consistent with the nominal interest rate (plus risk premium) equality hypothesis for U.K., France, and Canada.

Finally, the joint model for the relative purchasing power parity theory, the real interest rate parity theory, and the nominal interest rate equality theory, Equations (7-21)-(7-23), is tested by the seemingly unrelated regression method. In Table 20, we note that the inflation rate differentials have all correct positive signs for the rate of change in exchange rate for six countries. Also, the real interest rate differential have correct negative signs for the rate of change in exchange rate. The intercept constants are positive and significant for Korea, U.K, France, Germany, and Canada, except for Japan. As for the nominal interest rate equations, each country's nominal interest rate is positively correlated with the U.S. nominal interest rate for 5 countries, except for Korea. The intercept constants are positive and significant for five countries except for Canada. These results are consistent with the real interest rate (plus risk premium) parity hypothesis. Recall that Canada was the only country for which the joint model of the relative purchasing power parity theory, the nominal interest rate parity theory, and the Fisher open condition was supported. For other countries, namely, U.K., France, and Germany, the real interest rate (plus risk premium) hypothesis is supported.

IX. Summary and Conclusions

Many previous empirical studies were unable to find strong supporting evidence for the theories on exchange rate determination using daily, weekly, monthly or quarterly data. In this paper, using the annual data, we have found strong supporting evidence for the absolute and relative purchasing power parity theories for Korea, Japan, U.K, France, Germany and Canada for the period 1962–84. (Tables 1-4).

As for the nominal interest rate parity theory, the empirical results were consistent with the theory only for Canada. That is, when the rate of change in exchange rate was regressed on the nominal interest rate differential, the slope coefficient had a significant positive sign only for Canada. (Tables 5-6). As an alternative model, i.e., the real interest rate (plus risk premium) parity model, the rate of change in exchange rate was regressed on the real interest rate differential. The real interest rate differential had negative signs for the rate of change in exchange rate for all six countries, and was significant for Korea, Japan, France, and Germany. For the U.K and Canada, it was not significant. (Tables 16-17). But, in a joint model, the real interest rate differential was negatively correlated with the rate of change in exchange rate for five countries, except for Canada.

The absolute and relative monetary models were also tested. Only the most simple monetary model was supported for Korea and U.K., and not for Japan, France, Germany, and Canada. (Tables 8-10). When the trade balance model was tested, it was supported only for France (Table 15).

Finally, we have tested the interest rate equality theories. The Fisher open condition was met for Korea, Japan, U.K. and Canada, but not for France and Germany. (Table 16). When the nominal interest rate (plus risk premium) parity hypothesis was tested, it was supported for U.K., France, Germany, and Canada, but not for Korea and Japan. (Tables

19-20). The portfolio balance model was not tested in this paper since satisfactory data for the international bond holdings were not available.

Proving or disproving a theory is not an easy task. For further research in the exchange rate determination, particularly for the interest rate parity models, the following points may be taken into the consideration: (1) Different interest rates may be used, (2) additional variables may be included, (3) expected rate of change could be used. It may be calculated using ARIMA models and other predicting models, (4) simultaneous equation models (domestic and international) may be tested, (5) a longer sample period should be used, and (6) alternative models may be built, (7) the significant negative correlation between the actual rate of change in exchange rate and the real interest rate differential need to be examined further.[11)]

(8) Another question to be considered is that whether a theory should be universal, that is, should a model hold true for all countries all the time, or just for specific countries for a specific period of time? The above empirical results suggest that the foreign exchange and interest rate models are not necessarily universal. Depending upon each country's unique factors, some theories apparently better fit than others.[12)]

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11) In a recent paper, using six month moving average data, Hakkio (1986) examines the relationship betwen nominal interest rate, real interest rate, and effective exchange rate. . . a weighted average of 10 bilateral exchange rates. Glick (1986) provides a vector autoregressive results for Japan and Germany vis-a-vis the U.S. In his model, real exchange rate and money supply are included, but inflation and interest rate are excluded.

In the real world, foreign exchange rate, money supply, inflation, interest rate, imports, exports, stock and bond prices must be interdependent between countries as well as within a country. thus, simultaneous equation models may be more appropriate. Several simultaneous equation models were tested using the nonlinear least squares estimation method. However, we were unable to obtain any satisfactory results to support such models.

12) The purchasing power parity theory fits well for Korea, and the nominal interest rate parity theory fits well for Canada. It is possible that the Korean exchange rate authority was "maintaining" exchange retes on puchasing power parity, and the Canadian exchange rate authority was "managing" exchange rates on nominal interest rate parity. In such cases, a theory is used to support the fact, and the fact is not an evidence to support the theory.

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Table 1 Means and Standard Deviations

	Period	dE/E	s(dE/E)	dP/P	s(dP/P)	i	s(i)
(1) Korea	1962-84	9.20	14.35	14.23	11.37	14.87	6.98
(won)	1962-72	12.18	18.84	12.31	8.06	18.72	7.53
	1973-84	6.46	8.49	16.00	13.88	11.33	4.16
(2) Japan	1962-84	-0.15	7.00	4.02	7.79	5.92	1.31
(yen)	1962-72	-1.47	4.00	1.09	1.51	5.72	0.71
	1973-84	-1.61	9.14	6.71	10.14	6.10	1.70
(3) U.K.	1962-84	3.61	8.76	8.45	6.52	10.29	3.19
(pound)	1962-72	1.14	4.87	3.87	2.35	7.39	1.41
	1973-84	5.88	10.96	12.65	6.31	12.95	1.55
(4) Germany	1962-84	2.97	10.09	6.82	7.26	8.86	3.31
(Mark)	1962-72	0.28	3.92	2.98	3.62	6.19	1.24
	1973-84	5.44	13.26	10.33	8.08	11.31	2.63
(5) France	1962-84	-1.18	8.39	3.54	3.24	7.69	1.31
(franc)	1962-72	-2.06	3.24	1.70	1.82	7.08	0.87
	1973-84	-0.37	11.38	5.22	3.39	8.25	1.43
(6) Canada	1962-84	1.12	3.19	6.06	5.09	7.54	3.80
(C. $)	1962-72	-0.18	2.43	2.18	1.30	4.69	1.27
	1973-84	2.32	3.43	3.62	4.63	10.15	3.40
(7) U.S.	1962-84			5.42	5.17	6.63	2.96
($)	1962-72			2.13	1.75	4.50	1.25
	1972-84			8.43	5.48	8.57	2.75

Note: Calculated from IMF, *International Financial Statistics*, 1985.
dE/E = percentage rate of change in exchange rate (%)
dP/P = p = Inflation rate (WPI) (%)
i = The rate of interest (%)
s ( ) = Standard deviation

Table 2 Absolute Purchasing Power Parity Theory (1962–84)
(Auto Regression Results)

	a	P/P*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	7.8890	667.7	0.9820	0.9812	26.659	1148.65	1.2982	0.7665
(won)	(0.19)	(12.29)*						
(2) Japan	13.372	265.25	0.9190	0.9152	16.816	238.39	1.4029	0.8751
(yen)	(0.17)	(3.70)*						
(3) U.K.	-0.0489	0.6381	0.8817	0.8761	0.0368	156.50	1.1351	0.7964
(pound)	(-0.44)	(5.04)*						

(4) France (franc)	-1.1002 (-0.59)	2.7039 (4.73)*	0.8662	0.8598	0.4004	135.91	0.8691	0.9494
(5) Germany (Mark)	-0.2649 (-0.23)	2.7039 (3.32)*	0.9355	0.9514	0.1799	432.02	0.9728	0.9355
(6) Canada (C.$)	-0.7171 (-3.07)*	1.8430 (7.82)*	0.9204	0.9166	0.0251	243.27	1.7861	0.5936

Note: The t-ratios are in parentheses below the regression coefficients.
*Significant either at the 5% or 1% level.
Estimation equation: $E = a + b\ P/P^* + e$
E = exchange rate per U.S. dollar except for U.K. for which the U.S. dollar is expressed per pound.
P/P* = the relative price ratio.

Table 3 Absolute Purchasing Power Parity Theory (1962–84) (Auto Regression Results in Natural Log)

	ln a	ln(P/P*)	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	6.5108 (116.70)*	0.9856 (10.61)*	0.9765	0.9753	0.0809	831.86	1.5053	0.5591
(2) Japan	5.5626 (66.24)*	1.0114 (3.40)*	0.9110	0.9065	0.0626	204.63	1.5653	0.8407
(3) U.K.	-0.5623 (-8.77)*	0.9855 (5.34)*	0.8852	0.8798	0.0726	161.98	1.2543	0.7627
(4) France	1.6806 (6.88)*	1.206 (3.99)*	0.8298	0.8213	0.0761	97.495	1.0200	0.4814
(5) Germany	0.9160 (2.68)*	1.3486 (2.58)*	0.9376	0.9345	0.0728	300.51	1.1089	0.9538
(6) Canada	0.1132 (9.90)*	1.7279 (7.81)*	0.9178	0.9137	0.0234	223.34	1.8361	0.5578

Note: See Table 2. The drop option was used in the SHAZAM computer program.
Estimation equation: $\ln E = \ln a + b \ln(P/P^*) + e$.

Table 4 The Relative Purchasing Power Parity Theory (1962–84)
(Auto Regression Results)

	a	P-P*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	0.3085 (0.10)	1.0080 (4.00)*	0.4262	0.3989	11.125	15.60	1.9942	-0.0423
(2) Japan	-0.3919 (-0.25)	0.7972 (2.87)*	0.2798	0.2455	6.0809	8.157	1.9362	0.1588
(3) U.K.	1.8955 (0.72)	0.6056 (1.45)	0.2362	0.1998	7.8313	6.495	1.9164	0.3088
(4) France	1.6221 (0.58)	0.9752 (4.20)*	0.5413	0.5195	6.9942	24.786	1.5737	0.4978
(5) Germany	1.3703 (0.54)	1.2589 (2.18)*	0.3648	0.3346	6.8401	12.061	1.9339	0.4038
(6) Canada	0.2556 (0.45)	1.2965 (3.33)*	0.3154	0.2828	2.7038	9.677	1.8794	-0.1086

Note: See Table 2.
Estimation equation: dE/E = a + b (P-P*) + e
dE/E = the percentage rate of change in exchange rate (%)
P = inflation rate (%).

Table 5 Interest Rate Parity Theory (1962–84)
(Auto Regression Results)

	a	i-i*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	9.6599 (2.04)*	-0.0637 (-0.16)	0.0125	-0.0345	14.595	0.266	1.9318	0.1129
(2) Japan	-1.5294 (-0.93)	0.0012 (0.002)	0.0053	-0.0420	7.1461	0.113	1.9461	0.0732
(3) U.K.	1.1277	0.4720	0.1820	0.1431	8.1045	4.672	1.7944	0.4354
(4) France	-0.8063 (-0.18)	-1.7609 (-1.44)	0.2056	0.1678	9.2046	5.436	2.0559	0.3266
(5) Germany	0.5972 (0.23)	-1.3517 (-2.37)*	0.2918	0.2581	7.2223	48.654	1.8322	0.4062
(6) Canada	0.1423 (0.21)	1.0401 (2.37)*	0.1735	0.1341	2.9709	4.408	1.8568	-0.1093

Note: See Table 2.
Estimation equation: dE/E = a + b(i-i*) + e.
i = the nominal interest rate(%)

Table 6 Nominal Interest Rate Parity Theory (1962-84)
(Auto Regression Results)

	a	$i-i^*_{t-1}$	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	12.003 (2.43)*	-0.3283 (-0.79)	0.0397	-0.0061	14.393	0.867	1.9359	0.1083
(2) Japan	-1.6593 (-1.04)	-0.4553 (-0.92)	0.4360	-0.0019	7.0072	0.958	1.9491	0.0846
(3) U.K.	4.2287 (0.85)	-0.1139 (-0.10)	0.1747	0.1354	8.1407	4.445	1.7648	0.4234
(4) France	4.2169 (0.85)	-0.4235 (-0.26)	0.1655	0.1258	9.4340	4.166	2.0356	0.4264
(5) Germany	1.3351 (0.57)	-1.7478 (-2.08)	0.3324	0.3007	7.0121	10.458	1.8493	0.3080
(6) Canada	0.0133 (0.02)	1.2291 (2.98)*	0.2572	0.2219	2.8164	7.273	1.7842	0.1278

Note: See Table 2.
Estimation equation: $dE/E = a + b\,(i-i^*)_{t-1} + e$.

Table 7 Inflation—Interest Rate Parity Theory (1962-84)
(Auto Regression Results)

	a	$p-p^*$	$i-i^*$	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	0.5053 (0.13)	1.0080 (3.90)*	-0.0238 (-0.09)	0.4264	0.3691	11.398	7.434	1.9949	-0.0414
(2) Japan	-0.6243 (-0.45)	0.9382 (3.07)*	-0.5758 (-1.23)	0.3234	0.2558	6.0392	4.781	1.9460	0.0587
(3) U.K.	4.8774 (1.33)	1.1781 (2.11)*	-1.3162 (-1.17)	0.2688	0.1957	7.8517	3.676	1.9530	0.1475
(4) France	-0.9369 (-0.25)	0.9679 (4.09)*	1.1404 (0.96)	0.5606	0.5166	7.0150	12.756	1.7036	0.4616
(5) Germany	4.2302 (2.39)*	1.7305 (3.94)*	-2.0140	0.5601	0.5161	5.8327	12.733	1.9475	0.1021
(6) Canada	0.0747 (0.12)	1.0994 (2.15)*	0.3304	0.3288	0.2617	2.7433	4.900	1.8900	-0.1411

Note: See Table 2.
Estimation equation:
$dE/E = a + b\,(p-p^*) + c\,(i-i^*) + e$
p = inflation rate
i = nominal interest rate

Table 8 The Absolute Monetary Model (1962–84)
(Auto Regression Results)

	a	M/M*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	667.76	54.323	0.9820	0.9812	26.659	1148.54	1.2982	0.7665
	(0.19)*	(12.29)*						
(2) Japan	404.98	-907.07	0.9061	0.9017	18.107	202.71	1.5887	0.8065
	(12.07)*	(-3.60)*						
(3) U.K.	0.1081	6.1338	0.8534	0.8464	0.0410	122.23	1.0931	0.7208
	(1.30)	(4.66)						
(4) France	6.7372	-2.0804	0.8184	0.8093	0.4780	90.10	1.7633	1.2675#
	(4.88)*	(-1.74)*						
(5) Germany	5.7019	-5.1967	0.9483	0.9459	0.1899	385.48	1.1834	0.9244
	(6.15)*	(-2.87)*						
(6) Canada	0.9126	0.3449	0.8680	0.8614	0.0331	131.53	1.5491	1.0646#
	(7.85)*	(0.36)						

Note: See Table 2.
#For France and canada, the drop option was used
using the SHAZAM computer program due to instability of the estimate.
Estimation equation: E = a + b M/M* + e.
M/M* = the money supply ratio.

Table 9 The Absolute Monetary Model (1962–84)
(Auto Regression Results in Natural Log)

	ln a	ln(M/M*)	R^2	R^2	S	F	DW	ρ
(1) Korea	5.7538	0.3043	0.9552	0.9530	0.1118	426.43	1.5432	0.5880
	(72.53)*	(6.44)*						
(2) Japan	4.6725	-0.4818	0.8832	0.8774	0.0717	151.24	1.5989	0.7213
	(15.12)*	(-3.15)*						
(3) U.K.	1.2294	0.7020	0.8528	0.8458	0.0822	121.65	1.1575	0.6968
	(2.71)*	(4.46)*						
(4) France	3.1056	0.0492	0.7045	0.6897	0.1002	47.683	1.1681	0.9838
	(1.56)	(0.08)						
(5) Germany	0.3248	-1.0624	0.9335	0.9301	0.0752	280.55	1.2531	0.8808
	(1.08)	(-2.35)*						
(6) Canada	-0.3170	0.0206	0.8553	0.8481	0.0311	118.20	1.5433	1.0178
	(-0.67)	(0.31)						

Note: See Table 2.
Estimation equation: ln E = ln a + b in (M/M*) + e.

Table 10 Monetary Model (1962–84)
(Auto Regression Results)

	ln a	ln(M/M*)	ln(Y/Y*)	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	6.4094	0.2628	0.1347	0.9553	0.9506	0.1145	203.04	1.5524	0.5913
	(2.05)*	(1.30)	(0.21)						
(2) Japan	4.5573	-0.4608	-0.0626	0.8834	0.8711	0.0735	71.944	1.6029	0.7216
	(5.72)	(-2.23)*	(-0.16)						
(3) U.K.	0.0770	0.6158	-0.3832	0.8544	0.8398	0.0837	56.660	1.1516	0.6853
	(0.03)	(2.54)*	(0.47)						
(4) France	1.5187	0.6298	-0.2913	0.7047	0.6737	0.1028	22.675	1.0385	0.8693
	(4.97)	(1.21)	(-0.31)						
(5) Germany	0.0049	-0.9889	-0.5903	0.9357	0.9289	0.0759	138.14	1.2202	0.8928
	(-0.81)	(-2.16)*	(-0.81)						
(6) Canada	-3.5507	0.0133	-1.1493	0.9293	0.9219	0.0223	124.87	2.1974	1.0154*
	(-4.41)*	(0.28)	(-4.46)*						

Note: See Table 2.
Estimation equation:
$\ln E = \ln a + b \ln (M/M^*) + c \ln (Y/Y^*) + e.$

Table 11 The Absolute Monetary Model (1962–84)
(Auto Regression Results in Natural Log)

	ln a	ln (M/M*)	ln(Y/Y*)	(i-i*)	R^2	R^2	S	F	DW	ρ
(1) Korea	6.7085	0.2581	0.2005	0.0015	0.9554	0.9480	0.1175	128.62	1.5609	0.5946
	(1.94)*	(1.19)	(0.28)	(0.23)						
(2) Japan	5.1316	-0.3880	0.0957	0.0234	0.9105	0.8955	0.0662	61.017	1.7296	0.6031
	(8.50)*	(-2.31)*	(0.29)	(2.58)*						
(3) U.K.	-0.9837	0.5569	-0.7349	0.0182	0.8667	0.8457	0.0822	41.19	1.2627	0.6990
	(-0.38)	(2.28)*	(-0.87)	(1.33)						
(4) France	2.7623	0.0693	-1.8344	0.0435	0.7856	0.7498	0.9000	21.981	1.7954	0.9751
	(2.27)*	(0.12)	(-1.87)*	(2.59)*						
(5) Germany	-0.5948	-1.4901	-0.9528	0.0332	0.9501	0.9417	0.0687	114.13	1.5636	0.6138
	(-1.31)	(-4.95)*	(-1.34)	(2.64)*						
(5) Canada	-2.1549	0.0042	-1.2854	0.0019	0.9277	0.9157	0.0231	77.032	2.1606	0.9725
	(-3.36)*	(0.08)	(-4.25)*	(0.43)						

Note: See Table 2.
The drop option was used for the SHAZAM computer program.
Estimation equation:
$\ln E = \ln a + b \ln (M/M^*) + c \ln (Y/Y^*) + d (i - i^*) + e$

Table 12 The Relative Monetary Model (1962–84) (Auto Regression Results)

	a	m-m*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	12.720	-0.1753	0.0660	-0.0092	14.415	0.800	1.9337	0.0660
	(2.26)*	(-0.77)						
(2) Japan	-0.6704	-0.1131	0.0273	-0.0190	7.0668	0.589	1.9469	0.0705
	(-0.33)	(-0.69)						
(3) U.K.	3.6133	0.0546	0.1757	0.1304	8.1357	4.476	1.7788	0.4194
	(1.21)	(0.20)						
(4) France	1.9004	0.2897	0.1777	0.1385	9.3651	4.537	1.9949	0.4568
	(0.47)	(0.65)						
(5) Germany	0.2635	-0.5914	0.3135	0.2808	7.1111	9.589	1.8051	0.4183
	(0.10)	(-1.66)						
(6) Canada	1.1035	0.0322	0.0517	0.0065	3.1823	1.145	1.9160	0.2328
	(1.26)	(0.60)						

Note: See Table 2.
Estimation equation is dE/E = a + b (m-m*) + e.
m = dM/M = the percentage rate of change in money supply.

Table 13 The Relative Monetary Model (1962–84) (Auto Regression Results)

	a	m-m*	y-y*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	14.225	-0.1147	-0.5123	0.0619	-0.0319	14.576	0.660	1.9075	0.0645
	(2.35)*	(-0.47)	(-0.73)						
(2) Japan	-3.1548	-0.1917	0.7977	0.1515	0.0666	6.7633	1.785	1.9857	-0.0329
	(-1.41)	(-1.23)	(1.78)						
(3) U.K.	3.6311	0.0550	0.0129	0.1757	0.0933	8.3365	2.132	1.77947	0.4191
	(1.14)	(0.20)	(0.04)						
(4) France	1.8626	0.2954	0.0384	0.1778	0.0956	9.5955	2.163	1.9961	0.4601
	(0.44)	(0.05)	(0.64)						
(5) Germany	-0.1644	-0.5583	-0.8486	0.3655	0.3021	7.0051	5.761	1.7557	0.3655
	(-0.06)	(-1.59)	(-1.28)						
(6) Canada	2.0269	-0.0041	-1.1794	0.4686	0.4155	2.4410	8.819	1.8144	-0.0800
	(3.71)*	(-0.10)	(4.34)*						

Note: See Table 2.
Estimation equation:
dE/E = a + b (m-m*) + c(y-y*) + e
m = dM/M = the growth rate of money supply (%)
y = the growth rate of real GNP (%)

Table 14 The Relative Monetary Model (3) (1962–84) (Auto Regression Results)

	a	m-m*	y-y*	i-i*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	14.024	-0.1501	-0.4938	0.1026	0.0641	-0.0837	14.938	0.433	1.1910	0.0435
	(2.24)*	(-0.52)	(-0.69)	(0.23)						
(2) Japan	-0.5475	-0.2445	0.7893	0.2450	0.1586	0.0258	6.910	1.194	1.9910	-0.0345
	(-0.93)	(-1.19)	(1.72)	(0.40)						
(3) U.K.	2.1067	0.0313	0.0027	0.4481	0.1825	0.0534	8.518	1.413	1.7999	0.4311
	(0.41)	(0.11)	(0.004)	(0.40)						
(4) France	-1.7622	-0.2487	-0.1066	1.7096	0.2172	0.0936	9.6060	1.757	2.0378	0.3751
	(-0.33)	(0.53)	(-0.13)	(1.06)						
(5) Germany	0.5742	-0.4236	-0.9006	-0.9934	0.3967	0.3014	7.0083	4.164	1.7601	0.4093
	(0.22)	(-1.10)	(1.35)	(-1.00)						
(6) Canada	1.6853	-0.0006	-1.0715	0.2600	0.4779	0.3955	2.4824	5.798	1.8317	-0.1232
	(2.10)*	(-0.01)	(-3.28)*	(0.58)						

Note: See Table 2.
Estimation equation:
$dE/E = a + b\,(m-m^*) + c\,(y-y^*) + d\,(i-i^*) + e$

Table 15 Trade Balance Theory (1962–84) (Auto Regression Results)

	a	(M-X)/X	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	9.3997	-0.1932	0.0118	-0.2353	14.600	0.250	1.9358	0.1163
	(2.19)*	(-0.10)						
(2) Japan	-1.2171	5.8633	0.0453	-0.0001	7.001	0.997	1.9700	0.0720
	(-0.76)	(0.94)						
(3) U.K.	1.7432	13.384	0.1864	0.1477	8.0826	4.811	1.7296	0.4594
	(0.37)	(0.58)						
(4) France	-5.4496	107.54	0.4349	0.4080	7.7637	16.159	1.8945	0.1918
	(-1.72)	(3.45)*						
(5) Germany	2.4063	26.760	0.2458	0.2099	7.4533	6.845	1.8683	0.4497
	(0.46)	(0.71)						
(4) Canada	1.6587	9.3312	0.0631	0.0185	3.1630	1.415	1.9150	0.2140
	(1.66)	(0.78)						

Note: See Table 2.
Estimation Equation: $dE/E = a + b\,(M-X)/X + e$.
M = imports of country A.
X = exports of country A.

Table 16 The Real Interest Rate Equality Theory (1962–84) (Fisher Open Condition) (Auto Regression Results)

	a	r*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	-1.5080	1.5747	0.3408	0.3094	11.527	10.86	1.9113	0.4400
	(-0.35)	(2.12)*						
(2) Japan	0.4454	1.2030	0.6038	0.5849	4.3762	32.00	1.9152	0.0355
	(0.45)	(5.58)*						
(3) U.K.	1.0284	0.6624	0.5599	0.5390	2.8568	26.72	1.8069	0.3149
	(1.16)	(3.88)*						
(4) France)	1.3547	0.6044	0.2670	0.2321	5.4412	7.65	2.0242	-0.2486
	(1.42)	(2.74)*						
(5) Germany	3.6221	0.4004	0.5255	0.5029	1.5858	23.26	1.9273	0.4430
	(6.11)*	(3.92)*						
(6) Canada	0.3130	0.9599	0.9240	0.9204	1.2507	255.29	2.0105	-0.0141
	(1.17)	(6.13)*						

Note: See Table 2.
Estimation equation: $r = a + b\ r^* + e$.
r = the real interest rate, $r = i - p$.

Table 17 Nominal Interest Parity Theory (1962–84) (Seemingly Unrelated Regression Results)

	a			R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea (won/$)									
dE/E =	0.3380	1.0047	(p-p*)	0.4252	0.3978	11.135	15.533	2.0638	-0.043
	(0.10)	(3.94)*							
dE/E =	9.4236	0.0275	(i-i*)	0.0003	-0.0473	14.685	0.006	1.7709	0.1090
	(2.18)*)	(-0.07)							
r =	-1.0098	1.3593	r*	0.1891	0.1505	12.784	4.898	1.1390	0.4298
				Loglikelihood function = -270.61					
(2) Japan (yen/$)									
dE/E =	-0.4446	0.7848	(p-p*)	0.2613	0.2261	6.1584	7.428	1.6743	0.1580
	(-0.33)	(2.73)*							
dE/E =	-1.5660	-0.0356	(i - i*)	0.0003	-0.0474	7.1644	0.005	1.8564	0.0697
	(-1.02)	(-0.073)							
r =	0.46103	1.1891	r*	0.6034	0.5845	4.3786	31.946	1.8524	0.0297
				LLF = -215.83					

(3) U.K. (pound/$)											
dE/E	=	1.1712	0.8047	(p-p*)	0.1712	0.1317	8.1581	4.336	1.4229	0.2716
		(0.57)	(2.08)*							
dE/E	=	2.4298	0.3232	(i - i*)	0.0076	-0.0396	8.9266	1.675	1.1207	0.4314
		(0.70)	(0.40)							
r	=	1.0163	0.6785	r*	0.5120	0.4888	3.0084	22.035	1.3650	0.3137
		(1.56)	(4.69)*							
					LLF = -218.73					
(4) France (franc/$)										
dE/E	=	1.4378	1.0943	(p-p*)	0.3952	0.3664	8.0318	13.7196	1.0338	0.4818
		(0.83)	(3.70)*							
dE/E	=	-2.4296	2.4191	(i - i*)	0.1256	0.0840	9.6569	3.0173	1.3793	0.2972
		(-0.66)	(1.74)*							
r	=	1.2417	0.6617	r*	0.2236	0.1866	5.6000	6.0480	2.3678	-0.2380
		(1.02)	(2.46)*							
					LLF = -234.47					
(5) Germany (Mark/$)										
dE/E	=	1.3589	1.3513	(p-p*)	0.2527	0.2171	7.4190	7.102	1.1768	0.3994
		(0.75)	(2.67)*							
dE/E	=	0.3252	-1.4109	(i - i*)	0.1621	0.1222	7.8562	4.062	1.1757	0.4024
		(0.18)	(-2.02)*							
r	=	3.7486	0.3335	r*	0.4328	0.4058	1.7338	16.026	1.2128	0.3902
		(9.99)*	(4.00)*							
					LLF = -200.93					
(6) Canada (Canadian $/$)										
dE/E	=	0.3163	1.2469	(p-p*)	0.3073	0.2744	2.7197	9.3180	2.0390	-0.1004
		(0.51)	(3.05)*							
dE/E	=	0.2466	0.9611	(i - i*)	0.1644	0.1246	2.9872	4.1320	2.0221	-0.0940
		(0.33)	(2.03)*							
r	=	0.3127	0.9601	r*	0.9204	0.9240	1.2508	255.24	2.0266	0.0140
		(1.16)	(15.98)*							
					LLF = -148.10					

Note: See Table 2.

Estimation equation:

dE/E = a + b (p-p*) + e

dE/E = a + b (r-r*) + e

i = a + b i* + e

Table 18 The Real Interest Rate Parity (1962–84)
(Auto Regression Results)

	a	r-r*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	8.7217	-0.6202	0.2660	0.2311	12.582	7.611	1.9841	0.1833
	(2.74)*	(-2.73)*						
(2) Japan	-0.9255	-0.8709	0.3012	0.2680	5.9896	9.053	1.9272	0.0640
	(-0.69)	(-2.98)*						
(3) U.K.	4.3542	-1.1421	0.2678	0.2330	7.6676	7.681	1.9502	0.1546
	(2.29)*	(-2.18)*						
(4) France	3.7929	-0.9036	0.4965	0.4725	7.3284	20.704	1.4936	0.5307
	(1.22)	(-3.80)*						
(5) Germany	4.1870	-1.8192	0.5557	0.5346	5.7204	26.270	1.9457	0.0970
	(2.43)*	(-4.74)*						
(6) Canada	1.4036	-0.6296	0.0970	0.0540	3.1054	2.255	1.9060	0.2509
	(1.63)	(-1.21)						

Note: See Table 2.
Estimation equation: $dE/E = a + b\ (r - r^*) + e$.
r = the real interest rate, $r = i - p$.

Table 19 Nominal Interest Rate Equality Theory (1962–84)
(Auto Regression Results)

	a	i*	R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea	12.076	0.0941	0.6132	0.5948	4.4404	33.30	1.5774	0.8316
	(2.03)*	(0.16)						
(2) Japan	5.1475	0.1157	0.1319	0.0905	1.2491	3.188	1.7124	0.3883
	(5.61)*	(0.93)						
(3) U.K.	6.2607	0.4839	0.8997	0.8949	1.0350	188.34	1.1268	0.9084
	(3.24)*	(3.57)*						
(4) France	5.6130	0.4940	0.8978	0.8929	1.0846	184.50	1.3493	0.8660
	(3.44)*	(3.48)*						
(5) Germany	4.7003	0.4283	0.6894	0.6746	0.7489	4.6610	1.2412	0.7810
	(5.31)*	(4.45)*						
(6) Canada	-0.0162	1.1470	0.9265	0.9230	1.0486	264.86	1.6609	0.5285
	(-0.02)	(9.84)*						

Note: See Table 2.
Estimating equations: $i = a + b\ i^* + e$
$r = c + c\ r^* + e$

**Table 20 Real Interest Rate Parity Theory (1962–84)
(Seemingly Unrelated Regression Results)**

	a			R^2	$\bar{R}^2$	S	F	DW	ρ
(1) Korea (won/$)									
dE/E =	0.3380	1.0047	(p-p*)	0.4252	0.3978	11.135	15.530	2.0638	-0.0426
	(0.10)	(3.94)*							
dE/E =	8.8730	-0.0562	(r-r*)	0.2433	0.2072	12.776	6.7506	1.0518	0.1654
	(3.33)*)	(-0.26)							
r =	20.300	-0.8200	i*	0.1218	0.0800	6.6909	2.913	0.5439	0.5687
	(5.84)*	(-1.71)							
				Loglikelihood function = -252.51					
(2) Japan (yen/$)									
dE/E =	-0.4446	0.7848	(p-p*)	0.2613	0.2261	6.1584	7.428	1.6743	0.1580
	(-0.33)	(2.73)*							
dE/E =	-0.9362	-0.8770	(r-r*)	0.2982	0.2648	6.0024	8.925	1.8266	0.0636
	(-0.74)	(-2.99)*							
r =	5.6511	0.0403	i*	0.0086	-0.0389	1.3349	0.1769	1.3026	0.3353
	(8.15)*)	(0.42)							
				LLF = -184.44					
(3) U.K. (pound/$)									
dE/E =	1.1712	0.8047	(p-p*)	0.1712	0.1317	78.1581	4.336	1.4229	0.2716
	(0.57)	(2.08)*							
dE/E =	4.4660	-1.3577	(r-r*)	0.2567	0.2213	7.7256	7.252	1.7740	0.1000
	(2.72)*	(-2.69)*							
r =	5.2505	0.7604	i*	0.5002	0.4764	2.3102	21.014	0.2531	0.8752
	(4.38)*	(4.58)*							
				LLF = -209.33					
(4) France (franc/$)									
dE/E =	1.4379	1.0943	(p-p*)	0.3952	0.3664	8.0318	13.720	1.0338	0.4818
	(0.83)	(3.70)*							
dE/E =	3.7827	-0.9779	(r-r*)	0.3023	0.2691	8.6262	9.099	0.9473	0.5252
	(2.08)*	(-3.02)*							
r =	2.2364	0.9992	i*	0.8011	0.7916	1.5131	84.591	0.9301	0.5352
	(2.85)*	(9.20)*							
				LLF = -291,77					
(5) Germany (Mark/$)									
dE/E =	1.3589	1.3513	(p-p*)	0.2527	0.2171	7.4190	7.102	1.1768	0.3994
	(0.75)	(2.67)*							
dE/E =	4.1994	-1.8272	(r-r*)	0.5516	0.5302	5.7470	25.834	1.7946	0.0967
	(2.63)*	(-5.08)*							

r	=	5.8817	0.2731	i*	0.3812	0.3521	1.0567	12.958	0.6537	0.6648
		(10.72)*	(3.60)*							
					LLF = -182.35					
(6) Canada (Canadian $/$)										
dE/E	=	0.3163	1.2469	(p-p*)	0.3073	0.2744	2.7197	9.318	2.0390	-0.1004
		(0.51)	(3.05)*							
dE/E	=	1.2545	-0.5043	(r-r*)	0.0380	-0.0078	3.2051	0.830	1.3995	0.2361
		(1.83)*	(-0.91)							
r	=	-0.4641	1.2074	i*	0.8996	0.8948	1.2262	188.07	0.9616	0.4980
		(0.73)	(13.71)*							
					LLF = -149.26					

Note: See Table 2.
Estimation equation:
$dE/E = a + b\,(p-p^*) + e$
$dE/E = a + b\,(r-r^*) + e$
$i = a + b\,i^* + e$