Using Financial Prices to Test Exchange Rate Models: A Note
Author(s): Bruno Solnik
Source: *The Journal of Finance*, Vol. 42, No. 1 (Mar., 1987), pp. 141-149
Published by: Blackwell Publishing for the American Finance Association
Stable URL: http://www.jstor.org/stable/2328424
Accessed: 26/11/2009 08:07

THE JOURNAL OF FINANCE • VOL. XLII, NO. 1 • MARCH 1987

Using Financial Prices to Test Exchange Rate Models: A Note

BRUNO SOLNIK*

THE PURPOSE OF THIS note is to illustrate how tests of exchange rate models can be conducted using financial prices rather than macroeconomic data. All empirical tests of exchange rate models have met with limited success so far.[1] A major problem encountered is the poor quality of the macroeconomic data used. Most of the data suffer from large measurement error or cannot even be measured directly. For example, these models often require measures of changes in expected real activity or in monetary policy; such variables can only be poorly estimated from time-series models on industrial production or money supply. The innovation in this paper is to use financial prices such as stock prices instead of the traditional macroeconomic data.

There exists convincing empirical evidence that stock returns forecast changes in economic activity as measured by industrial production, real growth in GNP, employment rate, or corporate profits (Fama [5] and Geske and Roll [8]). In the domestic context, stock prices have been used to test the relation between economic activity and inflation (e.g., Fama [5], Geske and Roll [8], and Solnik [12]). In the same spirit, stock returns are used in this paper as proxies for changes in economic activity to test the relation between exchange rates and economic activity. Interest rates are determined by monetary policies, and changes in interest rates are used in this article as indicators of monetary shocks. The approach used is introduced in Section I, while the empirical results are presented in Section II. The data cover the eight major western countries over the recent period of flexible exchange rates (July 1973 to December 1983).

I. Methodology

Since the purpose of this note is only to illustrate how stock returns can be used to test exchange rate models, we will not review the numerous and often conflicting theories of exchange rate determination.[2] However, most theories would call for a positive association between economic activity and the exchange rate. This phenomenon usually works through *money demand.* For example, Lucas [9] proposed a microeconomic approach stressing the consumption side and relative prices; he concludes that a productivity gain will generally lead to a real appreciation of the domestic currency. Similarly, a macroeconomic money-demand explanation has been advanced for the positive relation between eco-

* Centre HEC-ISA, Jouy-En-Josas, France. Financial support from the French Commissariat Général du Plan is gratefully acknowledged.

[1] See Bilson and Marston [1], Frenkel [7], and Meese and Rogoff [11].

[2] Reviews of the literature might be found in Bilson and Marston [1] and Frenkel [7].

nomic activity and the exchange rate (e.g., Cornell [3]). The argument starts from a traditional domestic money-demand equation,

$$M/P = f(Q),$$

where M is the money stock of the country, P the price level, and Q the domestic production. An increase in domestic economic activity, Q leads to an increase in demand for real domestic currency balances and, therefore, to an appreciation in the exchange rate. This money-demand model is often complemented by a *money-supply* approach. In this widely used money-supply approach of Keynesian inspiration, domestic monetary policy shocks affect the domestic interest rate, and changes in the interest rate differential induce capital flows and, therefore, exchange rate movements. For example, an unanticipated contraction in domestic money supply leads to a liquidity effect with an increase in the interest rate differential (domestic minus foreign) and an immediate real currency appreciation (see Dornbusch [4]). The money-demand and money-supply models are complementary, and a majority of economists would agree that economic activity and monetary shocks are major determinants of the short-run behavior of exchange rates.

Exchange rates are financial prices. In an efficient market, they already discount all available information about expected future activity and monetary policy. Exchange rates should be affected only by changes in expectations about economic activity or monetary policy. A traditional problem with the estimation of exchange rate models is that one mixes financial prices such as exchange rates with time series of macroeconomic variables such as industrial production or money. In these models, the influence of a shock is spread over several periods with feedback. The poor quality of the economic data makes the estimation of such time-series models very difficult,[3] especially since the international monetary system changes quite rapidly. In this paper, we use a rational-expectations framework, where asset prices are assumed to take into account instantaneously the influence of a shock on the whole future process. For example, if real economic activity is expected to improve over the next eight quarters, it will be immediately discounted in current stock prices as well as in the exchange rate. Similarly, it has been shown that news about monetary policy such as announcements of money supply are immediately reflected in a change in interest rates (Cornell [3]). Changes in interest rates are used here as indicators of monetary shocks.

Fama [5] and Geske and Roll [8], found a strong association between real stock returns and various indicators of future economic activity (growth rate in GNP, industrial production, unemployment, and corporate earnings). Mandelker and Tandon [10] studied the relation between real stock returns and future economic activity (growth rate in GNP and industrial production) for six countries (U.S.A., U.K., France, Canada, Japan, and Belgium) using quarterly data from 1966 to 1979. They found a significant positive association between current stock returns and future activity in the next three quarters; the R^2 ranged from eleven percent to thirty-eight percent. de Freitas [6] studied the same relation

[3] Stulz and Wasserfallen [13] discuss some of the methodological problems involved with time-series models of economic variables.

using monthly, quarterly, and annual data from 1972 to 1983 for seven countries (U.S.A., U.K., France, Canada, Japan, Germany, Brazil, and Mexico). He found that real stock returns had a strong positive association with future values in the growth rate of industrial production for each country. Both papers concluded that anticipated real activity dominates money growth rates and expected inflation in explaining real stock returns.

This evidence shows that real stock returns are good indicators of changes in anticipated real activity in every country. We will now present a simple test of the relation between economic activity, interest rates, and exchange rates using financial prices.

II. Tests of the Exchange Rate Model

A. The Data

The data consist of monthly and quarterly observations for the period July 1973 to December 1983. While data were available prior to mid-1973, this period is chosen because it might be characterized as a period of flexible exchange rates. Eight countries were selected on the basis of data availability. The stock markets of Canada, France, Germany, Japan, Netherlands, Switzerland, U.K., and U.S.A. represent over ninety percent of the world market capitalization. These countries have free capital markets as well as representative short-term interest rates on eurocurrency markets. Eurocurrency rates might be regarded as true market rates, free of government control and consistent across currencies.

National stock-price indices and dividend data come from Capital International. One-month and three-month eurocurrency rates were obtained from the Bank for International Settlements. Spot exchange rates and inflation rates (CPI) come from the IMF financial statistics. All observations are end-of-the-month data.

The model requires computation of the domestic real stock return *relative* to the rest of the world. Market capitalization weights are used to calculate the world real stock return. Of course, for each country regression, the "rest-of-the-world" real stock return is computed excluding that country in the weighting. Once this system of market capitalization weights is used for stock returns, we have to use the same weights for the interest rate differential relative to the rest of the world and the (weighted-average) exchange rate of the domestic currency relative to the rest of the world. Different systems of weights could have been used. One often computes a real effective exchange rate weighting the foreign countries proportionally to the importance of their trade (exports or imports) with the domestic country. This exclusive reliance on international trade is not satisfactory for our purpose. Other sensible weighting systems could be based on real money supply or GNP. We chose stock market capitalizations as indicators of the relative importance of countries because of our focus on the stock market.

All of our relative variables are computed as domestic minus foreign. A change in the interest rate differential, *Di*, is positive if the differential (the domestic minus the foreign interest rate) increases. The exchange rate is computed as the foreign price of one unit of domestic currency so that a positive real exchange rate variation implies a domestic currency appreciation beyond the inflation differential.

All returns have been annualized, i.e., expressed in percentages per year. In other words, a currency appreciation of one percent during a month is annualized (linearly) and expressed as twelve percent.

B. A First Look at the Data

The exchange rate theory outlined in Section I combined with the efficient-market hypothesis can be tested in equation (1):

$$Ds_t = a + bDRS_t + cDi_t + \varepsilon_t, \tag{1}$$

where

- Ds_t is the change in the real exchange rate; s is the foreign currency price of the domestic currency;
- DRS_t is the real stock-return differential (domestic minus foreign); and
- Di_t is the change in the interest rate differential.

According to the theories outlined above, both coefficients b and c should be positive.

We jointly estimate the coefficients for each country running a multivariate GLS estimation using the seemingly unrelated regression equations technique (SURE). Table I provides the major results of this joint estimation for monthly

Table I

Multivariate Regressions (SURE) of Real Exchange Rate Movements on Relative Real Stock Returns and Changes in Interest Rate Differentials, July 1973 to December 1983

	$Ds_t = a + b\ DRS_t + c\ Di_t$			
	Quarterly Data		Monthly Data	
	b (t-Statistic)	c (t-Statistic)	b (t-Statistic)	c (t-Statistic)
Canada	−0.051	0.461	−0.008	1.286
	(1.87)	(0.82)	(0.39)	(0.96)
France	−0.059	0.489	0.016	1.719
	(2.64)	(1.68)	(0.65)	(2.26)
Germany	−0.098	−0.067	−0.009	0.993
	(3.78)	(0.05)	(0.44)	(0.93)
Japan	−0.084	0.291	−0.020	3.713
	(4.09)	(0.87)	(1.10)	(3.78)
Netherlands	−0.098	−0.651	−0.058	3.892
	(2.48)	(1.85)	(2.09)	(4.23)
Switzerland	−0.166	−0.672	−0.077	−1.593
	(1.87)	(0.59)	(1.04)	(0.50)
U.K.	−0.060	0.196	−0.036	0.386
	(2.68)	(0.53)	(1.76)	(0.46)
U.S.A.	−0.076	0.197	−0.010	2.711
	(3.70)	(0.67)	(0.62)	(3.93)
All countries, same coefficients	−0.060	0.442	−0.031	2.840
	(3.01)	(1.62)	(2.32)	(5.01)

and quarterly data over the period July 1973 to December 1983. We use a maximum-likelihood method, so R^2 are not reported. The value of the constant term a is of little interest and is not reported here to save space. To compare the monthly and quarterly estimations, one should remember that all rates of return have been annualized; this means that DRS_t and Ds_t have the same monthly and quarterly mean. On the other hand, Di_t is the realized change over the observation period (a month or a quarter) of the annualized interest rate differential; this implies that the mean of Di_t is multiplied by three when we move from monthly to quarterly observations. This should be kept in mind when comparing the estimates of the regression coefficient c for monthly and quarterly regression. (The monthly coefficient should be three times as large as the quarterly coefficient.)

The last line of Table I gives the estimation of equation (1) assuming that the same model holds for each country, i.e., assuming identical coefficients a, b, and c. It might be useful to start with these results before moving to an interpretation of the coefficients for each country. We see that the monetary coefficient c has a positive and significant sign, while the real coefficient b has a negative and significant sign. Note, however, that the monthly coefficient of Di_t is much larger than the quarterly one (seven times larger rather than three times as expected) and much more statistically significant. The reverse is true for b. Looking at the SURE results with different national coefficients, it is striking to note that the monetary coefficient is usually positive and significant in the monthly tests but not in the quarterly tests. This suggests a more detailed analysis of the cross-correlation structure with leads and lags.

No monthly cross correlation was found for Ds and DRS except for contemporaneous observations; this is not surprising since a lagged response in any direction would provide profit opportunities. However, this is not the case for the relation between Ds and Di. Table II reports their cross-correlation structure. The general impression for monthly variations is that there is a lagged negative reaction of interest rate differentials to exchange movements; the association of contemporaneous changes tends to be positive (especially for the U.S., Japan, and Netherlands), while there is no systematic pattern for lead reaction. This is confirmed by the quarterly cross correlation. Note that, except in a couple of cases, neither series exhibits significant autocorrelation. This result seems to be in line with the exchange-rate-policy-reaction model ("leaning-against-the-wind") introduced by Branson [2]. A drop in the real exchange rate tends to be immediately followed by an increase in the short-term interest rate differential.[4] It is not clear why exchange rate intervention is desirable, but the evidence is that several governments attempt to stabilize their exchange rates.[5] The EEC monetary agreement (the "snake") is a typical illustration. The basic idea is to prevent a depreciation of the domestic currency to avoid a depreciation-induced increase in the inflation rate *and* to prevent an appreciation of the domestic currency to maintain the competitiveness of the domestic economy.

[4] Note that this behavior is not inconsistent with market efficiency since there is no way to arbitrage away an expected rise in short-term interest rates. However, a lagged reaction of exchange rates to interest rate movements would create profit opportunities.

[5] Branson [2] found evidence of this "leaning-against-the-wind" policy for most countries, including the U.S.

Table II

Cross Correlation of Changes in Real Exchange Rates with Leads and Lags in Interest-Differential Movements, Monthly Data from July 1973 to December 1983

	Correlation of Ds_t with Di_T for Values of T											
	Monthly Observations							Quarterly Observations			Monthly Autocorrelation	
	$t+3$	$t+2$	$t+1$	t	$t-1$	$t-2$	$t-3$	$t+1$	t	$t-1$	Di_t	Ds_t
Canada	−.06	.15	−.09	−.07	.11	.11	.17	−.04	.00	.32	−.00	.04
France	−.09	−.10	−.06	.06	.00	.04	−.08	−.46	.12	.01	−.26	−.25
Germany	−.05	−.20	−.06	.12	.08	−.09	.07	−.27	.06	.10	.07	.08
Japan	−.09	−.23	−.10	.22	.08	−.04	−.00	−.33	.20	.10	.21	.08
Netherlands	−.01	−.11	−.15	.31	−.06	.23	.03	−.15	.25	.14	.03	.02
Switzerland	−.10	−.13	−.03	−.06	.10	−.03	.00	−.50	.05	.01	.11	−.25
U.K.	−.09	−.07	−.28	−.10	.02	.05	.14	−.47	−.23	.16	−.11	.12
U.S.A.	−.09	−.32	−.13	.28	.16	−.01	.01	−.49	.42	.09	.12	−.03

The asymptotic monthly standard deviation of the correlation coefficients estimate is .09 for monthly coefficients and .15 for quarterly estimates.

Furthermore, we would expect the influence of monetary policy on exchange rates to be stronger after the U.S. Federal Reserve changed its operating procedures in October 1979, with both the U.S. and U.K. adopting stricter monetary policy targets. This leads to an analysis of two periods, preceding and following October 1979.

C. *Subperiod Analysis*

This analysis of the periods around October 1979 has to be conducted on monthly data to have a sufficient number of observations. The estimation of equation (1) is given in Table III. Again, the bottom line gives the results obtained under the multivariate model with identical coefficients.

The results for the *most recent period* are consistent with the theory. Both coefficients tend to be positive and significant. Monetary policy and therefore changes in interest rate differentials seem to have a strong positive influence on the short-run behavior of real exchange rates. Consistent with money-demand theory, relative economic growth and therefore real stock returns seem to have a significant positive, although weak, influence on real exchange rates. The direct correlation between DRS_t and Ds_t is very weak, but the inclusion of Di_t in the regressions transforms it into a marginal positive and significant association. The reason is that stock returns are negatively affected by changes in interest rates as shown by Geske and Roll [8] and Solnik [12]. When both variables are included in regression (1), the monetary effects are picked up by Di_t, and the marginal contribution of DRS_t is the real growth effect.

The story is quite different for the first period (1973–1979). The interest rate coefficient c is not significant. Cornell [3] reached similar conclusions for the U.S.A. He concluded that there was a positive correlation between the dollar/DM exchange rate and changes in U.S. short-term interest rates after October 1979; both variables are positively correlated with the unexpected component of U.S. money-supply announcements. Prior to October 1979, these relations were weak and not significant. Cornell's explanation is that the U.S. did not focus on money supply prior to that date, but rather on the Federal Funds rate. In the early days of the floating-rate system, most countries focused on interest rate and exchange rate policies rather than on money-supply policies. This is not surprising since we were coming from an era of controlled exchange rates.

The negative coefficient of the real stock-return differential in the first period is still puzzling. This result might please journalists and some traditional balance-of-payments economists; it would be consistent with the idea that an (exogenous) real appreciation of the currency is bad for domestic corporations because it reduces their competitiveness. A real exchange rate depreciation stimulates the economy in the short run because of opposite effects on imports and exports of this change in the term of trade.

III. Summary and Conclusions

Several theories have recently justified the negative relation between domestic interest rates and stock-price movements by the link between money (and hence inflation) and real economic activity, real stock returns being an indicator of

Table III

Multivariate Monthly Regressions (SURE); First Period: July 1973 to September 1979; Second Period: October 1979 to December 1983

$Ds_t = a + b\ DRS_t + c\ Di_t$

	First Period		Second Period	
	b (t-Statistic)	c (t-Statistic)	b (t-Statistic)	c (t-Statistic)
Canada	−0.046	−2.510	0.034	3.635
	(1.79)	(1.33)	(1.71)	(3.65)
France	0.057	0.266	0.053	3.338
	(2.99)	(0.33)	(2.41)	(3.73)
Germany	−0.093	−2.673	0.055	3.556
	(4.69)	(2.49)	(2.53)	(3.46)
Japan	−0.067	1.024	0.040	3.002
	(3.97)	(1.02)	(1.91)	(3.17)
Netherlands	−0.027	3.632	0.043	1.669
	(0.82)	(3.74)	(0.20)	(1.62)
Switzerland	−0.164	−3.553	0.063	2.977
	(3.26)	(1.26)	(0.63)	(0.92)
U.K.	−0.064	−0.474	0.044	3.324
	(3.58)	(0.50)	(1.96)	(3.36)
U.S.A.	−0.056	−0.159	0.041	2.951
	(3.39)	(0.18)	(2.05)	(3.34)
All countries, same coefficients	−0.063	0.343	0.040	1.940
	(2.32)	(0.48)	(1.90)	(2.66)

changes in economic activity. In the same spirit, this paper assumes rational expectations and investigates the relation between real exchange rates, economic activity, and monetary policy using real stock returns as a proxy for changes in expected economic activity.

After October 1979, real exchange rates seemed strongly affected by changes in the interest rate differentials. This was not the case prior to 1979. The natural explanation is that the U.S. and U.K. moved in 1979 to a strict monetary policy focusing on monetary aggregates rather than interest rate levels. This monetary policy induced short-run movements in both the real interest rate and exchange rate. A weak positive relation has been found between real stock-return differentials and changes in the real exchange rate, especially in the second period. This would support the idea that anticipated real growth has a positive influence on the exchange rate. However, the relation is fairly weak. The weak relation might be caused by the fact that stock returns are a poor proxy for real economic growth; it might also be explained by conflicting influences such as the negative association called by the competitiveness argument.[6] A more complete model should probably be specified; the purpose of this note was only to illustrate how

[6] The weak relation could be in part attributable to measurement errors associated with the weighting scheme used for the regressors and with linear annualization of returns.

we could use financial prices such as stock prices in lieu of traditional macroeconomic time series such as economic activity.

REFERENCES

1. J. Bilson and R. Marston (eds.). *Exchange Rate Theory and Practice.* Chicago: University of Chicago Press, 1984.
2. W. Branson. "Exchange Rate Policy after a Decade of Floating." In J. Bilson and R. Marston (eds.), *Exchange Rate Theory and Practice.* Chicago: University of Chicago Press, 1984.
3. B. Cornell. "The Money Supply Announcement Puzzle: Review and Interpretation." *American Economic Review* 73 (September 1983), 644–57.
4. R. Dornbusch. "Expectations and Exchange Rate Dynamics." *Journal of Political Economy* 84 (December 1976), 1161–76.
5. E. F. Fama. "Stock Returns, Real Activity, Inflation and Money." *American Economic Review* 71 (September 1981), 545–65.
6. A. de Freitas. "La Relation entre Cours Boursiers, Monnaie et Activité Réelle." Ph.D. dissertation, Centre HEC-ISA, 1985.
7. J. Frenkel (ed.). *Exchange Rates and International Macroeconomics.* Chicago: University of Chicago Press, 1983.
8. R. Geske and R. Roll. "The Fiscal and Monetary Linkage between Stock Returns and Inflation." *Journal of Finance* 38 (March 1983), 1–34.
9. R. E. Lucas. "Interest Rates and Currency Prices in a Two Country World." *Journal of Monetary Economics* 10 (November 1982), 335–60.
10. G. Mandelker and K. Tandon. "Common Stocks Returns, Real Activity, Money and Inflation: Some International Evidence." *Journal of International Money and Finance* 4 (June 1985), 267–86.
11. R. Meese and K. Rogoff. "Empirical Exchange Rate Models of the Seventies: Are Any Fit to Survive?" *Journal of International Economics* 14 (February 1983), 3–24.
12. B. Solnik. "The Relation between Stock Prices and Inflationary Expectations: The International Evidence." *Journal of Finance* 38 (March 1983), 35–48.
13. R. Stulz and W. Wasserfallen. "Macroeconomic Time Series, Business Cycles and Macroeconomic Policies." *Carnegie-Rochester Conferences in Public Policy*, 1985.