Advanced Topic 6:
Exchange Rate Determination III

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The analysis below involves an empirical investigation of the role of real shocks in determining movements in real exchange rates. The task is to try to determine the extent to which observed real exchange rate changes are a consequence of real shocks to technology and capital accumulation. Given the lack of useful models of technological change, we can only attempt to discern whether observed real exchange rate movements can be statistically explained by factors such as income growth, terms of trade changes, world oil and commodity price changes, shifts in world investment, and differential changes in government activity, that would obviously be expected to influence countries' real exchange rates. To investigate the frequent claim that an increase in domestic/foreign interest differentials arising from monetary policy will cause capital inflows and real exchange rate appreciation, we must create additional regressions that are augmented by adding the interest rate differential to the variables that were otherwise statistically significant.

On the basis of earlier theoretical analysis, we have to conclude that the argument that monetary policy affects exchange rates through its effects on interest rate differentials makes no economic sense for two reasons. First, central banks will not be able to affect overall domestic/foreign real interest rate differentials by monetary expansion because those differentials are determined in world asset markets, although the monetary authories in big countries will be able to affect the overall level of world interest rates. And second, the view that international capital flows respond to interest rate differentials involves a fallacy of composition. While any one individual might well shift her portfolio in towards securities whose interest rates have risen, when everyone tries to do this they reduce the demand for the lower-interest-rate securities and increase the demand for the higher-interest-rate securities, causing the higher interest rates to fall and/or the lower interest rates to rise until there is no gain from shifting portfolios. Interest rate differentials are determined by the willingness of world asset holders to hold the existing stocks of the various securities—actual aggregate asset flows are not required.

To the extent that interest rate differentials and real exchange rates are related, the relation must be in the reverse direction to that postulated above—domestic/foreign interest rate differentials clearly could change as a consequence of the behaviour of real forces that lead to real exchange rate changes, or perhaps in response to movements of real exchange rates. For that reason, we also run OLS regressions of the interest rate differentials on the same factors that have been shown to cause movements in a country's real exchange rate with respect to the U.S., including among the independent variables the real exchange rate itself.

We start with **Canada vs. the United States**. Below are three Tables of regression results interspersed with plots showing the response of the real exchange rate to various statistically significant real forces. **The real exchange rate is defined using, alternatively, the implicit GDP deflators and the consumer price indexes as measures of the price levels. The real commodity price variable is an index of world prices of commodities excluding energy in U.S. dollars divided by an equal weighted index of U.S. export and import prices. The energy price variable is an index of world energy prices in U.S. dollars divided by the equal weighted index of U.S. export and import prices. The real net capital inflow variable is the excess of Canadian imports of goods and services over exports of goods and services as a percentage of Canadian GDP minus the excess of U.S. imports of goods and services over U.S. exports of goods and services as a percentage of U.S. GDP. The government consumption expenditure variable is Canadian government consumption expenditure as a percentage of GDP minus U.S. government consumption expenditure as a percentage of GDP. The Canadian and U.S. terms of trade are the countries' export prices divided by their import prices. The real GDP variables are constructed by dividing GDP by the implicit GDP deflator. The employment rate variables, which were only available from 1976Q1, are constructed by subtracting the country's percentage of labour force unemployed from 100. And the interest rate differentials are obtained by subtracting the relevant U.S. interest rate from the Canadian one**. In the three left-most regressions in Table 1, the real exchange rate is constructed using the countries' consumer price indexes while in the three right-most regressions it is constructed using the countries' implicit GDP deflators. The three regressions on the left are ones used in *Interest Rates, Exchange Rates and World Monetary Policy* while the three on the right take advantage of additional data available since the book was published and also include the Canadian and U.S. employment rates as independent variables. **The addition of these employment rates resulted in the real GDP variables becoming statistically significant. While the ratio of the Canadian to the United States terms of trade was statistically insignificant, a significant coefficient with the expected positive sign was obtained when the Canadian terms of trade alone was used. Basing the real exchange rate on the implicit GDP deflators rather than the consumer price indexes resulted in a statistically significant coefficient for the government expenditure variable. Logarithms of all variables other than those representing differences in percentages were used.**

Table 1: OLS regression analysis of real factors affecting the real exchange rate: Canada vs. United States, 1974:Q1 to 2010:Q4

Independent Variables	Dependent Variable Logarithm of Real Exchange Rate					
	1974Q1 — 2007Q4			1976Q1 — 2010Q4		
Constant	2.612 (0.187)***	2.369 (0.185)***	2.292 (0.186)***	2.206 (1.102)**	1.205 (0.894)	0.620 (0.872)
Log of Commodity Prices	0.310 (0.065)***	0.372 (0.068)***	0.388 (0.071)***	0.441 (0.118)***	0.529 (0.104)***	0.529 (0.106)***
Log of Energy Prices	0.154 (0.034)***	0.134 (0.034)***	0.132 (0.034)***	0.140 (0.034)***	0.156 (0.030)***	0.158 (0.030)***
Real Net Capital Inflow	0.028 (0.004)***	0.022 (0.004)***	0.021 (0.005)***	0.026 (0.004)***	0.025 (0.003)***	0.024 (0.003)***
Gov't Consumption Expenditure				0.023 (0.014)**	0.008 (0.011)	0.004 (0.011)
Log of Canadian Terms of Trade				0.738 (0.285)***	0.639 (0.245)***	0.666 (0.247)***
Log Canadian Real GDP				2.593 (0.520)***	1.733 (0.408)***	1.279 (0.414)***
Log U.S. Real GDP				-2.288 (0.459)***	-1.479 (0.361)***	-1.050 (0.369)***
Canadian Employment Rate				-0.040 (0.009)***	-0.045 (0.008)***	-0.040 (0.008)***
U.S. Employment Rate				0.032 (0.009)***	0.032 (0.007)***	0.027 (0.007)***
		1-Month Corporate Paper	3-Month Tresury Bills		1-Month Corporate Paper	3-Month Treasury Bills
Interest Rate Differential		0.015 (0.004)***	0.017 (0.004)***		0.017 (0.003)***	0.022 (0.004)***
Num. Obs.	136	136	136	140	140	140
R-Squared	.775	.802	.808	.835	.865	.870

Note: The variables are defined in the main text. The figures in brackets are the heteroskedasticity and autocorrelation adjusted coefficient standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. Significant serial correlation was present in the residuals of all regressions. The superscripts *** indicate significance at the 1% levels according to a standard t-test.

The real exchange rate is positively related, as our theory suggests, to commodity prices, energy prices, the excess of Canadian over U.S. net capital inflows as percentages of their GDPs, the excess of Canadian over U.S. government consumption expenditures as percentages of their GDPs, and the Canadian terms of trade with respect to the rest of the world. And the two interest rate differential variables that were added in turn were all significantly positively related to the relevant real exchange rates. **The sign of the Canadian real GDP variable is positive and the sign of the U.S. real GDP variable is negative as consistent with the Balassa-Samuelson hypothesis and the employment rate variables have opposite signs to the real GDP variables as is consistent with our expectation that a temporary increase in a country's output should reduce its value in world markets**. The R-square in the 1976Q1 through 2010Q4 regression was .835. **The plots in Figure 1 below indicate that the major movements prior to year 2000 are quite well explained by the real net capital inflow variable and after 2000 by commodity and energy prices. The other statistically significant variables did not have effects on the real exchange rate that were visible to the naked eye.**[1]

Someone might try to argue that the regression results in Table 1 above could be spurious. When a unit-root variable is regressed on other unit-root variables, statistically significant coefficients will often arise even though the unit-root variables involved may be totally independent of each other. **There are three reasons why the above regression results could not be spurious. First, there are stationary independent variables in each regression—in particular the commodity price variable and the interest rate differentials**. For these stationary variables to be statistically significant they must be correlated with the residuals of a regression that includes only the non-stationary variables, which can only happen if those residuals are stationary—for that regression to be spurious, its residuals would have to be non-stationary. **Second, while it is possible for a regression involving two or three totally independent non-stationary variables to yield statistically significant results, the chances of a regression of one non-stationary variable on nine other non-related variables producing nine statistically significant coefficients with the expected signs is virtually zero. Third, for the sake of argument a Johansen cointegration test was conducted in `Gretl` on the three non-stationary variables consisting of the logarithm of the real exchange rate, the net capital inflow difference and the logarithm of energy prices for the period 1974Q1 through 2007Q4.**[2] **The hypothesis of no-cointegration—that is, that the relationship between them is spurious—could be rejected at the 1% level.**[3] Since these variables are cointegrated, all the regressions in the Table must be non-spurious since all the coefficients are statistically significant.

[1] This econometric work for the 1974Q1–2007Q4 period was performed alternatively in `Gretl`, and `XLispStat` using the respective input files `rexcaus.inp` and `rexcaus.lsp` which, using the respective data files `jfdataqt.gdt` and `jfdataqt.lsp`, produced the output files `rexcaus.got`, `rexcaus.lou`. The data are also in the Excel spreadsheet file `jfdataqt.xls`. The sources are explained in the `Gretl` data file `jfdataqt.gdt` and in the text file `jfdataqt.cat`. The calculations for the period 1976Q1–2010Q4 were performed in a `Gretl` session for which the session file is `causrex.gretl`, which contains and properly describes all the data used and the output produced.

[2] For a discussion of the nature of this test, see pages 385-400 of the Enders book cited in the course outline. It is also discussed more briefly on page 166 of *Interest Rates, Exchange Rates and World Monetary Policy.*

[3] The variables were first tested for stationarity in `Gretl` using augmented Dickey-Fuller tests and the null-hypothesis of stationarity could easily be rejected in all three cases.

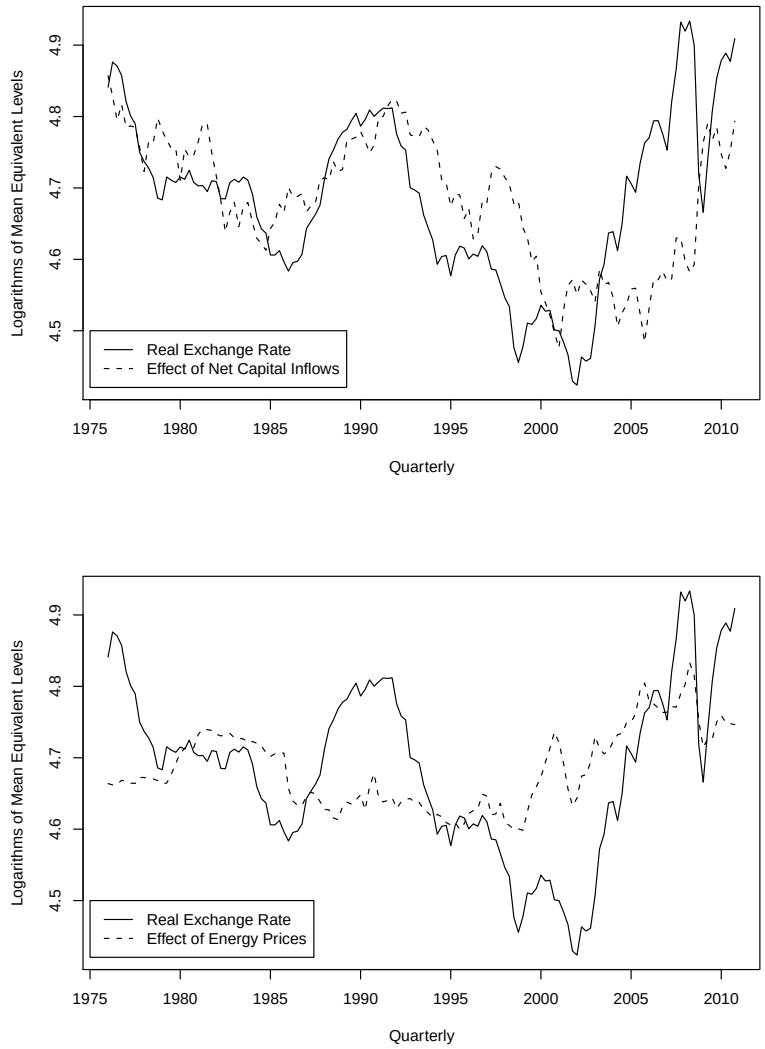

Figure 1: The effects of real net capital inflows energy prices and the prices of commodities exclusive of energy on the Canadian real exchange rate with respect to the United States.

The fact that the interest rate variables were positively signed and statistically significant in the regressions in Table 1 might be taken as support for the view that capital flows are a function of interest rate differentials which are determined by the monetary authorities of the respective countries. The fact that there is no theoretical basis for this view requires an alternative explanation of what is observed. Indeed, **it is quite reasonable to argue that the observed interest rate differentials might be explained by the same variables that determine real exchange rates as well as by the real exchange rate itself. That is, the causality of the observed relationship between the real exchange rate and interest rate differentials may be the direct opposite of that implied by the real exchange rate regressions in the table above**. To check this out we run regressions of the interest rate differentials on the real exchange rate and the variables found to explain it. These interest rate differential regressions presented in Table 2 below for the period 1976Q1 through 2010Q4. The U.S. employment rate and net capital inflow variables were insignificant in the T-Bill rate regression and were therefore dropped.[4]

A potential interpretation of these results is that increases in the real exchange rate and Canadian relative to U.S. real income and employment increase the risk of holding Canadian as compared to U.S. assets while increases in commodity and energy prices, net capital inflows and government consumption expenditure reduce that relative risk. Given that the real exchange rate and the differences in income and employment have no trend, high levels of these variables increase the probability of future declines and low levels increase the probability of future increases. Increased Canadian relative to U.S. government consumption expenditure would reduce the risk by making future increases in income more likely. And increased capital inflows, higher prices of commodities and energy and an improvement in the terms of trade, at given levels of income and employment and the real exchange rate, reduce the risk because they signify that Canada is better off. The problem with this interpretation is that **it is difficult to imagine that the default risk on treasury bills and would change as a result of the magnitudes of changes in real exchange rates and commodity prices that have been observed**.

An alternative approach would **explain the coefficients of the variables as reflecting the correlation of changes in those variables with expected future Canadian inflation relative to that in the United States. Expansion of income and employment in a country might tend to increase the prospect of domestic inflation, And increases in commodity and energy prices, net capital inflows and the terms of trade, holding real incomes and the price of domestic output in terms of foreign output constant, would tend to increase the supply of domestic output with the result that the upward pressure on domestic nominal prices will be smaller. And, holding other things constant, an increase in the real exchange rate—that is, the price of domestic in terms of foreign output—might be expected to exert upward pressure on domestic nominal prices**.

[4]The analysis here is performed entirely in the `Gretl` session `causrex.gretl`.

Table 2: OLS Regression analysis of real Factors affecting interest rate differentials: Canada vs. United States, 1976:Q1 to 2010:Q4

Independent Variables	Dependent Variables: Interest Rate Differentials	
	1-Month Corporate Paper	3-Month Treasury Bills
Constant	40.092 (16.349)***	57.837 (14.294)***
Log of Energy Prices	-1.452 (0.610)***	-0.837 (0.478)**
Log of Commodity Prices	-9.213 (1.932)***	-7.626 (1.766)***
Net Capital Inflow	-0.180 (0.090)**	
Government Consumption	-0.668 (0.274)***	-0.551 (0.227)***
Log of Canadian Terms of Trade	-6.419 (2.706)***	-6.297 (2.428)***
Log of Canadian Real GDP	24.163 (12.304)**	37.242 (9.558)***
Log of U.S. Real GDP	-23.915 (10.995)**	-35.882 (8.480)***
Canadian Employment Rate	0.718 (0.200)***	0.459 (0.127)***
U.S. Employment Rate	-0.316 (0.177)**	
Log of Real Exchange Rate	10.793 (2.127)***	7.788 (1.578)***
Num. Obs.	140	140
R-Squared	.605	.708
Adjusted R-Squared	.575	.690

Note: The figures in the brackets ( ) are the heteroskedastic and autocorrelation adjusted standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. The superscripts *** indicate significance at the 1% levels according to a standard t-test. The adjusted R-Squared is adjusted for degrees of freedom.

Table 3: OLS Regression analysis of relationship between interest rate and inflation rate differentials: Canada vs. United States, 1975:Q1 to 2010:Q4

Independent Variables	Dependent Variables: Interest Rate Differentials	
	1-Month Corporate Paper	3-Month Treasury Bills
Constant	1.096	1.429
	(0.225)***	(0.237)***
Inflation Rate Differential	0.336	0.314
	(0.097)***	(0.097)***
Num. Obs.	140	140
R-Squared	.120	.107
Adjusted R-Squared	.113	.101

Note: The interest rate differentials are those in Table 1 and the inflation differential is the excess of the Canadian over U.S. year-over-year CPI inflation rate. The figures in brackets are the heteroskedastic and autocorrelation adjusted standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. The superscripts *** indicate significance at the 1% levels according to a standard t-test. The adjusted R-squared is adjusted for degrees of freedom.

In this respect, it is interesting that the excess of the Canadian over the U.S. year-over-year inflation rate was insignificant when added to the regressions in Table 2. Yet this variable is always significant with the expected positive sign when it is the only explanatory variable, as shown in Table 3 above, but the R-squares, both unadjusted and adjusted for degrees of freedom, are very low compared to those in the Table 2 regressions. This is consistent with the interpretation that the variables in the latter regressions are indeed capturing changes in the expected future inflation differential—they encompass all explanatory power contained in the inflation differential over the previous year, suggesting that the real variables indirectly reflect both the actual and expected differences in Canadian relative to U.S. inflation. Final conclusions regarding the determination of the Canada/U.S. interest rate differential must nevertheless wait until monetary shocks are introduced into the analysis.

Next we turn to evidence with respect to the **United Kingdom vs. United States** with the tabular and graphic results interspersed below. **With respect to the forces determining the real exchange rate** in the regressions presented in the Table 4 below, **the logarithms of the two countries' real outputs have the signs predicted by the Balassa-Samuelson hypothesis and a rise in the U.K. terms of trade with respect to the rest of the world relative to the U.S. terms of trade with respect to the rest of the world is positively related to the real exchange rate as would be expected.**[5] It is not clear what to make of the signs of the logs of the prices of commodities less energy and the price of oil. Since Britain imports commodities and produces oil, any interpretation one might make would seem to be ad-hoc. **Given the crudeness of the available underlying theory of real exchange rate determination, it would probably be best to conclude that the oil and commodity price variables are correlated with real factors influencing the real exchange rate that could not be included.** The excess government consumption expenditure in the U.K. as a fraction of output over the corresponding ratio for the U.S. and the magnitude of the net inflow of capital into the U.K. relative to output less the corresponding magnitude for the U.S. were not statistically significant and therefore not included. The oil price variable yielded a better fit than an index of energy prices—both of these prices were divided by equally weighted average of U.S. export and import price indices and then expressed in logarithms.

Adding the U.K. minus U.S. interest rate differentials to the two right-most regressions in Table 4 weakens the effects of U.K. real output in both cases and that of U.S. real output in the case where the treasury-bill rate differential is used. And **the treasury-bill rate differential is not statistically significant at the 5% level.**

With regard to the possibility that the regressions in the table below could be spurious, we need simply note that the commodity price variable and both the interest rate differential variables are stationary.[6] **The fact that both the commodity price variable and the long-term government bond rate differential are statistically significant** therefore **rules out spurious regression results**.

[5]The real exchange rate regressions and unit root tests were performed in `Gretl` and `XLispStat` using the input files `rexukus.inp` and `rexukus.lsp` and the output files are `rexukus.got` and `rexukus.lou`. The data files are the `jfdataqt.gdt` and `jfdataqt.lsp`.

[6]This is shown in Table 10.6 on page 178 of *Interest Rates, Exchange Rates and World Monetary Policy.*

Table 4: OLS Regression analysis of real factors affecting the real exchange rate: United Kingdom vs. United States, 1974:Q1 to 2007:Q4

Independent Variables	Dependent Variable Logarithm of Real Exchange Rate		
Constant	-2.043 (1.282)	-3.609 (1.309)***	-4.391 (1.356)***
Log of Commodity Prices	0.466 (0.085)***	0.513 (0.072)***	0.359 (0.081)***
Log of Oil Prices	-0.206 (0.051)***	-0.184 (0.053)***	-0.174 (0.038)***
Log of Terms of Trade Ratio	1.835 (0.213)***	1.846 (0.225)***	1.932 (0.200)***
Log of U.K. Real GDP	2.216 (0.731)***	1.714 (0.786)**	1.432 (0.556)**
Log of U.S. Real GDP	-1.619 (0.586)***	-1.191 (0.632)*	-0.905 (0.451)**
		Treasury Bills	Long-Term Gov't Bonds
Interest Rate Differential		0.012 (0.006)*	0.027 (0.008)***
Num. Obs.	136	136	136
R-Square	.720	.748	.770

Note: The real exchange rate is CPI based and the commodity price and energy price variables are the same as those used in the Canadian case. The interest rate differentials are U.K. minus U.S. The figures in brackets are the heteroskedasticity and autocorrelation adjusted coefficient standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. Significant serial correlation was present in the residuals of all regressions. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

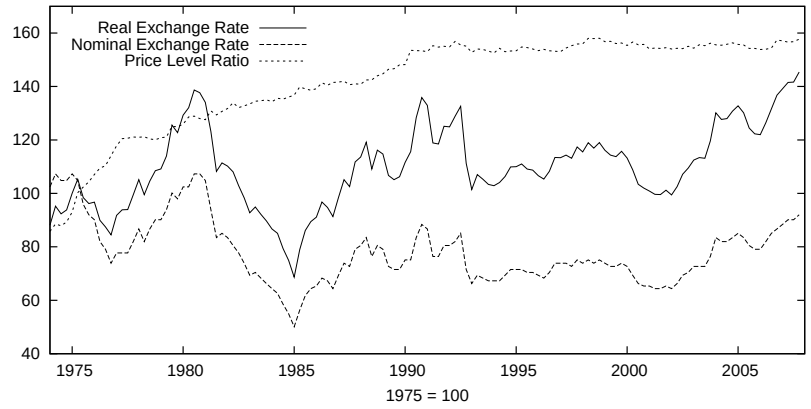

Figure 2: Real and nominal exchange rates of the United Kingdom with respect to the United States and the ratio of the United Kingdom over United States price level, 1975 = 100.

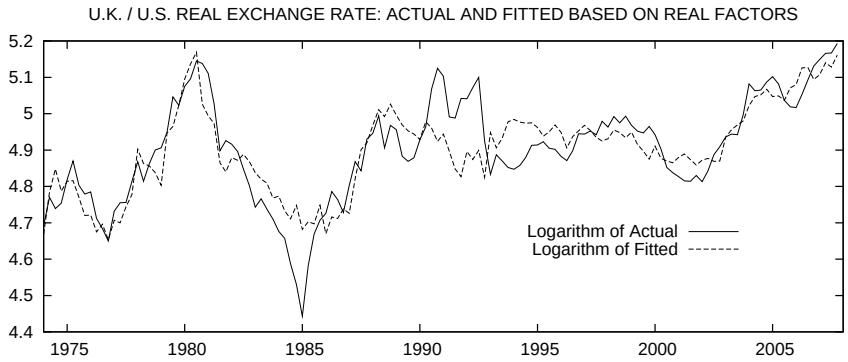

Figure 3: The real exchange rate of the United Kingdom with respect to the United States: Actual and fitted levels in logarithms.

The real and nominal exchange rates of the United Kingdom with respect to the United States and the ratio of the U.K. over the U.S. price levels are plotted in Figure 2 above. The actual and fitted values in the regression that excludes interest rate differentials are plotted in Figure 3 and contributions of important variables to explaining the real exchange rate movements are plotted in Figure 4. **The terms of trade ratio provides some explanation of the real exchange rate movements prior to 1985 as well as the increase that occurred after 2000. The commodity price variable also seems to explain the rise in the real exchange rate after 2000 with the real oil price variable having the opposite effect, although it is unclear what forces these variables are capturing. The income variables simply help explain the trend.**

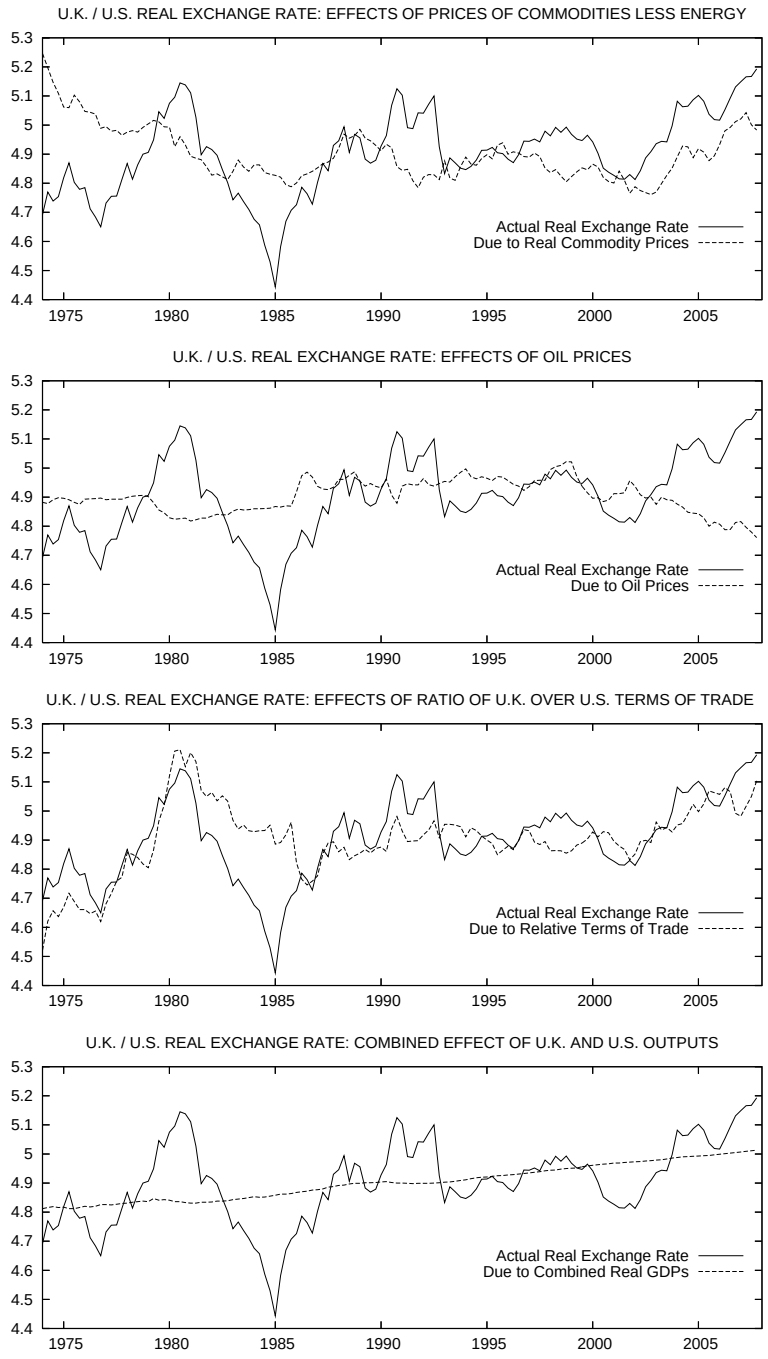

Figure 4: The effects of oil prices, the prices of commodities exclusive of energy, the ratio of the U.K. to U.S. terms of trade and the combined effect of U.K. and U.S. outputs on the U.K. real exchange rate with respect to U.S.

Table 5: OLS Regression analysis of real factors affecting interest rate differentials: United Kingdom vs. United States, 1974:Q1 to 2007:Q4

Independent Variables	Dependent Variables: Interest Rate Differentials		
	Treasury Bill Interest Rate Differential		Long-Term Gov't Bond Rate Differential
Constant	26.858 (8.825)***	59.373 (22.511)***	119.095 (11.000)***
Log of Commodity Prices	-5.766 (1.976)***	-4.553 (1.915)**	
Log of Energy Prices	1.534 (0.712)**		
Difference Gov't Cons.	-0.929 (0.370)**		0.441 (0.223)**
Difference Cap. Inflow	0.593 (0.169)***		
Terms of Trade Ratio		-13.452 (4.916)***	-18.875 (3.041)***
Log of U.K. Real GDP			15.302 (6.416)**
Log of U.S. Real GDP			-16.978 (5.263)***
Log of Real Exchange Rate		5.249 (2.532)**	7.643 (1.255)***
Inflation Rate Difference	0.244 (0.070)***	0.255 (0.089)***	
Num. Obs.	136	136	136
Adj. R-Square	.426	.297	.782

Note: The variables are defined in the text and in the notes to Table 4. The R-Square statistics are adjusted for degrees of freedom. The figures in brackets are the heteroskedasticity and autocorrelation adjusted standard errors calculated in the Gretl statistical program, and the significance levels shown, in the same way as in Table 4.

Table 6: OLS Regression analysis of relationship between interest rate and inflation rate differentials: United Kingdom vs. United States, 1974:Q1 to 2007:Q4

Independent Variables	Dependent Variables: Interest Rate Differentials	
	Treasury Bills	Short-Term Gov't Bonds
Constant	1.889	2.352
	(0.302)***	(0.273)***
Inflation Rate Differential	0.257	0.264
	(0.067)***	(0.053)***
Num. Obs.	136	136
Adj. R-Square	.179	.262

Note: The interest rate differentials are defined in Table 4 and the inflation differential is the excess of the U.K. over U.S. year-over-year CPI inflation rate. The figures in brackets are the heteroskedastic and autocorrelation adjusted standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. The superscripts *** indicate significance at the 1% levels according to a standard t-test.

With reference to the interest rate differential regressions in Table 5 above it is important to keep in mind that the risk premiums on government debt will represent the probability of default plus the probability of unexpected inflation.[7] And the interest rate differentials themselves will directly reflect the excess of expected inflation in the U.K. over that in the U.S. **It is** therefore **not surprising that the inflation rate difference is statistically significant with a positive sign in the treasury bill rate differential regression—greater past inflation tends to generate the expectation of greater future inflation in the short-run. In the case of the long-term government bond rate differential, the long-run expected inflation differential must have been captured by the time patterns of the real variables rather than by the past inflation rate.**

Any interpretation of the coefficients of the real variables in Table 5, however, will involve little more than an ad-hoc exercise of theoretical imagination. **If one believes that the probabilities of default are very small and more or less constant, all that can be said is that a collection of real factors that would be expected to determine the real exchange rate are also correlated with the U.K. minus U.S. expected inflation rate differential.**

[7]The respective `Gretl` and `XLispStat` input files are `idfukus.inp` and `idfukus.lsp` and the output files are `idfukus.got` and `idfukus.lou`. The data files are the same as referred to in Footnote 5 above.

In contrast to the Canada vs. U.S. case, **the actual inflation rate differential, obviously through its effect on expectations, is a major independent factor affecting the U.K. minus U.S. interest rate differentials**. This can be seen from the fact that the R-Square statistics, adjusted for degrees of freedom, in the regressions in Table 6 using the inflation rate difference as the only independent variable are one-third to one-half the magnitudes of the degrees-of-freedom-adjusted R-Squares in Table 5.

We turn now to the case of **Japan with respect to the United States** in the collection of tables and figures that follow. Figure 5 plots the real and nominal exchange rates of Japan with respect to the United States, along with the ratio of Japanese over the U.S. price level. **The Japanese real exchange rate increased about 100 percent between 1974 and 1995 and then has declined by somewhat less than that amount by 2007. The Japanese price level fell rather steadily relative to the U.S. price level by about 50 percent from the late 1970s to 2007.**

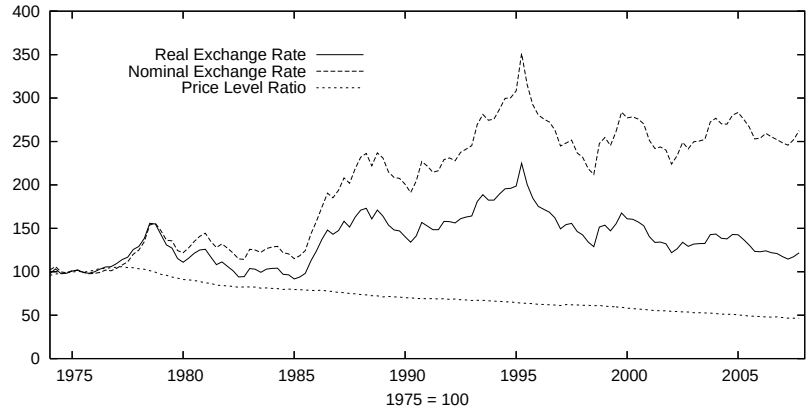

Figure 5: Real and nominal exchange rates of the Japan with respect to the United States and the ratio of the Japanese over U.S. price level, 1975 = 100.

Table 7: OLS Regression analysis of real factors affecting the real exchange rate: Japan vs. United States, 1974:Q1 to 2007:Q4

Independent Variables	Dependent Variable Real Exchange Rate	
Constant	-9.610	-10.038
	(1.442)***	(1.541)***
Log of Oil Prices	0.160	0.123
	(0.051)***	(0.053)**
Log of Terms of Trade Ratio	1.237	1.188
	(0.188)***	(0.166)***
Gov't Consumption Expenditure	0.033	
	(0.010)***	
Net Capital Inflow	-0.014	
	(0.006)**	
Log of Japanese Real GDP	1.224	0.817
	(0.182)***	(0.153)**
Log of U.S. Real GDP	-1.868	-0.272
	(0.200)***	(0.105)**
Interest Rate Differential		-0.028
		(0.007)***
Num. Obs.	136	136
R-Square	.829	.841

Note: The construction of the variables is explained in the text. The figures in brackets are the heteroskedasticity and autocorrelation adjusted standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a Bartlett kernel. Significant serial correlation was present in the residuals of all regressions. The superscripts ***, ** and *indicate significance at the 1%. 5% and 10% levels, respectively.

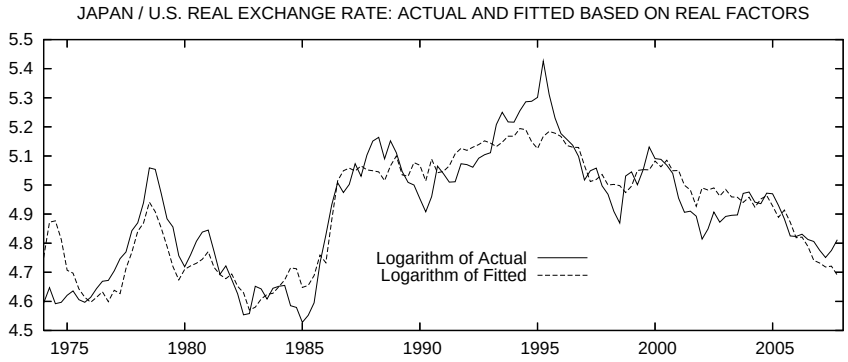

Figure 6: Actual and fitted values of the logarithm of the Japanese real exchange rate with respect to the U.S.

In the OLS regression analysis of real factors affecting the CPI-based Japanese real exchange rate with respect to the U.S. presented in Table 7 above, the logarithm of the ratio of the Japanese terms of trade with respect to the rest of the world over the U.S. terms of trade with respect to the rest of the world is positively related to the real exchange rate and the logarithm of Japanese real GDP is positively related and that of U.S. real GDP is negatively related as consistent with the Balassa-Samuelson hypothesis.[8] **The logarithm of U.S. oil prices relative to the average of U.S. export and import prices and the excess Japanese government consumption expenditure as a percentage of GDP over U.S. government consumption expenditure as a percentage of that country's GDP are positively related and the excess of the negative of the Japanese trade balance—that is, real net capital inflow—as a percentage of GDP over the negative of the U.S. trade balance as a percentage of real GDP has, surprisingly, a negative sign. There is no obvious reason why the sign of the oil prices variable should be positive for Japan. In this respect it must be kept in mind that the results represent a relationship between the variables that undoubtedly suffers from simultaneity bias and left-out variables. When the Japanese less U.S. interest rate differential on long-term government bonds is added to the equation, it comes in with a negative sign and drives out the government consumption expenditure and real net capital inflow variables**.

Figure 6 above plots the actual and fitted values of the Japanese real exchange rate with respect to the U.S. and Figures 7 and 8 below plot the measured effects of the various independent variables in the left-most regression in Table 7 on the real exchange rate. **It is clear in second panel from the top in Figure 7 that movements in the relative terms of trade account for a substantial part of the time pattern of the real exchange rate movements**, and it is clear in the second panel from the to in Figure 8 that Japanese real income growth has had an important influence. The effects of the other variables, apart from income growth in the U.S., are not observable on the graphs.

[8]The relevant `Gretl` and `XLispStat` input and output files here are `rexjnus.inp`, `rexjnus.lsp`, `rexjnus.got` and `rexjnus.lou` and the data files are the same as used for the U.K. calculations.

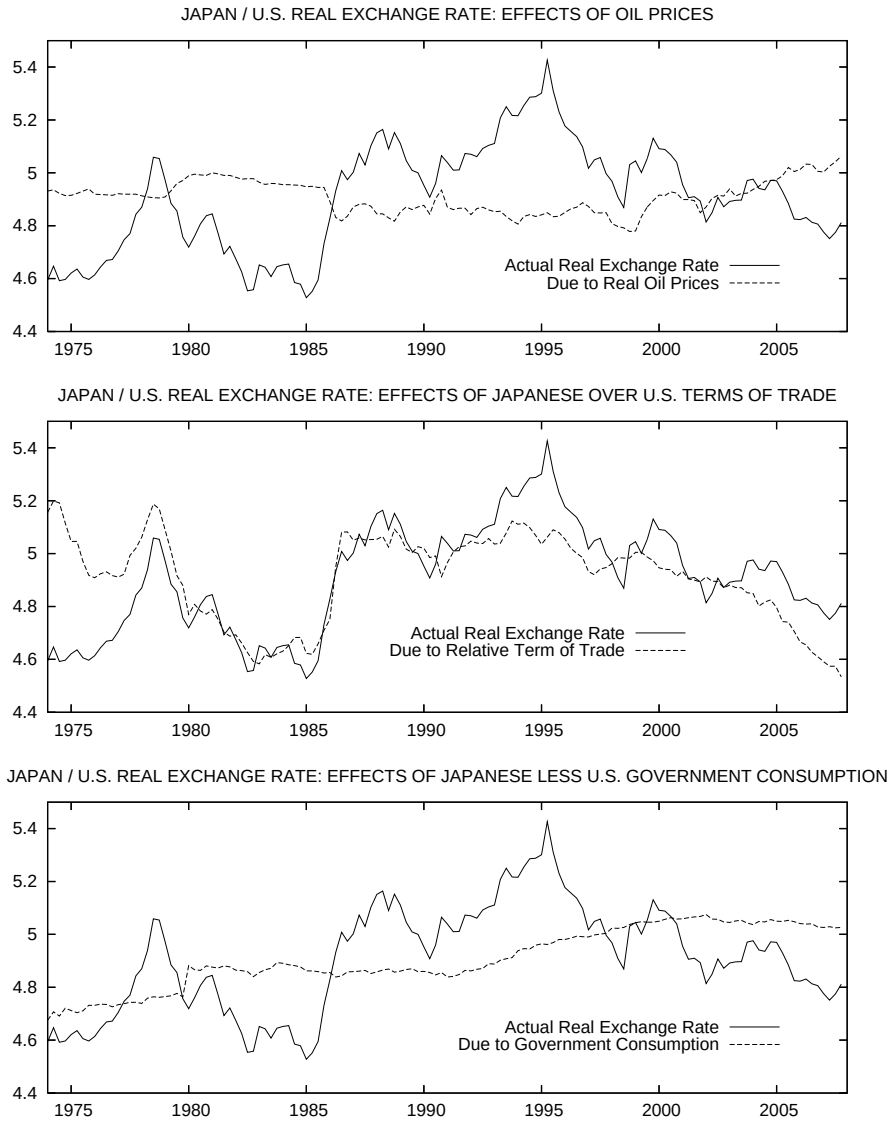

Figure 7: Effects on the logarithm of the Japanese real exchange rate with respect to the U.S. of oil prices, the ratio of the Japanese terms of trade with respect to the rest of the world over the U.S. terms of trade with respect to the rest of the world, and the excess of Japanese government consumption as a percentage of GDP over U.S. government consumption as a percentage of U.S. GDP.

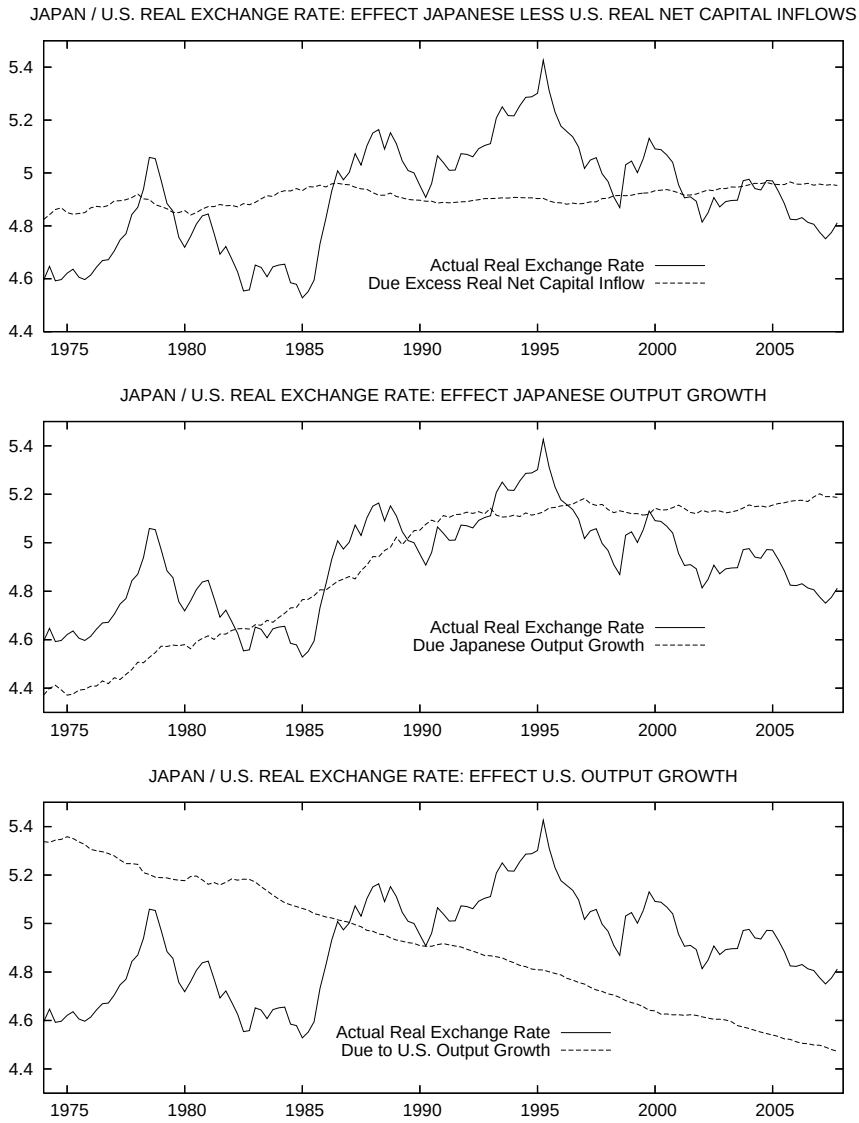

Figure 8: Effects on the Japanese real exchange rate with respect to the U.S. of the excess of Japanese real capital inflows as a percentage of GDP over U.S. real capital inflows as a percentage of U.S. GDP and of Japanese and U.S. real GDP growth.

As in the case of the U.K. with respect to the United States, **the real exchange rate regressions contain statistically significant stationary variables**—in particular, the government consumption expenditure variable, the log of Japanese real GDP and the interest differential and inflation differential variables.[9] **This rules out the possibility that the regressions are spurious**.

Table 8 below presents the results of regressions that purport to explain movements in the excess of the Japanese over the U.S. interest rates on long-term government bonds on the basis of the type of real factors that would be expected to explain movements in the Japanese vs. U.S. real exchange rate.[10] An obvious explanatory variable, the Japanese minus U.S. year-over-year inflation rate difference, was added. The left-most regression was obtained by starting with all relevant real variables and dropping successively the least-significant variable until the remaining variables were all significant at the 5 percent level or better. The regression in the middle column was obtained by starting with the variables that were significant in explaining the real exchange rate movements and then dropping, in turn, the least significant variable other than the real exchange rate until all remaining variables were significant at the 5 percent level or better. The inflation differential when added turned out to be significant at only the 10 percent level and the real exchange rate variable was not significant at even the 10 percent level. The regression in the right-most column has the inflation differential as the only independent variable.

Since it is difficult to imagine that any significant probability of default exists for the public debt of either country, **the most reasonable interpretation of the regression results is that they indicate the variables that are most correlated with the expected long-run inflation rate difference in Japan as compared to the U.S.** While the positive sign of the terms of trade ratio variable in the middle regression is encouraging in that a rise in the price of traded output components in Japan relative to the United States might be expected to increase the probability of Japanese inflation, that variable is not statistically significant in the left-most regression, which has a much higher degrees-of-freedom-adjusted R-square. Any attempt to explain the signs of the variables would be ad-hoc—all that can be said is that they are correlated with the factors that determined the expected long-run inflation rate difference. Not surprisingly, **the actual year-over-year inflation rate difference alone can explain over 40% of the variation in the long-term interest rate differential**. As in the case of all countries being examined, a fuller analysis awaits the incorporation of monetary shocks.

[9] The relevant unit root test results are presented in Table 10.10 in *Interest Rates, Exchange Rates and World Monetary Policy.*

[10] The relevant `Gretl` and `XLispStat` files here are `idfjnus.inp`, `idfjnus.lsp`, `idfjnus.got` and `idfjnus.lou` and the data file used is the same as used previously.

Table 8: OLS Regression analysis of real factors on interest rate differentials: Japan vs. United States, 1974:Q1 to 2007:Q4

Independent Variables	Dependent Variable Long-Term Government Bond Rate Differential		
Constant	-14.301	-50.198	-2.217
	(15.901)	(11.304)***	(0.249)***
Log of Commodity Prices	-3.890		
	(1.165)***		
Log of Oil Prices		2.496	
		(0.577)***	
Log of Terms of Trade Ratio		10.319	
		(2.098)***	
Difference Gov't Cons.	-1.095		
	(0.141)***		
Difference Capital Inflow	0.460		
	(0.080)***		
Log of Japanese Real GDP	-10.989		
	(1.620)***		
Log of U.S. Real GDP	19.355		
	(2.330)***		
Log of Real Exchange Rate		-2.215	
		(1.357)	
Inflation Rate Differential	0.198	0.237	0.359
	(0.043)***	(0.087)*	(0.072)***
Num. Obs.	136	136	136
Adj. R-Square	.779	.597	.408

Note: The construction of the variables is explained in the text. The figures in brackets are the heteroskedasticity and autocorrelation adjusted coefficient standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

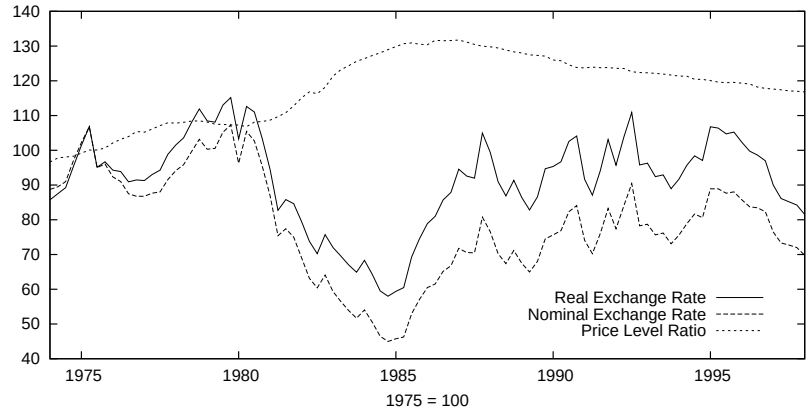

Figure 9: Real and nominal exchange rates of France with respect to the United States and the ratio of the French over U.S. price level, 1975 = 100.

The empirical results with respect to **France vs. the United States** are presented in the tables and charts that follow. We restrict ourselves to the **period before France joined the European Currency Union. Table 9 on the next page presents the results of regressions of the logarithm of the CPI-based French vs. U.S. real exchange rate on a set of real factors that would be expected to determine it.**[11] The logarithm of energy prices in U.S. dollars divided by an equally weighted average of U.S. export and import prices provided a better fit than the logarithm of U.S. oil prices divided by the same U.S. traded goods price index. And the excess of net capital inflows and debt service flows into France—represented by the negative of the French trade balance—as a percentage of GDP over the corresponding U.S. net inflows as a percentage of that country's GDP turned out to be statistically insignificant and was not included. **The logarithm of the ratio of the French terms of trade with respect to the rest of the world over the U.S. terms of trade with respect to the rest of the world is positively related to the real exchange rate, as might be expected, and the effects of the logarithms of the French and U.S. real GDPs are positive and negative, respectively, as consistent with the Balassa-Samuelson hypothesis. The excess of French government consumption expenditure as a percentage of GDP over U.S. government consumption expenditure as a percentage of that country's GDP had the expected positive effect. The signs of the coefficients of the logarithms of U.S. dollar prices of energy and of commodities excluding energy, both deflated by U.S. traded goods prices, do not have an obvious non-ad-hoc interpretation.**

[11] The `Gretl` and `XLispStat` files for these calculations are `rexfrus.inp`, `rexfrus.lsp`, `rexfrus.got` and `rexfrus.lou` and the data file is again the one used previously.

Table 9: OLS Regression analysis of real factors affecting the real exchange rate: France vs. United States, 1974:Q1 to 1998:Q4

Independent Variables	Dependent Variable Logarithm of Real Exchange Rate		
Constant	-3.901	-3.809	-4.048
	(2.636)	(2.580)	(2.393)*
Log of Commodity Prices	0.313	0.300	0.343
	(0.130)**	(0.121)**	(0.119)***
Log of Energy Prices	-0.279	-0.283	-0.272
	(0.078)***	(0.078)***	(0.076)***
Gov't Cons. Difference	0.033	0.032	0.035
	(0.018)*	(0.018)*	(0.018)*
Log of Terms of Trade Ratio	2.143	2.129	2.162
	(0.144)***	(0.160)***	(0.162)***
Log of French Real GDP	1.778	1.810	1.564
	(0.517)***	(0.551)**	(0.665)**
Log of U.S. Real GDP	-1.911	-1.935	-1.717
	(0.432)***	(0.446)***	(0.557)***
		Treasury Bills	Long-Term Gov't Bonds
Interest Rate Differential		-0.001	0.015
		(0.004)	(0.016)
Num. Obs.	100	100	100
R-Square	.803	.803	.809

Note: The construction of the variables is explained in the text. The figures in brackets are the heteroskedasticity and autocorrelation adjusted coefficient standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. Significant serial correlation was present in the residuals of all the regressions. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

The regressions in the two right-side columns in Table 9 add the French minus U.S. interest rate differentials to the regression in deference to the common view that central bank imposed increases in domestic interest rates lead to an inflow of capital and an increase in the real exchange rate. It turns out that **interest rate differentials on both treasury-bills and long-term government bonds are statistically insignificant** and the former has a sign opposite to that required by the argument above.

It turns out **that non-stationarity of all of the statistically significant variables in the above regressions cannot be ruled out using the standard tests, except for the commodity price variable and possibly the U.S. real GDP variable.** To be safe, **a Johansen Cointegration Test was performed on the remaining five variables and the null hypothesis of no cointegration could clearly be rejected**.[12]

Figures 10 and 11 plot the actual and fitted levels of the left-most regression in the table along with the separate effects of the individual included variables on the real exchange rate. An examination of these plots leads one to the conclusion that **the main factor accounting for the decline in the real exchange rate between 1980 and 1985 and the increase thereafter was changes in the ratio of the French terms of trade with respect to the rest of the world over the U.S. terms of trade with respect to the rest of the world**.

Regressions of **the effects of real factors on the French minus U.S. interest rate differentials are presented in Table 10.**[13] The regression results are obtained by starting with all variables of interest and successively dropping the ones that are the least statistically significant until a completely significant set is obtained. As in previous cases, with the exception of Canada, any attempt to interpret these regression results, which really show the effect of the variables on the excess of the expected French relative to U.S. inflation rates, would be ad-hoc. **The proper interpretation of the underlying nature of the effects of the independent variables is not obvious with the exception of the logarithm of the terms of trade ratio in the first regression on the left. When this variable is dropped and replaced by the inflation rate differential, the R-Square improves slightly and the sign of the inflation rate differential is the one that would be expected.** As shown in the right-most column of Table 11, **the terms of trade ratio and the inflation differential happen to be highly negatively correlated**. This occurs **because of an increase and subsequent decline in French relative to U.S. inflation rates that happens to coincide with the decline and subsequent increase in the terms of trade ratio during the 1980s**. It is also clear from that Table that **the inflation rate differentials alone are significantly positively related to the interest rate differentials** although the correlation is only about $\sqrt{0.111} = 0.333$ in the case of the treasury bill rate differential and around $\sqrt{0.3} = 0.547$ in the case of the interest rate differential on long-term government bonds.

[12] All these tests results are presented on pages 193 and 194 of the book cited in previous footnotes.

[13] Here the `Gretl` and `XLispStat` input and output files are `idffrus.inp`, `idffrus.lsp`, `idffrus.got` and `idffrus.lou` and the data file is the same as before.

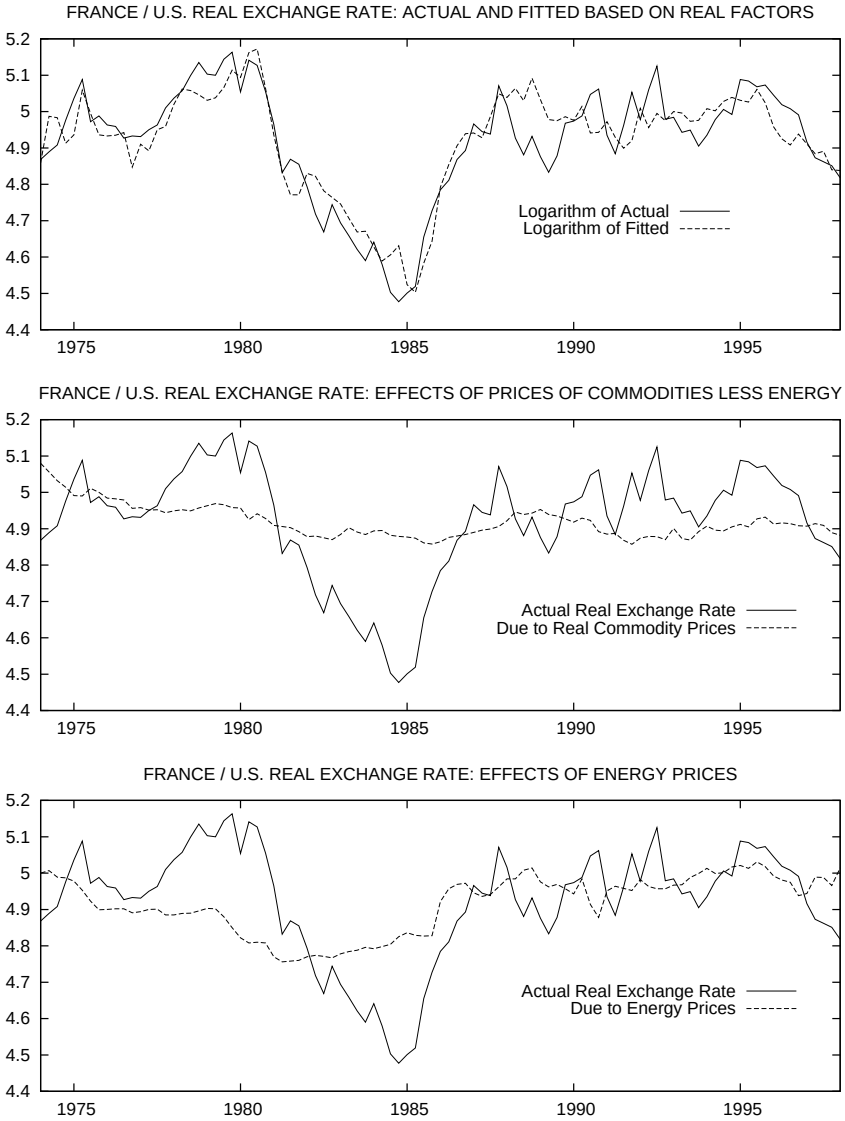

Figure 10: Actual and fitted values of the logarithm of the French real exchange rate with respect to the U.S. and the effects of of commodity prices and energy prices.

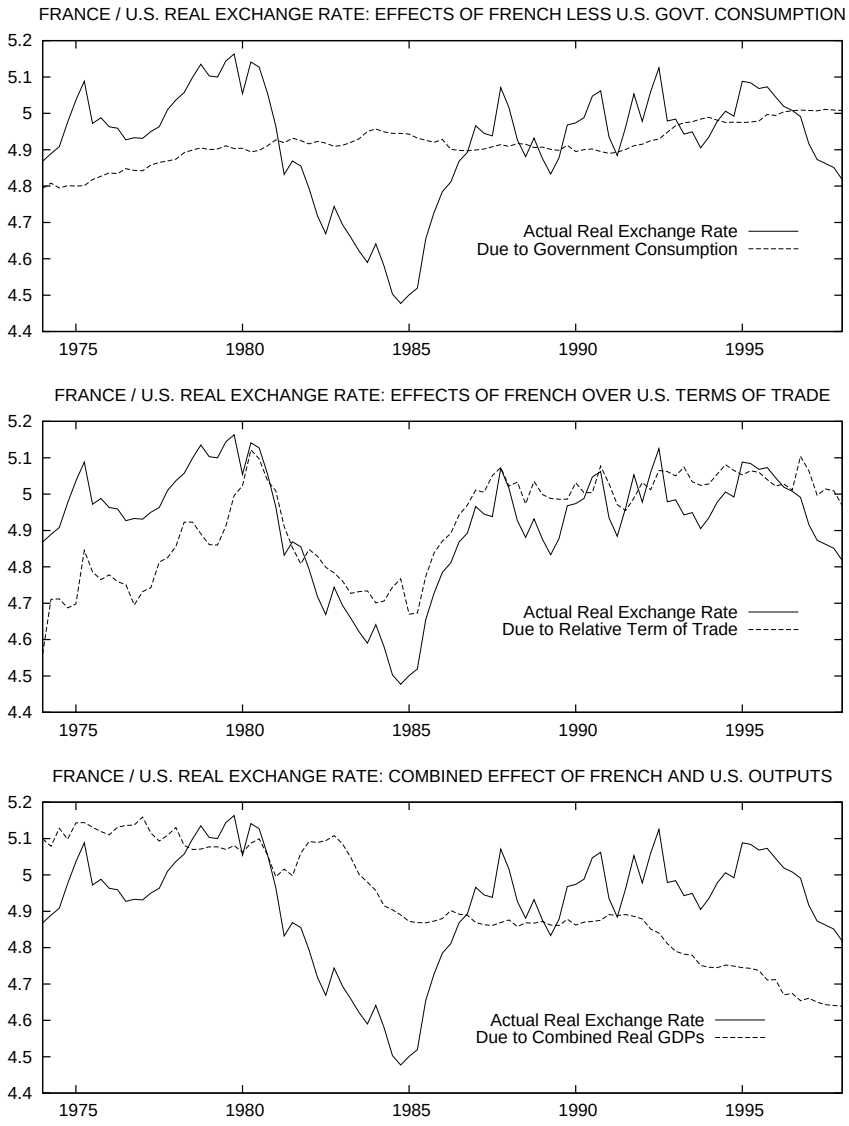

Figure 11: Effects on the logarithm of the French real exchange rate with respect to the U.S. of the excess excess of French government consumption as a percentage of GDP over U.S. government consumption as a percentage of U.S. GDP, of the logarithm of the ratio of the French terms of trade with respect to the rest of the world over the U.S. terms of trade with respect to the rest of the world and of combined French and U.S. real GDP growth.

Table 10: OLS Regression analysis of real factors on interest rate differentials: France vs. United States, 1974:Q1 to 1998:Q4

Independent Variables	Dependent Variable: Interest Rate Differential		
	Treasury Bills		Long-Term Gov't Bonds
Constant	141.163 (30.475)***	83.713 (17.291)***	1.822 (5.420)
Log of Commodity Prices	-13.899 (2.687)***	-12.795 (2.734)***	-2.762 (1.158)**
Log of Energy Prices	-3.789 (2.425)***	-4.223 (1.353)***	
Gov't Cons. Difference	-0.738 (0.247)***	-0.837 (0.228)***	-0.229 (0.064)***
Real Net Capital Inflow	0.667 (0.205)***	0.544 (0.217)**	0.211 (0.057)***
Log of Terms of Trade Ratio	-11.486 (4.894)**		
Log of Real Exchange Rate			2.641 (0.894)***
Intflation Rate Differential		0.333 (0.121)***	0.217 (0.054)***
Num. Obs.	100	100	100
R-Square	.473	.477	.661

Note: The figures in brackets are the heteroskedasticity and autocorrelation adjusted standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. Significant serial correlation was present in the residuals of all the regressions. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

Table 11: OLS Regression analysis of the effects of inflation rate differentials on interest rate differentials and the relationship between the terms of trade ratio and inflation rate differentials: France vs. United States, 1974:Q1 to 1998:Q4

Independent Variables	Dependent Variable		
	Interest Rate Differential		Inflation Rate Differential
	Treasury Bills	Long-Term Gov't Bonds	
Constant	1.874 (0.493)***	0.848 (0.157)***	147.323
Log of Terms of Trade Ratio			-31.236 (4.152)***
Inflation Rate Differential	0.334 (0.128)**	0.249 (0.062)***	
Num. Obs.	100	100	100
R-Square	.111	.300	.660

Note: The figures in brackets are the heteroskedasticity and autocorrelation adjusted coefficient standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. Significant serial correlation is present in the residuals of all the regressions. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

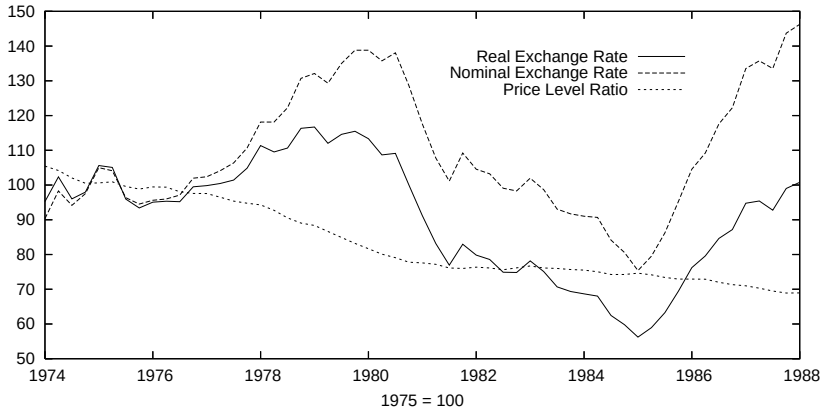

Figure 12: Real and nominal exchange rates of Germany with respect to the United States and the ratio of the French over U.S. price level, 1975 = 100.

Finally, we investigate the real factors affecting the real exchange rate of **Germany with respect to the United States**. We restrict ourselves to the **period before unification**, which occurred before Germany adopted the Euro as its currency. **As in the case of France, the real exchange rate fell by close to 50 percent between the late 1970s and 1985 and then recovered very substantially by 1988. The German price level fell continually relative to the U.S. price level throughout the period by an amount totaling more than 30 percent**.

The results of a regression analysis of the real factors affecting the CPI-based real exchange rate are presented in Table 12.[14] **The coefficients of the logarithms of German and U.S. real GDP are significantly positive and negative, respectively, as consistent with the Balassa-Samuelson hypothesis. The logarithm of the ratio of the German terms of trade with respect to the rest of the world over the corresponding U.S. terms of trade has a positive effect, reflecting the consequences of a rise in the prices of the traded components of output in Germany relative to the United States. The excess of German government consumption expenditure as a percentage of GDP over U.S. government consumption expenditure as a percentage of that country's GDP has a positive sign, as would be expected from a bias of public expenditure in the direction of domestic non-traded components. The logarithm of oil prices is negatively related to the real exchange rates as is consistent with the fact that Germany is not an oil producer. The logarithm of commodity prices excluding energy has a positive sign for reasons that are not clear.**

Short-term and long-term **interest rate differentials, when added to the regressions in the right-most two columns of the table have signs opposite to what would be expected by those who argue that a central bank induced increase in domestic interest rates attracts capital and thereby raises the real exchange rate. The long-term government bond rate differential is not statistically significant and both it and**

[14]The relevant `Gretl` and `XLispStat` files are `rexgrus.inp`, `rexgrus.lsp`, `rexgrus.got` and `rexgrus.lou` and the data file is the same as used previously.

the treasury bill rate differential are obvious substitutes for the difference between German and U.S. government consumption expenditures, taken as percentages of their respective GDPs.

Again, largely for the sake of interest, **a Johansen Cointegration Test was performed on the group of five non-stationary variables—the real exchange rate, oil price, government consumption expenditure, terms of trade and German real GDP variables—and the null-hypothesis of no cointegration was clearly rejected.**[15]

The actual and fitted values of the left-most regression in Table 12 are plotted in the top panel of Figure 13 and **the effects of the variables used as regressors** are plotted, along with the actual series, in the bottom two panels of that figure and in Figure 14. **The results are very similar to what occurred in the cases of France, Japan, and the United Kingdom. Of all the variables, only the logarithm of the ratio of the German terms of trade to the U.S. terms of trade has had a quantitative effect easily visible to the naked eye. The terms of trade ratio obviously significantly accounted for the observed pattern of real exchange rate movements**.

Table 13 below presents the results of an OLS regression analysis of the relationship between the treasury bill and long-term government bond interest rate differentials and the set of real factors potentially affecting the real exchange rate.[16] The logarithm of the prices of commodities excluding energy was statistically insignificant and therefore excluded, while the logarithm of energy prices provided a better fit than, and was therefore substituted for, the logarithm of oil prices. **As in the corresponding interest rate differential regressions for the other countries with respect to the United States, about all that can be said about the signs of the coefficients is that they somehow capture the relationship between the independent variables and the expected inflation rate in Germany relative to the United States**. As can be seen from the R-Squares adjusted for degrees of freedom, the inflation rate differential can account for a rather small fraction of the variation in the treasury bill rate differential and for virtually none of the variation in the long-term government bond rate differential. Indeed, in the case of the latter variable, the inflation rate differential has the wrong sign and in the regression on itself alone is statistically insignificant. When included along with the other variables, the inflation rate differential tends to capture the effects of, and thereby displace, the German real GDP variable.

With the shortening of the sample period to end with 1988 combined with the fact that the treasury bill rate differential starts in the third quarter of 1975, the regressions which include that variable are based on only 54 observations—less than 14 years of quarterly data. One might argue that this sample is too small, given that the distributions of OLS regression coefficients, standard-errors and t-ratios approach their true values in the limit. Accordingly, a boot-strap procedure is used and presented on pages 206 and 207 of *Interest Rates, Exchange Rates and World Monetary Policy* to verify the conclusions reached above.

[15] See tables on pages 203 and 204 of *Interest Rates, Exchange Rates and World Monetary Policy* for details.

[16] The `Gretl` and `XLispStat` input and output files are `idfgrus.inp`, `idfgrus.lsp`, `idfgrus.got` and `idfgrus.lou` and the data file is the same as before.

Table 12: OLS Regression analysis of real factors affecting the real exchange rate: Germany vs. United States, 1974:Q1 to 1988:Q4

Independent Variables	Dependent Variable Logarithm of Real Exchange Rate		
Constant	-1.243 (1.566)	0.170 (1.713)	-1.194 (1.560)
Log of Commodity Prices	0.259 (0.083)***	0.259 (0.114)**	0.292 (0.103)***
Log of Oil Prices	-0.126 (0.046)***	-0.130 (0.038)***	-0.134 (0.051)**
Gov't Cons. Difference	0.048 (0.022)**	0.015 (0.012)	0.041 (0.022)*
Log of Terms of Trade Ratio	1.370 (0.219)***	1.504 (0.249)***	1.362 (0.228)***
Log of German Real GDP	2.283 (0.620)***	1.942 (0.672)***	2.331 (0.654)***
Log of U.S. Real GDP	-2.105 (0.365)***	-2.036 (0.386)***	-2.161 (0.404)***
		Treasury Bills	Long-Term Gov't Bonds
Interest Rate Differential		-0.014 (0.006)**	-0.006 (0.011)
Num. Obs. R-Square	60 .925	54 .945	60 .926

Notes: The regression that includes the treasury bill interest rate differential begins in the third quarter of 1975. The construction of the variables is explained in the text. The figures in brackets are the heteroskedasticity and autocorrelation adjusted standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. Significant serial correlation is present in the residuals of all the regressions. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

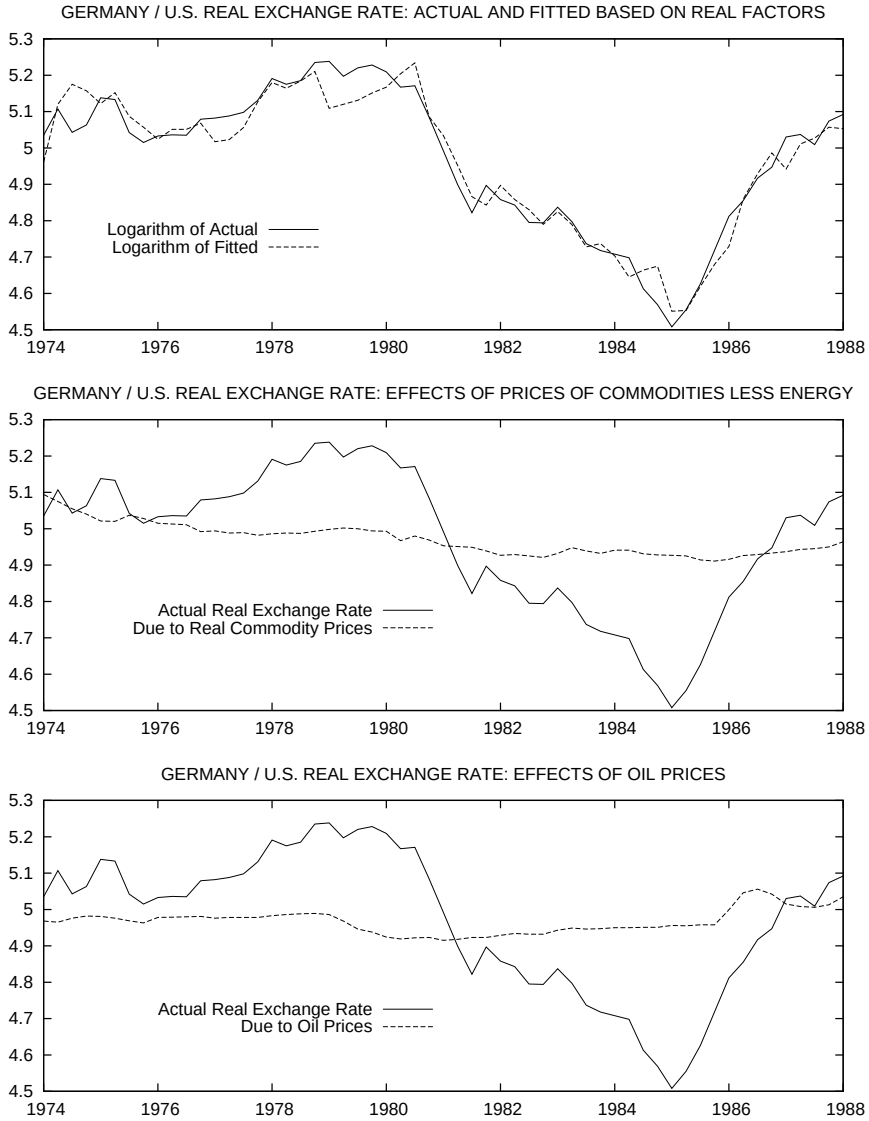

Figure 13: Actual and fitted values of the logarithm of the German real exchange rate with respect to the U.S. and the effects of of commodity prices and oil prices.

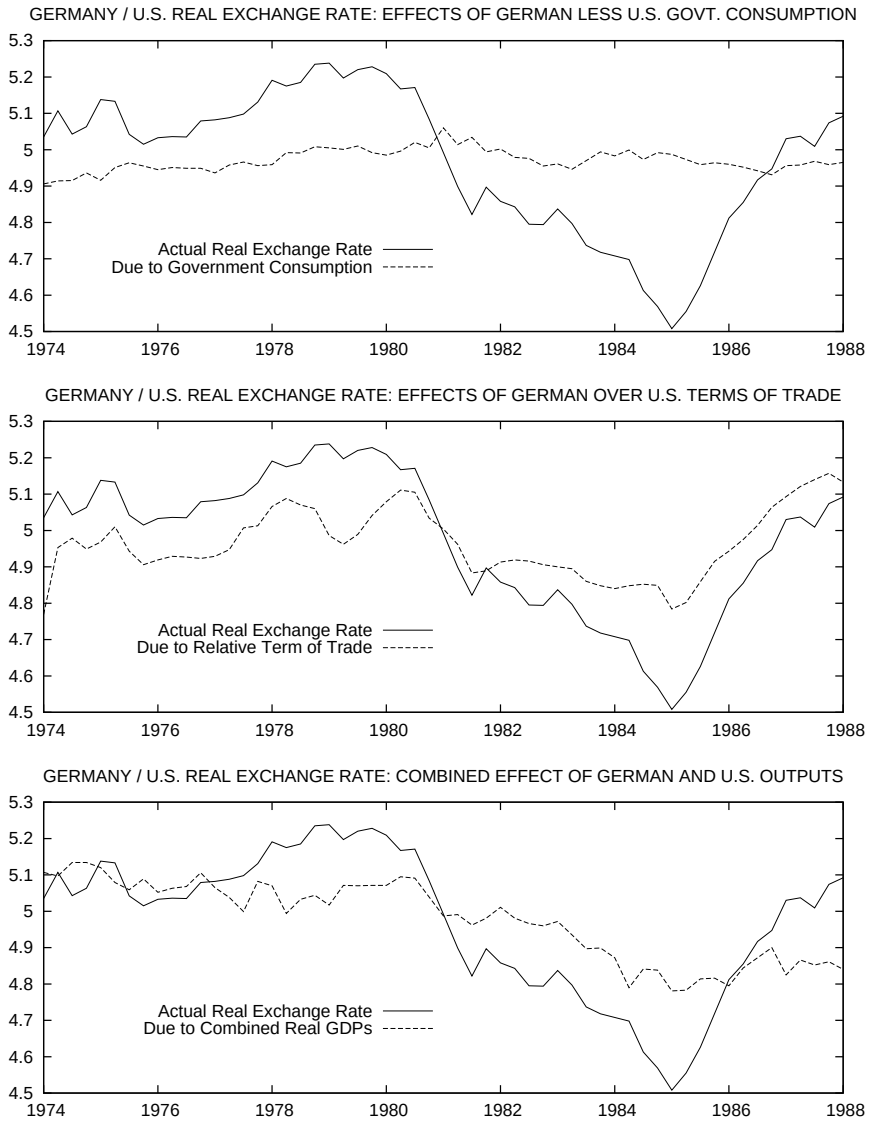

Figure 14: Effects on the logarithm of the German real exchange rate with respect to the U.S. of the excess excess of German government consumption as a percentage of GDP over U.S. government consumption as a percentage of U.S. GDP, of the logarithm of the ratio of the German terms of trade with respect to the rest of the world over the U.S. terms of trade with respect to the rest of the world and of combined German and U.S. real GDP growth.

Table 13: OLS Regression analysis of real factors on interest rate differentials: Germany vs. United States

Independent Variables	Dependent Variable: Interest Rate Differential				
	Treasury Bills		Long-Term Gov't Bonds		
	1975:Q3 to 1988:Q4		1974:Q1 to 1988:Q4		
Constant	61.252	-1.666	79.367	81.606	-2.446
	(10.794)***	(0.477)***	(11.362)***	(12.405)***	(0.592)***
Log of Energy Prices	-1.670		-4.153	-4.035	
	(0.756)**		(0.534)***	(0.507)***	
Gov't Cons. Difference	-0.943		-0.641	-0.737	
	(0.346)***		(0.289)**	(0.363)**	
Log of Terms of Trade Ratio			-4.575	-4.813	
			[2.173]**	[2.187]***	
Log of German Real GDP			13.594	11.853	
			(4.920)***	(6.111)*	
Log of U.S. Real GDP	-6.112		-16.402	-15.063	
	(1.019)***		(2.935)***	(4.114)***	
Intflation Differential	0.250	0.322		-0.044	-0.105
	(0.101)**	(0.103)***		(0.076)***	(0.130)
Num. Obs.	54	54	60	60	60
R-Sq. (Adj.)	.594	.222	.883	.882	-.002

Note: The construction of the variables is explained in the text. The figures in brackets are the heteroskedasticity and autocorrelation adjusted standard errors calculated in the Gretl statistical program, which chose a band width of 3 and a bartlett kernel. Significant serial correlation is present in the residuals of all the regressions. The superscripts ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively.

To end this Topic we summarize the conclusions reached. First, it is clear that more than 75% of movements in the real exchange rates of the five countries examined with respect to the United States can be attributed to real factors that would be expected to have such affects. Second, it is clear that in the case of Canada with respect to the United States, net inflows of capital relative to GDP minus net inflows of capital into the U.S. relative to that country's GDP, and to a lesser extent, commodity and energy prices relative to U.S. export and import prices were the dominant real factors. Third, in the cases of the real exchange rates with respect to the United States of all the other countries examined, the most important factors were the ratios of the domestic terms of trade with respect to the rest of the world over the U.S. terms of trade with respect to the rest of the world, and the increase in domestic real GDP as compared to the increase in the United States real GDP, as consistent with the Balassa-Samuelson hypothesis. Finally, the best explanation of the relationship between domesic minus U.S. interest rate differentials and real exchange rates is the relationship between those interest differentials and real forces determining real exchange rate movements that happen to be correlated with the difference between domestic and U.S. expected inflation rates—often better correlated than actual inflation rate differences.

Of course, a more complete analysis of the determinants of interest rate differentials involves incorporating the effects of monetary shocks, which we turn to in the next Advanced Topic on exchange rate determination.