

PRINCETON STUDIES IN INTERNATIONAL FINANCE

No. 56, September 1985

Real-Exchange-Rate Variability from
1920 to 1926 and 1973 to 1982

Paul De Grauwe
Marc Janssens
and
Hilde Leliaert

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY

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Paul De Grauwe, one of the authors of this Study, is Professor of Economics at the University of Louvain, Belgium. He has been a visiting professor at the Universities of Michigan and Pennsylvania and at the University of Paris. He has published a number of books, including *Macroeconomic Theory for the Open Economy*, as well as articles on international monetary economics. Marc Janssens was a research associate at the University of Louvain and is now an economic journalist at the Flemish newspaper, *De Standaard*. Hilde Leliaert is a graduate student at the University of Michigan.

PETER B. KENEN, *Director*
International Finance Section

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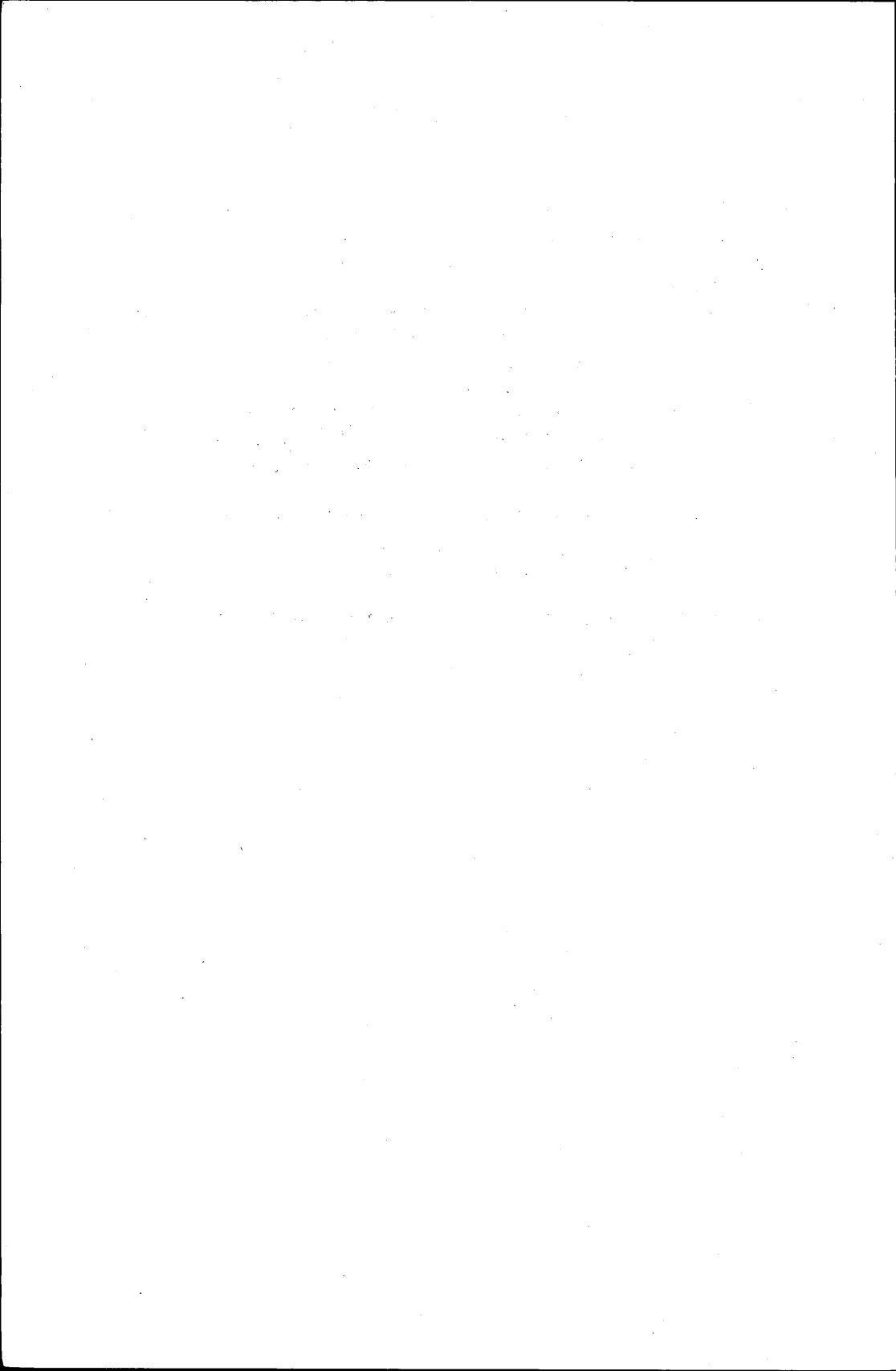
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I INTRODUCTION

The exchange-rate movements observed during the 1970s were larger than predicted by most economists. These large exchange-rate movements led in turn to large and sometimes sustained movements in real exchange rates, that is, deviations from purchasing-power parities. Have these recent variations in real exchange rates been larger than those that occurred during other historical episodes of flexible exchange rates? In this Study we analyze this question by comparing the exchange-rate experience of the 1970s with the experience in the first half of the 1920s, when the prevailing exchange-rate regime among the major currencies was similar.

Such a historical study is important because recent economic theorizing about exchange rates has started from a number of stylized facts pertaining to the 1970s. As will be clear from the present Study, however, these stylized facts do not all carry over to other historical periods with different experiences of inflation and monetary policy-making (called, for short, "monetary regimes"). As a result, the models we have now may not be very robust in the face of important changes in the monetary regime. By attempting to broaden the historical horizon to include the 1920s in our sample, and in particular the hyperinflationary German episode, we hope to shed some light on the relationship between the variability of real exchange rates and the monetary regime.

Chapter 2 defines real exchange rates and describes their historical path. Chapter 3 contains a spectral analysis of real exchange rates during 1920-26 and 1973-82. Chapter 4 advances a hypothesis to explain the short-run variability of real exchange rates, and Chapters 5 and 6 present the empirical evidence. The final chapter summarizes the main findings.

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2 REAL-EXCHANGE-RATE VARIABILITY: THE HISTORICAL EVIDENCE

This chapter presents real exchange rates against the dollar for three major currencies during the 1920s and 1970s: the French franc, the mark, and the pound. The real exchange rate is defined as follows:

$$R_{jk} = S_{jk}(P_j/P_k),$$

where S_{jk} = index of the price of currency j in units of currency k (the nominal exchange rate)

P_j = general price index for country j

P_k = general price index for country k (using two alternative indices—wholesale and CPI).

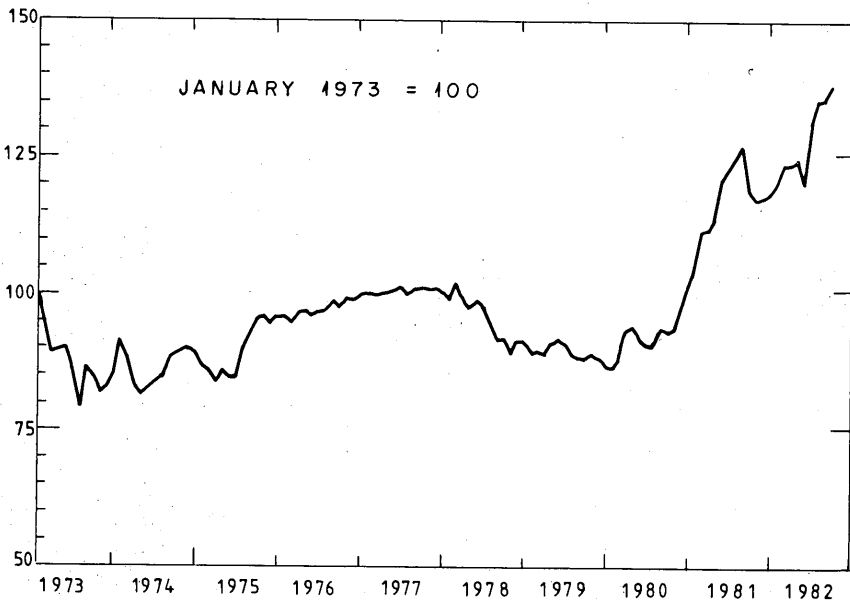
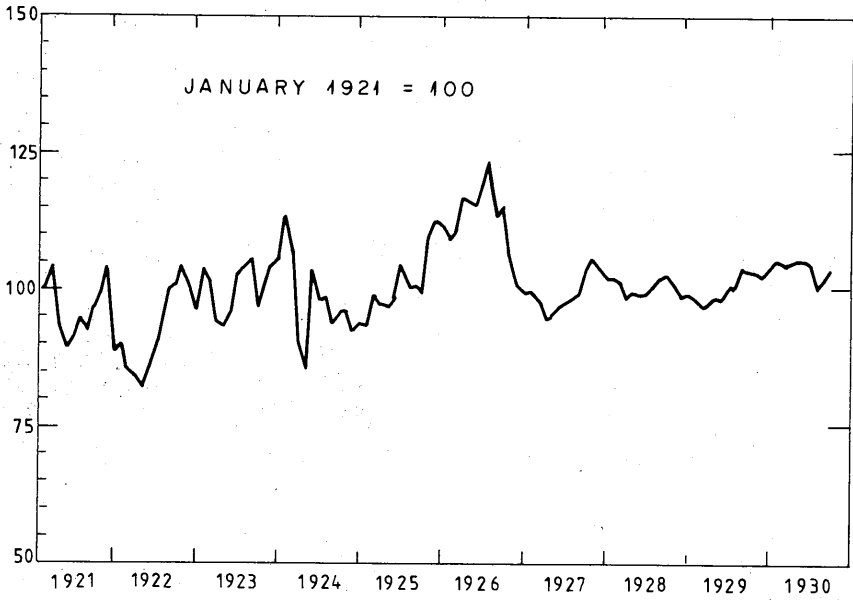
Figures 1 to 3 present the real exchange rates for the two periods, using the wholesale-price index.¹ We concentrate on the first half of the 1920s because from 1925-26 on there was a general return to fixed exchange rates.

From a visual inspection of the series it appears that, in the case of the franc and the mark, the short-run (monthly) variability of the real exchange rate was higher during the 1920s than during the 1970s. During the 1970s, however, the data seem to show more protracted and systematic movements in the real exchange rates, especially in the case of the franc and pound. It is especially noteworthy that after 1975-76 the real exchange rates of the three currencies exhibited trendlike or cyclical movements. Such systematic movements do not seem to have occurred during the 1920s.

To give more precision to the previous observations, several indicators of variability were computed. (For a more detailed discussion of measures of exchange-rate variability, see Kenen, 1979; Kenen and Rodrik, 1984; and Lanyi and Suss, 1982.) As indicators of short-run variability, we selected the mean monthly absolute change in the real exchange rate, its standard deviation, and the range between the maximum and the minimum monthly change (Table 1). We also computed the standard deviation of the real exchange rate around its sample mean (Table 2). This last indicator also measures the long-run variability of the real exchange rate; it will be high when the real exchange rate moves little over periods of a month but tends to wander in one or the other direction over a longer period.

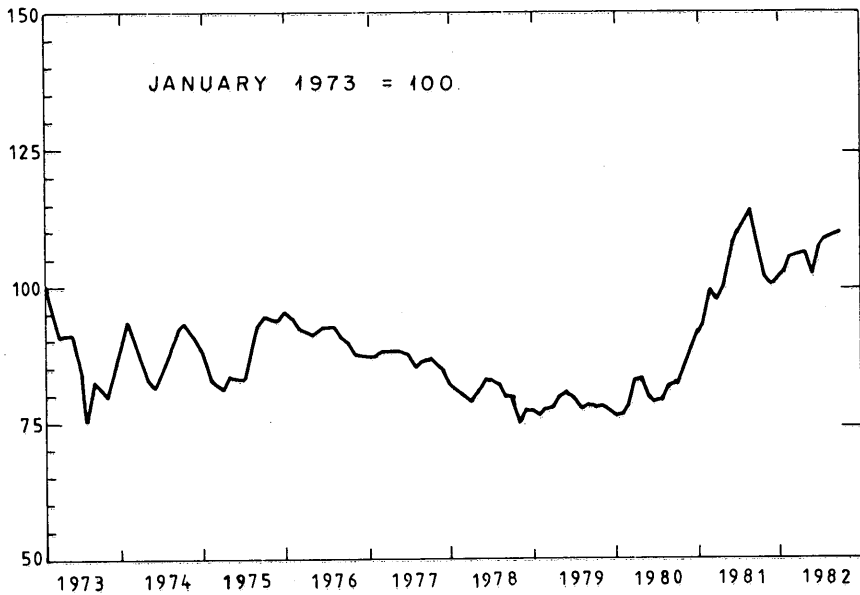
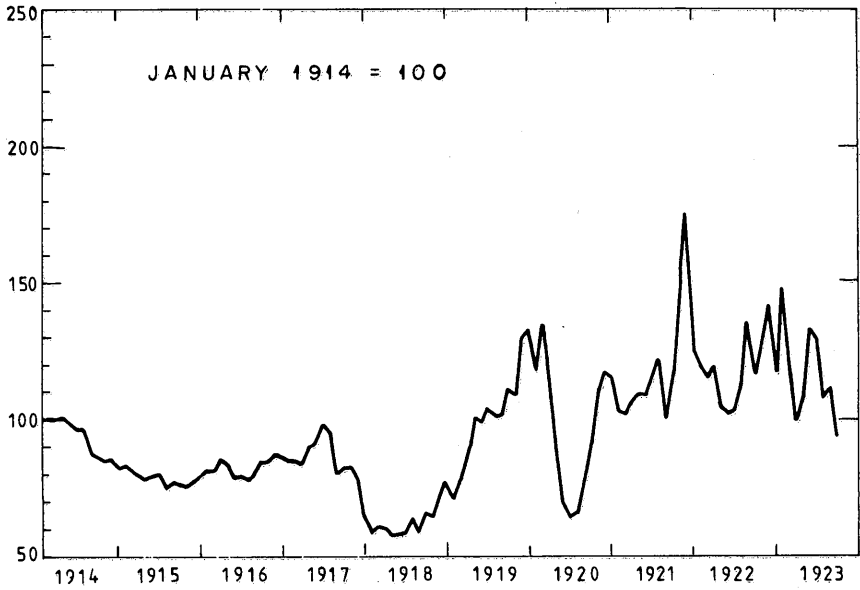
¹ Appendix A presents alternative measures of real exchange rates using the material-price or cost-of-living index for the 1920s and the consumer-price index (CPI) for the 1970s.

FIGURE 1
REAL FRANC/DOLLAR EXCHANGE RATE, FRANCE



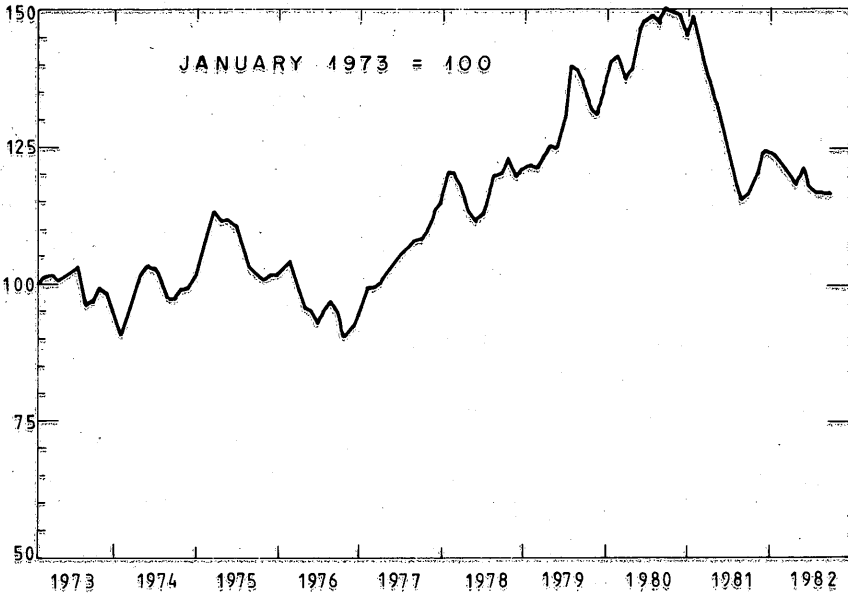
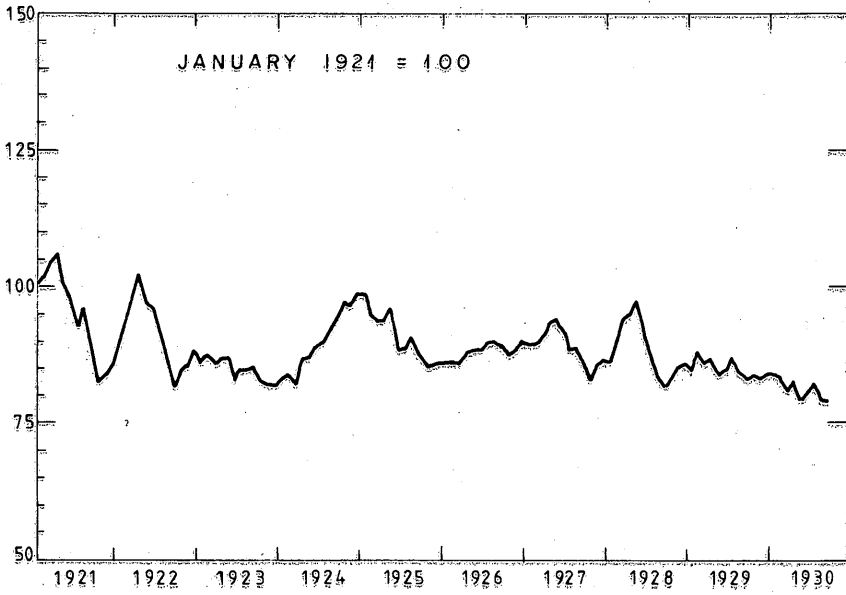
SOURCE: See Appendix B.

FIGURE 2
REAL MARK/DOLLAR EXCHANGE RATE, GERMANY



SOURCE: See Appendix B.

FIGURE 3
REAL STERLING/DOLLAR EXCHANGE RATE, UNITED KINGDOM



SOURCE: See Appendix B.

TABLE 1
 MEAN AND STANDARD DEVIATION OF MONTHLY ABSOLUTE CHANGES IN
 REAL EXCHANGE RATES, WHOLESALE PRICES
 (in percent)

	<i>Mean Absolute Change</i>	<i>Standard Deviation</i>	<i>Range^a</i>
1920s:			
franc/dollar (1921-26)	4.2	3.7	35.9
mark/dollar (1919-23)	11.0	8.0	31.0
sterling/dollar (1921-25)	2.7	2.0	13.4
1970s:			
franc/dollar (1973-82)	2.0	2.0	17.0
mark/dollar (1973-82)	2.3	2.1	21.0
sterling/dollar (1973-82)	2.1	1.5	15.0

SOURCE: See Appendix B.

^a The difference between the maximum and minimum monthly change.

The following generalizations can be drawn from the evidence in Table 1. First, the short-run (monthly) variability of real exchange rates was larger during the 1920s than during the 1970s for the franc/dollar and mark/dollar rates. The variability of the sterling/dollar rate was of the same order of magnitude in the two periods. The difference in the degree of variability is most pronounced in the case of the mark/dollar rate. During the German hyperinflation it was not uncommon for the real exchange rate to change 50 to 100 percent in a few months' time. This statistical evidence is in accordance with the anecdotal evidence about this period, indicating how large deviations from purchasing-power parity (PPP) led to large profit opportunities (see Bresciani-Turroni, 1937, and de Jonge, 1979; see also Aliber, 1980). But it seems to contradict the empirical study by Frenkel (1978), which concluded that the PPP relationship was very tight during the German hyperinflation. When we come to this problem we will indicate how Frenkel's results can be interpreted in the light of our own results.

The evidence in Table 2 confirms the visual impression given by Figures 1 through 3 that real exchange rates exhibited longer movements during the 1970s than during the 1920s. Although real exchange rates tended to fluctuate less in the short run during the 1970s, there was a substantial amount of variation over longer runs of several years. In other words, deviations from PPP appear to have been more protracted. We come back to this issue in Chapter 3, where we subject the data to spectral analysis.

TABLE 2
 STANDARD DEVIATION OF REAL EXCHANGE RATES
 FROM SAMPLE MEAN, WHOLESALE PRICES
 (in percent)

	<i>Standard Deviation</i>
1920s:	
franc/dollar (1921-26)	8.8
mark/dollar (1919-23)	20.2
sterling/dollar (1921-25)	7.0
1970s:	
franc/dollar (1973-82)	14.6
mark/dollar (1973-82)	11.1
sterling/dollar (1973-82)	29.2

SOURCE: See Appendix B.

In this Study we will be concerned mostly with exchange rates relative to the dollar. It is important, however, to know how cross rates have changed. The information given in Table 3 should be compared with that in Table 1. It appears that during the 1920s exchange rates involving the mark (which experienced hyperinflation) were much more volatile than other exchange rates (e.g., sterling/dollar, franc/sterling, and franc/dollar). Table 3 also confirms that during the 1970s the real exchange rates of the

TABLE 3
 MEAN AND STANDARD DEVIATION OF MONTHLY ABSOLUTE CHANGES IN
 REAL CROSS EXCHANGE RATES, WHOLESALE PRICES
 (in percent)

	<i>Mean Absolute Change</i>	<i>Standard Deviation</i>	<i>Range</i>
1920s:			
franc/sterling (1921-25)	4.1	4.0	37.8
mark/franc (1919-23)	14.8	10.5	77.8
mark/sterling (1919-23)	13.4	8.9	60.1
1970s:			
franc/sterling (1973-82)	1.9	1.5	12.5
mark/franc (1973-82)	1.1	1.1	8.9
mark/sterling (1973-82)	1.9	1.7	11.1

SOURCE: See Appendix B.

European currencies against each other were much less volatile than during the 1920s.

For a better understanding of the nature of the short-term variability in real exchange rates, it is important to relate it to the volatility of other variables. We do this first by analyzing the variability of nominal exchange rates and of inflation rates (which together define the variability of real exchange rates), and second by relating exchange-rate variability to the variability of stock prices.

How are variations in nominal and real exchange rates related? Tables 4 and 5 provide some evidence. Table 4 shows the means and standard deviations of monthly changes in prices and nominal exchange rates. Table 5 presents the correlation matrix of changes in price levels, nominal exchange

TABLE 4
MEAN AND STANDARD DEVIATION OF MONTHLY ABSOLUTE CHANGES IN
THE WHOLESALE-PRICE INDEX AND THE NOMINAL EXCHANGE RATE
(in percent)

	<i>Mean Absolute Change</i>	<i>Standard Deviation</i>	<i>Range</i>
<i>Wholesale Prices</i>			
1920s:			
France	3.2	3.0	23.0
Germany	47.0	105.0	569.0
U.K.	2.5	2.4	17.9
U.S.	1.2	1.2	11.7
1970s:			
France	1.0	1.0	7.4
Germany	0.5	0.5	3.2
U.K.	1.2	0.7	4.3
U.S.	0.9	0.8	7.2
<i>Nominal Exchange Rates</i>			
1920s:			
franc/dollar	6.0	5.3	26.0
mark/dollar	51.7	100.7	554.5
sterling/dollar	1.4	1.3	10.3
1970s:			
franc/dollar	2.1	1.9	15.5
mark/dollar	2.2	1.9	16.7
sterling/dollar	1.9	1.4	12.5

SOURCE: See Appendix B. See also Appendix C for the graphs of inflation and exchange rates.

TABLE 5
CORRELATION BETWEEN CHANGES IN THE PRICE LEVELS (ΔP),
NOMINAL EXCHANGE RATES (ΔS), AND REAL EXCHANGE RATES (ΔR)

	<i>France</i>			<i>Germany</i>			<i>United Kingdom</i>		
	ΔP	ΔS	ΔR	ΔP	ΔS	ΔR	ΔP	ΔS	ΔR
1920s:									
ΔP	1.00			1.00			1.00		
ΔS	0.54	1.00		0.99	1.00		0.18	1.00	
ΔR	0.15	0.80	1.00	0.10	0.13	1.00	0.65	0.25	1.00
1970s:									
ΔP	1.00			1.00			1.00		
ΔS	0.31	1.00		0.27	1.00		0.04	1.00	
ΔR	0.27	0.82	1.00	0.29	0.91	1.00	0.33	0.76	1.00

SOURCE: See Appendix B.

rates, and real exchange rates. The simple correlation gives an indication of the extent to which the variations in the series are related. (Appendix C contains the graphs of these three variables.)

The data in these two tables lend themselves to the following interpretation. First, the short-term variability of the wholesale-price changes was generally higher during the 1920s in the four countries analyzed here. Germany, of course, provides an extreme example of high price variability. The variability in the nominal exchange rates tended to be higher in the 1920s for the mark/dollar rate and to a lesser degree for the franc/dollar rate. Second, the pattern of correlation between the changes in these three variables (inflation, real exchange rates, and nominal exchange rates) was substantially different in the two periods. During the 1970s, one observes high correlations between real and nominal exchange-rate changes. These correlations are generally lower during the 1920s. On the other hand, the correlation between changes in prices and nominal exchange rates tended to be higher during the 1920s than during the 1970s.

This evidence supports the idea that prices tended to be stickier during the 1970s than the 1920s. It also explains why the sticky-price models of exchange-rate determination have become popular during the 1970s. We will return to this problem in Chapter 4, where we use a theoretical framework linking short-term price stickiness to the nature of stochastic shocks in the economy.

In this historical comparison it is useful to compare exchange-rate varia-

bility with the variability of stock prices. It is now generally recognized that, in the short run, nominal exchange rates behave like stock prices, as they adjust to maintain stock equilibrium in domestic and foreign asset markets. Table 6 compares the short-term variability of exchange rates and of stock prices during the two periods. The most striking result is that during the 1970s the variability of exchange rates was lower than the variability of stock prices, whereas the opposite was true for France and Germany during the 1920s.² During that period, exchange rates were substantially more variable than stock prices in these two countries.

TABLE 6
MEAN AND STANDARD DEVIATION OF MONTHLY ABSOLUTE CHANGES IN
NOMINAL EXCHANGE RATES AND STOCK PRICES
(in percent)

	<i>Mean</i>		<i>Standard Deviation</i>	
	<i>Exchange Rate</i>	<i>Stock Price</i>	<i>Exchange Rate</i>	<i>Stock Price</i>
1920s:				
France	6.2	3.5	5.3	2.8
Germany	51.7	13.8	100.7	12.5
U.K.	1.4	2.7	1.3	2.4
1970s:				
France	2.1	4.9	1.9	4.8
Germany	2.2	2.6	1.9	2.4
U.K.	1.9	4.6	1.4	4.8

SOURCE: See Appendix B.

² This is in accordance with Levich (1981).

3 SPECTRAL ANALYSIS OF REAL EXCHANGE RATES

The statistical analysis of changes in real exchange rates can be refined by using more powerful methods. In this chapter, the data are subjected to spectral analysis.

Spectral analysis is a statistical technique that makes it possible to decompose a time series into cycles of different frequencies. As a result, we obtain information about the extent to which the total variability of a series is due to cycles of different frequencies. For example, a time series of twenty years may exhibit strong seasonal variability around a business cycle of five years. Spectral analysis will tell us how much of the total change is due to the business cycle (a low-frequency cycle that repeats itself four times) and how much to seasonal movement (a high-frequency cycle that repeats itself twenty times).

Spectral analysis accomplishes this decomposition by attaching numerical values (the spectra) to these different cycles. A high spectrum for a cycle of particular frequency means that this cycle is important in explaining the total variability of the time series. In the example of the previous paragraph, the spectra of the cycles that occur four times and twenty times will be high. The others will be low.

To apply spectral analysis one must be sure that the time series is stationary. Stationarity here involves three different things. First, the series must be stationary in the mean: the mean must not change in a systematic way over the sample period. For all practical purposes, this statement implies that there should be no trend in the data. If there is, the series must be detrended. Second, the variance of the series should not change systematically during the sample period: the degree of variability should be constant. Third, the degree of covariation of observations at different time intervals should not change during the sample period. This is called "covariance stationarity."¹

Are the time series stationary in these three senses? Appendix D describes the tests used to answer this question. Here we discuss the main results.

During the 1970s, the levels of all real exchange rates are nonstationary in the mean: they exhibit clear trendlike behavior. This evidence confirms

¹ Thus, if during the sample period the autocorrelation of a time series increases, it is covariance nonstationary.

the findings described in Chapter 2 that systematic changes occurred in the real exchange rates of France, Germany, and the United Kingdom. The evidence for the 1920s is mixed. The franc/dollar rate is nonstationary in the mean; the sterling/dollar rate is on the borderline of being nonstationary; and the mark/dollar rates does not exhibit a clear trend.

Tests of stationarity in the variance revealed little evidence that real exchange rates were nonstationary in the variance during either the 1920s or the 1970s. Covariance nonstationarity was detected in the pound/dollar rate during the 1920s and in the franc/dollar and mark/dollar rates during the 1970s. Therefore, some caution should be exercised in the interpretation of the spectral analysis of these two series.

The next step in the analysis consists of computing the spectra of the levels of real exchange rates. All series are expressed as differences from the sample mean. When a series was found to be nonstationary in the mean, it was adjusted for trend.

The spectra of the different series are shown in Appendix D (Figures D-1 to D-3). In order to make the 1970s and the 1920s more comparable, the period 1973-82 was split into two equal subperiods, so that the length of these periods matches the period of the 1920s analyzed here.²

The main conclusions from this spectral analysis are the following: During the 1920s, spectra at frequencies higher than zero are significant. This is especially true for Germany and France. For Germany, cycles of 20 months were important during the hyperinflation. For France, larger cycles of 36 months are found. Similar results are obtained for the first part of the floating-rate period, from 1973 to 1978. Cycles of 20 to 30 months are significant for all three exchange rates, but the amplitude of these cycles is much lower than in the 1920s. A significant change in the nature of variability occurs from 1978 on (i.e., in the second subperiod). Short-term cycles almost completely disappear. The exchange-rate series are dominated by longer-run movements (i.e., low-frequency cycles). In addition, the spectra tend to be higher in the second subperiod than in the first.

Summing up these results from the spectral analysis, one can state that during the 1920s a substantial part of the total variability in real exchange rates was accounted for by short-term (20- to 30-month) cycles. This was much less the case during the 1973-82 period, and especially during the

² The spectra were computed after smoothing by using a Barlett filter. The use of a Daniel filter did not change the results in any significant way.

second half of that period, when changes in real exchange rates were dominated by long-run movements (low-frequency cycles).

The statistical evidence of this and the previous chapter demonstrates that in the floating-rate period of the 1920s the exchange markets for the mark and French franc were considerably more turbulent than in the 1970s. This led to larger short-term variations in the real exchange rates for those currencies. In addition, the changes in the nominal exchange rates were more highly correlated with price changes than in the 1970s. In contrast, during the 1970s there was a higher correlation between changes in real exchange rates and changes in nominal exchange rates.³ This empirical phenomenon has been important in the development of sticky-price models of exchange-rate determination.

A second element in this broad statistical picture is that real exchange rates tended to change in a more permanent way during the 1970s. There are several possible explanations. One relies on the idea that during the 1970s and early 1980s large real shocks (such as the oil shocks) occurred that necessitated permanent changes in real exchange rates (see Frenkel, 1981). Another interpretation of the sustained changes in real exchange rates, especially since 1979, is that macroeconomic policies (both monetary and budgetary) have been seriously out of line across major industrial countries, producing a set of misaligned real exchange rates (see Williamson, 1983, and Emminger, 1983).

The evidence provided here does not allow us to discriminate between these two competing hypotheses. The low-frequency band in which the spectra of real exchange rates are concentrated is wide enough to accommodate both explanations. We will therefore not deal with these long-run changes in real exchange rates, but instead attempt to explain their short-run variability.⁴

³ We also computed the cross-spectra between real and nominal exchange rates (not reported here). These cross-spectra allowed us to decompose the correlation between two different series into correlations of the cycles with different frequencies. However, we detected significant differences between the 1920s and the 1970s only for France, where we found substantially more correlation between the real and nominal exchange rates in the 3- to 4-month cycle during the 1970s.

⁴ For a thorough discussion of long-run changes, see Katseli (1979). For a recent empirical analysis of the structural factors affecting long-run deviations from PPP, see Kravis and Lipsey (1983). See also Officer (1982).