

BUSINESS CYCLES AND THE EXCHANGE-RATE REGIME Some International Evidence*

Marianne BAXTER

University of Rochester, Rochester, NY 14627, USA

Alan C. STOCKMAN

*University of Rochester, Rochester, NY 14627, USA
National Bureau of Economic Research, Cambridge, MA 02138, USA*

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This paper investigates the differences in time series behavior of key economic aggregates under alternative exchange-rate systems. We use a postwar sample of 49 countries to compare the behavior of output, consumption, trade flows, government consumption spending, and real exchange rates under alternative exchange-rate systems (pegged, floating, and cooperative systems such as the EMS). We then examine evidence from two particular episodes, involving Canada and Ireland, of changes in the exchange-rate system. Aside from greater variability of real exchange rates under flexible than under pegged nominal exchange-rate systems, we find little evidence of systematic differences in the behavior of macroeconomic aggregates or international trade flows under alternative exchange-rate systems. These results are of interest because a large class of theoretical models implies that the nominal exchange-rate system has important effects on a number of macroeconomic quantities.

1. Introduction

This paper investigates the manner in which the statistical character of business cycles depends on a country's choice of exchange-rate system. We have two objectives in this paper. First, we wish to determine how the choice of exchange-rate system affects the character of economic fluctuations. Second, we develop a set of facts about the character of international business cycles which can guide subsequent theoretical and empirical investigations.

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Many theories of the international transmission of real and monetary shocks predict that the transmission process depends critically on the exchange-rate system. An empirical implication of these theories is that the statistical properties of economic aggregates will depend on the exchange-rate system, holding fixed the source of the shocks. This paper asks whether, from a purely statistical point of view, it is reasonable to consider the fixed- and flexible-rate regimes as a single unit when processing data for comparison with theoretical models. The primary fixed-rate regime we study is the Bretton Woods system which broke down between 1971 and 1973; the primary flexible-rate regime we study covers the period from 1973–1986. While there is a small literature on the empirical relation between the variability of real exchange rates and the exchange-rate system,¹ we know of no systematic empirical studies of the relationship between the exchange-rate system and other real macroeconomic variables.

The paper proceeds as follows. Section 2 uses data from twenty-three OECD and twenty-one non-OECD countries to examine whether the statistical behavior of economic aggregates differs systematically across exchange-rate regimes. We investigate first whether the character of fluctuations in output, consumption, government consumption, and trade variables differs systematically between fixed- and flexible-rate regimes. Second, we investigate whether countries on fixed rates or cooperative schemes such as the EMS behave differently in the post-1973 period than countries on floating rates.

Because the industrialized nations adopted floating exchange rates nearly simultaneously, and at roughly the same time as some major world macroeconomic disturbances such as the oil price change, it is difficult to discriminate between the effects of changes in the exchange-rate system and other real disturbances. Section 3 discusses two episodes of change in the exchange-rate system that did not occur in 1973: the abandonment of the peg between the Irish pound and the British pound in 1979 and the Canadian float against the U.S. dollar in the 1950's and again beginning in 1970. These episodes provide additional evidence on the relation between the exchange-rate system and the behavior of real economic aggregates. Section 4 concludes the paper; it briefly reviews the empirical results and discusses avenues for further research.

2. The behavior of real aggregates before and after 1973

This section examines data from a large number of countries to determine whether the statistical properties of economic aggregates are systematically related to the exchange-rate system. We compare the behavior of these aggregates during the Bretton Woods period to their behavior after the adoption of generalized floating in 1973. First, we examine whether the

¹See, for example, Stockman (1983) and Mussa (1987).

volatility of detrended industrial production in fourteen OECD countries differs across the pre-1973 and post-1973 periods. Second, we examine whether the correlation of a country's industrial production with that of the U.S. differs across these two periods.² Because countries in the EMS, though not on a fixed-rate system *per se*, follow policies that limit exchange-rate movements and that require international cooperation, we examine whether the EMS countries as a group behave differently than non-EMS countries in the post-1973 period.

Second, for a smaller set of OECD countries, we examine the cross-regime volatility of consumption and changes in the cross-correlation between consumption and industrial production. Third, we examine the cross-regime volatility of real exports, imports, and the real exchange rate. The sample of countries includes both the previously analyzed OECD countries and thirty-two additional countries, mostly LDC's. Because the post-1973 sample includes countries on both fixed and flexible rates, we can separate effects due to a nation's exchange-rate system from a 'post-1973 effect' due to other changes in the world economy. Finally, we turn to the question of government behavior under alternative exchange-rate systems. We examine the variability and cross-country correlation of government consumption expenditures.

Because most of the time series we wish to study are nonstationary, we must filter the data to achieve stationarity before we can meaningfully compute statistics such as means and variances. We employ two common filters or detrending procedures: (i) removal of a linear trend fitted to the logarithm of the variable and (ii) computing first differences of the logarithm of the variable. As discussed in Baxter (1988), these two filters differ markedly in the degree to which they filter out particular frequencies. Relative to the linear trend filter, the first difference filter emphasizes the higher frequencies associated with business cycles.

2.1. *Industrial production*

Figs. 1 and 2 plot the standard deviations of filtered (detrended) industrial production in the fixed- and flexible-rate periods for fourteen OECD countries. The figures are read as follows: the vertical axis plots the standard deviation (computed as percent per quarter) for the fixed-rate period, and the horizontal axis plots the standard deviation for the flexible-rate period. A point on the 45° line means that there was no difference in volatility of industrial production for that country between the fixed- and flexible-rate periods. Fig. 1 presents results for the linear trend filter. Volatility increased in the flexible-rate period for all but three countries – Japan, Italy, and the U.S.

²Industrial production rather than GNP was used as a measure of output because quarterly GNP data were available for only a few countries.

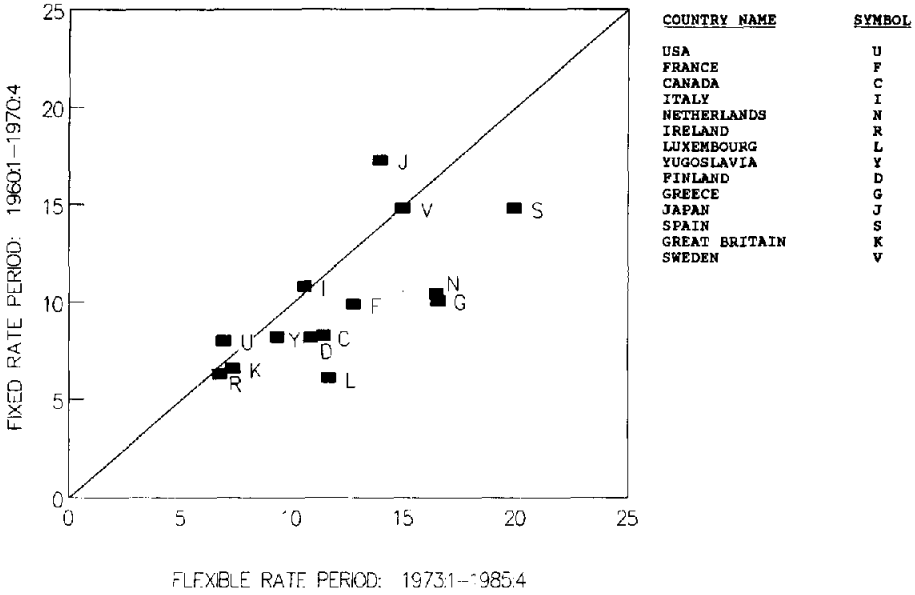


Fig. 1. Standard deviation of industrial production (%); linear trend filter.

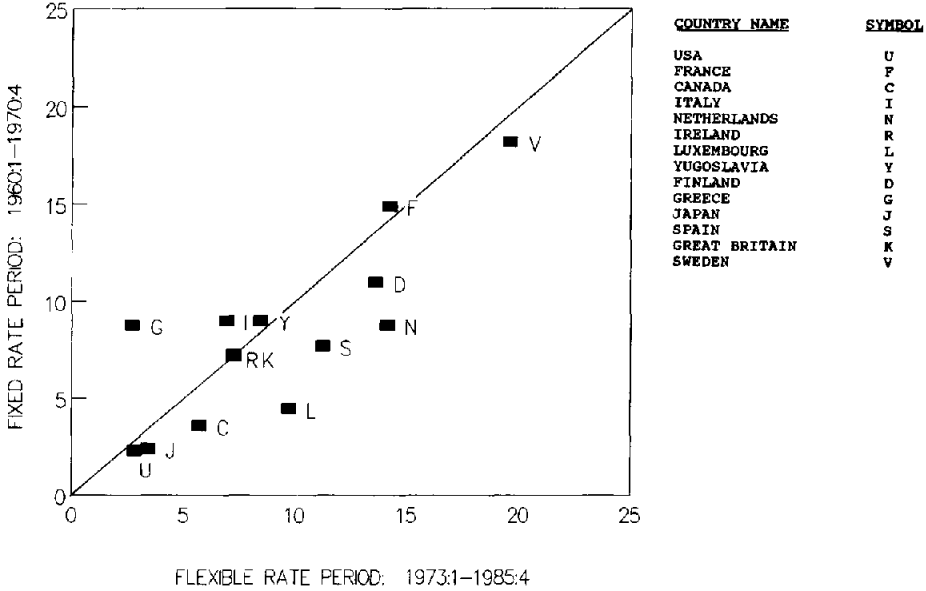


Fig. 2. Standard deviation of industrial production (%); first difference filter.

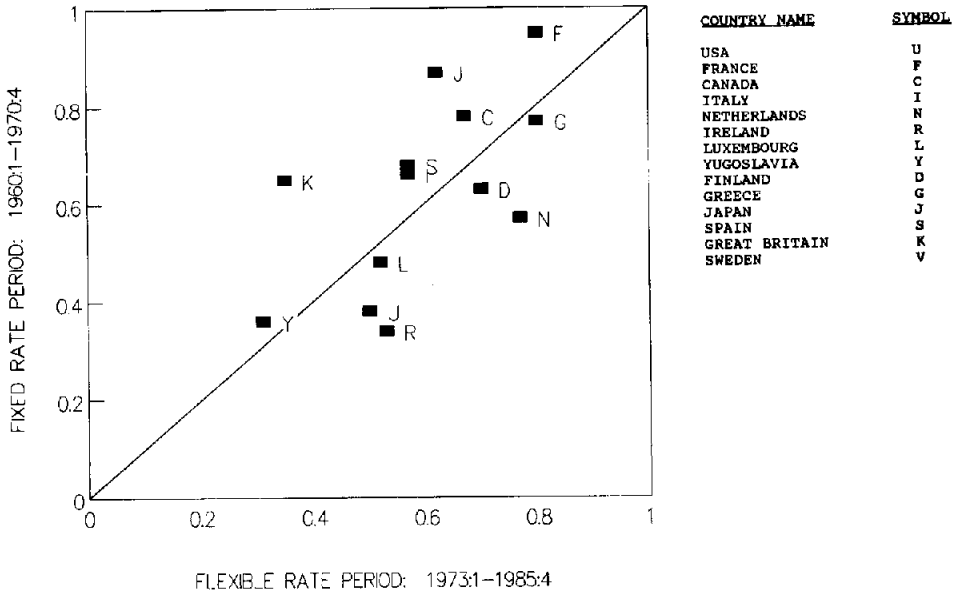


Fig. 3. Correlation of industrial production with U.S.; linear trend filter.

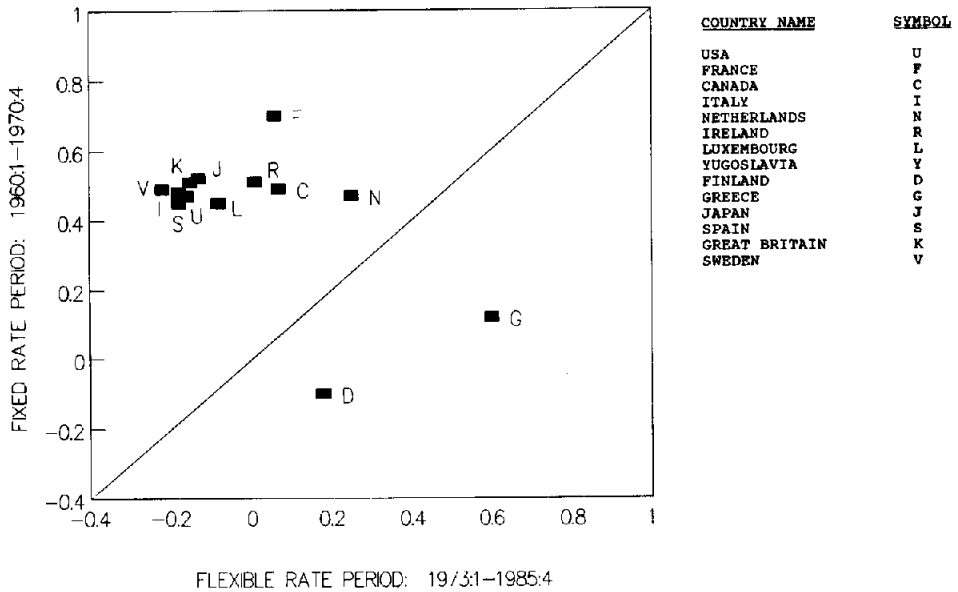


Fig. 4. Correlation of industrial production with U.S.; first difference filter.

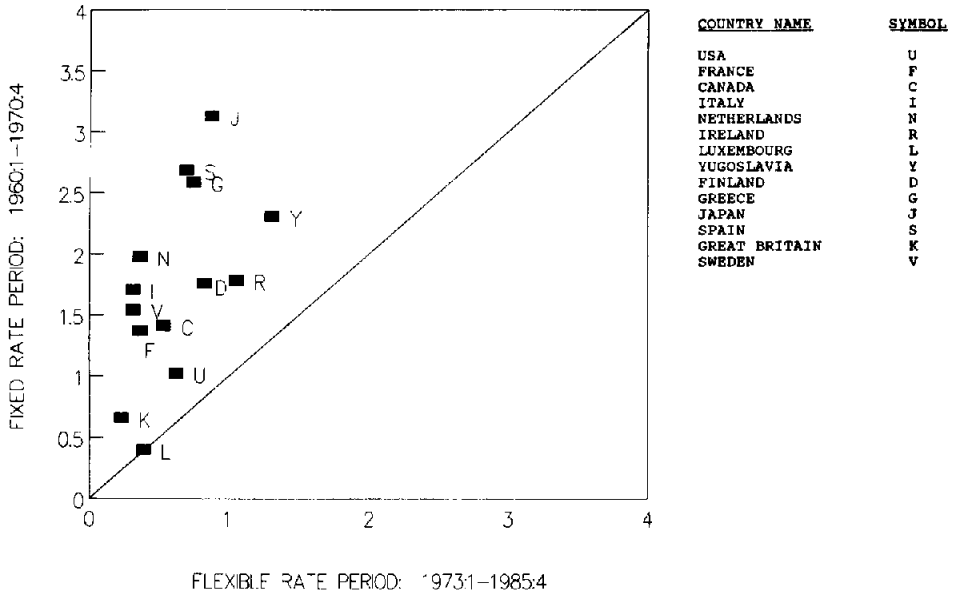


Fig. 5. Average growth rate of industrial production (%).

Fig. 2 presents results for the first difference filter. With this filter, volatility has increased for all but four countries – Germany, France, Italy, and Yugoslavia. Thus we find that both filters yield the result that the volatility of industrial production has generally increased in the flexible-rate period. In addition, we find that the increase was as likely to occur in previously high-volatility as in low-volatility countries.

Figs. 3 and 4 plot the correlations of industrial production in each country with that in the U.S. and yield somewhat different conclusions depending on the detrending method. Fig. 3 shows that with a linear trend filter there is no change in the average correlation: the countries plot about equally on either side of the 45° line. For the differenced data plotted in fig. 4, however, there is a marked tendency for this correlation to fall in the post-1973 period. Only Finland and Greece show an increase in correlation with the U.S. Thus it appears that the general decrease in cross-country correlation in industrial production has taken place in the relatively higher frequencies emphasized by the differencing filter.³

Fig. 5 plots the average quarterly growth rates for the fixed- and flexible-rate periods; this graph shows clearly the effect of the ‘slowdown’ of the 1970’s and 1980’s – every country’s growth rate is lower in this period.

³This issue could be addressed directly by estimating the cross-country correlations at distinct frequency bands, using techniques developed by Engle (1974).

Table 1
Industrial production.

Country	Standard deviation (%) detrending method		Correlation with U.S.I.P. detrending method		Average growth rate (%)
	Linear trend	Differencing	Linear trend	Differencing	
<i>Fixed-rate period</i>					
U.S.	8.0	2.3	1.00	1.00	1.02
France	9.9	14.9	0.38	0.47	1.37
Canada	8.3	3.6	0.95	0.70	1.41
Italy	10.8	9.0	0.78	0.49	1.71
Netherlands	10.4	8.8	0.66	0.48	1.98
Ireland	6.3	7.3	0.57	0.47	1.78
Luxembourg	6.1	4.5	0.34	0.51	0.40
Yugoslavia	8.2	9.0	0.48	0.45	2.31
Finland	8.2	11.0	0.36	0.49	1.76
Japan	17.3	8.8	0.77	-0.10	2.59
U.K.	6.5	2.4	0.68	0.12	3.13
Sweden	14.8	7.7	0.65	0.52	2.69
Greece	10.0	7.2	0.63	0.45	0.66
Spain	14.7	18.2	0.87	0.51	1.54
<i>Flexible-rate period</i>					
U.S.	6.9	2.8	1.00	1.00	0.62
France	12.7	14.2	0.50	-0.16	0.36
Canada	11.4	5.7	0.80	0.06	0.53
Italy	10.5	6.9	0.67	0.07	0.31
Netherlands	16.4	14.1	0.57	-0.18	0.36
Ireland	6.7	7.2	0.77	0.25	1.05
Luxembourg	11.6	9.7	0.53	0.01	0.39
Yugoslavia	9.3	8.4	0.52	-0.08	1.30
Finland	10.8	13.6	0.31	-0.22	0.82
Japan	13.9	2.7	0.80	0.18	0.74
U.K.	7.2	3.4	0.57	0.60	0.87
Sweden	14.9	11.2	0.35	-0.13	0.69
Greece	16.4	7.2	0.70	-0.18	0.23
Spain	19.9	19.6	0.62	-0.15	0.31

Fig. 5 helps explain why the two filters yield different answers regarding international output correlations. At the higher frequencies emphasized by the first difference filter, and which are typically associated with business cycles (e.g., Sargent's⁴ definition of 2-4 years for NBER minor cycles), the cross-country output correlation decreased in the recent flexible-rate period. At low frequencies, the common 'slowdown' probably means that the correlation increased at these frequencies. Thus with the linear trend filter (which weights high and low frequencies equally) these two effects tend to offset each other.

⁴Sargent (1979).

Table 2
Consumption; twelve OECD countries.

Country	Linear trend		Differencing			
	Fixed	Flexible	Fixed		Flexible	
	σ	σ	μ	σ	μ	σ
Germany	3.5	4.6	1.2	1.2	0.4	1.0
France	3.0	4.8	1.4	1.7	0.7	0.8
Australia	0.5	2.0	1.2	0.2	0.7	0.9
Canada	2.1	17.1	1.1	1.1	2.4	11.5
Italy	0.9	2.5	1.1	0.9	0.6	1.1
Netherlands	4.9	12.7	3.0	7.6	1.7	4.5
Finland	4.9	3.8	4.2	8.1	0.5	4.4
Japan	6.9	5.3	2.1	1.0	0.8	1.3
Switzerland	3.8	3.4	1.2	1.5	0.3	1.4
U.K.	1.6	3.2	0.6	1.1	0.5	1.4
Sweden	7.1	7.0	1.3	1.2	0.4	8.8
Austria	10.9	8.5	9.5	0.7	0.7	14.0

This helps explain the fact that, with the linear trend filter, there is no general tendency for international correlation either to increase or decrease in the flexible-rate period.

One interpretation of these results is that business cycles in the post-1973 period have been more country-specific than in the pre-1973 period. This is surprising because it is contrary to Mitchell's (1927) findings that the cross-country output correlations tend to rise over time and are positively related to the openness of financial markets. It is also contrary to theoretical predictions that, other things equal, increased openness of financial markets should lead to increased international correlation of business cycles. Two things may have changed in the post-1973 period: (i) the source of shocks may have changed and become more country-specific (although the largest shock, the oil shock, was certainly international in character) and (ii) government policies may have differed in the post-1973 period in a way that affected the international character of business cycles. It is well known [see, e.g., Darby and Lothian (1988)] that cross-country variation in money-supply growth rates and inflation increased in the latter period. Below, we examine the behavior of government consumption in the two exchange-rate regimes.

2.2. Consumption

We turn next to consumption in twelve OECD countries and its relation to industrial production. Table 2 gives volatility measures and mean growth rates

Table 3
 Cross-correlations of consumption with industrial production; eight OECD countries.

Country	Correlation of $C(t)$ with $IP(t+j)$					
	Linear trend			Differencing		
	- 4	0	4	- 4	0	4
Germany						
Fixed	0.534	0.742	0.094	0.060	-0.077	-0.297
Flexible	0.536	0.747	0.473	0.031	0.135	0.076
France						
Fixed	-0.003	0.348	0.068	-0.242	-0.006	-0.338
Flexible	0.528	0.699	0.467	-0.091	0.072	0.002
Canada						
Fixed	0.793	0.766	0.573	-0.143	0.056	0.128
Flexible	0.763	0.871	0.666	-0.006	0.216	0.002
Netherlands						
Fixed	0.375	0.507	0.310	0.582	0.702	0.644
Flexible	0.713	0.707	0.441	0.512	0.555	0.488
Japan						
Fixed	0.476	0.989	0.521	-0.228	0.156	0.212
Flexible	0.554	0.743	0.354	-0.050	0.175	0.414
Switzerland						
Fixed	0.361	0.921	0.333	0.488	0.442	0.137
Flexible	0.465	0.825	0.487	-0.034	0.054	0.013
Sweden						
Fixed	0.449	0.600	0.477	0.566	0.660	0.606
Flexible	0.715	0.696	0.518	0.735	0.801	0.731
United Kingdom						
Fixed	0.250	0.474	0.532	-0.111	-0.038	0.030
Flexible	0.238	0.614	0.235	0.097	0.197	0.002

of consumption for the two filters, by exchange-rate regime. There is no systematic change in the standard deviation of consumption across the two time periods: in the post-1973 period, the standard deviation rises in about half the countries and falls in the other half. This result is independent of the detrending method.

Table 3 shows the cross-correlations of consumption with industrial production; the zero-order correlation is higher for the linearly detrended data. However, the level of this correlation varies widely among the eight countries in the sample: for the fixed-rate system and the linear trend filter this correlation ranges from 0.35 for France to 0.99 for Japan. A similarly wide range is observed for the differenced data. Comparing the fixed- and flexible-rate systems, a general increase in correlation between consumption and industrial production in the flexible-rate period is observed for both detrending methods: six of the eight countries show increases in correlations in the

flexible-rate period. In the case of the linearly detrended data, the correlation between consumption and lagged output is also more persistent in the flexible-rate period.

While differences in national policies may help explain the decline in cross-country correlatedness in output, they do not explain the increase in correlation between cyclical movements in consumption and output. To the extent that cyclical movements in national output are temporary, the increased variability and decreased international correlation of output in the post-1973 period would lead us to expect a decreased correlation of consumption and output as consumers engage in international risk-sharing. Yet we find exactly the opposite; consumption and output are more highly correlated in the post-1973 period. Baxter (1988) finds similar results for the United States.

2.3. Exports, imports, and the real exchange rate

One would expect that the choice of exchange-rate regime would have important effects on trade variables such as exports, imports, and the real exchange rate. Since most OECD countries were on floating rates after 1973, we expand our sample to include about thirty-two other countries, many of them LDC's. Many of these countries pursued fixed-rate arrangements of various sorts in the post-1973 period. Table 4 catalogues exchange-rate systems by country and year. Some countries which actively intervened in the market for their currency are nevertheless included in the 'floating-rate' group. All countries manage their exchange rates to some degree, so there is no precise dividing line between 'floating' and 'adjustable peg' systems. We classify countries according to their stated policies as reported to the International Monetary Fund.

There are forty-nine countries in our post-1973 sample. Of these, fourteen were fixed to the dollar throughout, seventeen floated throughout, seven are members of the EMS, and eleven had some other arrangement or changed the exchange-rate system several times. Prior to 1973, all countries were on primarily fixed rates (although two, Canada and Korea, floated for short periods in the pre-1973 period).

Table 5 presents summary statistics for exports, imports, and the real exchange rate. Growth rates in all these variables appear to be serially uncorrelated, so we report the results of *F*-tests of the hypothesis of no change in the variances of these variables across exchange-rate regimes. Only two countries experienced significant decreases in volatility of real trade activity from pre-1973 to post-1973: New Zealand, in both exports and imports, and Korea, in imports only. Both of these countries were on flexible rates in the post-1973 period.

Many countries experienced increases in volatility in real exports and imports in the post-1973 period. Of the OECD countries, four (19%) experi-

Table 4
Exchange-rate system classification, by country and year.^a

Country	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69
Argentina	*	*	*	*	*	*		i	\$	\$	\$		F	F	F	F	F
Australia	*	*	*	*	*	*		*	*	*	C		F	F	F	F	F
Austria	C	C	C	C	C	C		C	C	C	C		F	F	F	F	F
Belgium	*	*	*	*	M	M		M	M	M	M		F	F	F	F	F
Canada	*	*	*	*	*	*		*	*	*	*		*	*	*	*	F
Costa Rica	*	*	*	*	*	*		\$	\$	\$	\$		F	F	F	F	F
Denmark	*	*	*	*	M	M		M	M	M	M		F	F	F	F	F
Dominican R.	*	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Ecuador	*	*	*	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Egypt	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
El Salvador	*	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Ethiopia	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Finland	C	C	C	C	C	C		C	C	C	C		F	F	F	F	F
France	*	*	*	*	M	M		*	*	*	M		*	F	F	F	F
Germany	*	*	*	*	M	M		M	M	M	M		F	F	F	F	F
Greece	*	*	*	*	*	*		*	*	*	C		*	F	F	F	F
Guatemala	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Haiti	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Honduras	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Iceland	*	*	*	*	*	*		*	*	*	*		*	F	F	F	F
India	*	*	*	*	*	*		*	C	C	C		F	F	F	F	F
Iraq	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Ireland	*	*	*	*	M	M		£	£	£	£		F	*	F	F	F
Israel	*	*	*	*	*	*		*	*	C	\$		F	F	F	F	F
Italy	*	*	*	*	M	M		*	*	*	*		*	*	F	F	F
Japan	*	*	*	*	*	*		*	*	*	*		*	F	F	F	F
Korea	*	*	*	*	*	*		\$	\$	\$	\$		F	F	*	*	F
Malaysia	C	C	C	C	C	C		C	C	C	C		*	F	F	F	F
Mexico	*	*	*	*	*	*		*	*	*	\$		F	F	F	F	F
Netherlands	*	*	*	*	M	M		M	M	M	M		F	F	F	F	F
New Zealand	*	*	*	*	*	*		C	C	C	C		F	F	F	F	F
Nicaragua	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Norway	C	C	C	C	C	C		C	M	M	M		F	F	F	F	F
Paraguay	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F
Peru	\$	*	*	*	i	i		i	*	\$	\$		F	F	F	F	F
Philippines	*	*	*	*	*	*		*	*	*	*		*	F	F	F	F
Portugal	*	*	*	*	i	i		i	C	*	*		*	F	F	F	F
South Africa	*	*	*	*	*	*		\$	\$	\$	\$		F	F	F	F	F
Spain	*	*	*	*	*	*		*	*	C	C		F	F	F	F	F
Sweden	C	C	C	C	C	C		C	C	M	M		F	F	F	F	F
Thailand	C	C	*	*	C	C		C	\$	\$	\$		F	F	F	F	F
Tunisia	C	C	C	C	C	C		C	C	C	C		F	F	F	F	F
U.K.	*	*	*	*	*	*		*	*	*	*		*	*	F	F	F
U.S.	*	*	*	*	*	*		*	*	*	*		*	F	F	F	F
Venezuela	\$	\$	\$	\$	\$	\$		\$	\$	\$	\$		F	F	F	F	F

^aPegged to dollar = \$; pound = £; combination = C; flexible = *; mutual exchange agreement = M; fixed = F; index of indicators = i.

Table 5
F-tests for change in volatility of exports and imports from pre-1970 to post-1973.^a

Country	Exports	Imports	Real exchange rates
Germany			21.16(+)
France			8.07(+)
Denmark			10.67(+)
Australia			28.86(+)
Canada			3.04(+)
Italy	0.25(+)	0.39(+)	35.76(+)
New Zealand	7.05(-)	7.04(-)	22.55(+)
Iceland			
Ireland			44.77(+)
Finland			
Greece		1.36(+)	24.83(+)
Japan	0.39(+)		29.55(+)
Switzerland	0.09(+)	0.24(+)	78.23(+)
Spain			3.88(+)
Turkey			
Portugal			12.37(+)
U.K.		0.39(+)	4.84(+)
Sweden	0.21(+)	0.37(+)	30.65(+)
S. Africa			93.96(+)
Costa Rica		0.25(+)	55.46(+)
Dominican R.			39.49(+)
El Salvador		0.01(+)	
Guatemala			3.34(+)
Haiti			
Honduras		0.01(+)	
Mexico		0.23(+)	66.35(+)
Paraguay	0.39(+)		16.49(+)
Peru		0.46(+)	2.54(+)
Venezuela	0.23(+)		3.25(+)
Egypt		0.17(+)	6.42(+)
India			2.68(-)
Korea		3.78(-)	3.12(+)
Malaysia			8.49(+)
Philippines			2.86(-)
Liberia			3.20(-)
Somalia	0.16(+)	0.13(+)	12.84(+)
Israel	NA	0.22(+)	
Netherlands		NA	14.42(+)
Thailand	0.01(+)		NA
Ethiopia		0.27(+)	NA
Tunisia	0.38(+)		NA
Belgium	NA	NA	NA
Austria	NA	NA	NA
Ecuador	NA	NA	NA

^a(+) = increase significant at 5% level, (-) = decrease significant at 5% level. Blank indicates no significant change. NA = data not available. The first difference filter was applied to all series in this table.

enced significant increases in export volatility, and of the non-OECD countries, five (21%) experienced increases in export volatility. For imports, five OECD countries had significant increases (24%), compared with nine non-OECD countries (38%). From these statistics, the OECD countries seem to behave similarly to the non-OECD group. But a closer look shows that this is not the case. Of the four OECD countries with increases in export volatility, each also experienced a rise in import volatility. But of the five non-OECD countries with increases in export volatility, only one experienced a significant rise in import volatility. This may result from the specialized export bases of the non-OECD countries.

We tested the hypothesis that the mean growth rates of exports and imports were unchanged across the two periods.⁵ Only two countries show (marginally) significant differences: Japan, which showed declines in growth rates of exports and imports, and Spain, which showed a decline in the growth rate of imports only. Overall, the flexible-rate period has been characterized by an increase in the volatility of real trade variables: 44% of the countries in our sample showed an increase in at least one of exports or imports. However, this period has not been characterized by significant shifts in the growth rates of real trade activity.

2.4. Real trade volatility and the exchange-rate system

A natural next question is whether the change in trade volatility can be linked to a country's choice of exchange-rate system. Four OECD countries experienced increases in export volatility, one of which is a member of the EMS (EMS countries represent seven of the twenty-one OECD countries). However, that one country is Italy, which has much wider allowable bands for exchange-rate fluctuation than other EMS countries. All the other OECD countries with increases in export volatility were on floating rates after 1973. Of the five non-OECD countries with increases in export volatility, three have had their exchange rate fixed to the dollar throughout the post-1973 period (these are Honduras, Ethiopia, and Egypt) and six have had other arrangements (El Salvador, fixed to the dollar until 1985, and floating thereafter; Costa Rica and Peru, both fixed to the dollar until 1981; Somalia, fixed until the end of 1982; and Mexico and Israel, which have floated with some intervention throughout). Thus for the OECD countries, there is some evidence that membership in the EMS is associated with lower volatility of

⁵The test statistics are not reported here. They can be found in our working paper with the same title.

imports and exports. Of course, whether this is due to the exchange-rate system or other factors such as EEC trade policy is an open question.

For the non-OECD countries, there does not seem to be any correlation between the choice of post-1973 exchange-rate system and the volatility of imports and exports during that period. Countries that remained fixed to the dollar were more likely to experience increased trade volatility than countries that chose to float. This is surprising, given that real exchange rates have become more volatile in the post-1973 period: real exchange-rate volatility is commonly thought to be associated with floating-rate systems. We therefore turn next to an investigation of real exchange-rate volatility, and its relation to the exchange-rate system and to volatility of real exports and imports.

The last column of table 5 presents the results of *F*-tests of the hypothesis of no change in real exchange-rate volatility between the fixed- and flexible-rate periods. A country's real exchange rate is computed as P/eP^* , where P is the country's consumer price index, P^* is the CPI for the United States, and e is the country's exchange-rate against the U.S. dollar. Four countries experienced significant decreases in real exchange-rate variability in the post-1973 period: India, Yugoslavia, and the Philippines, which were on floating exchange rates, and Liberia, which was fixed to the dollar.

By contrast, thirty of the forty-four countries for which data are available experienced significant increases in real exchange-rate variability in the post-1973 period. Surprisingly, of the four OECD countries which escaped an increase, none is a member of the EMS. Of the seven non-OECD countries with no significant change, four were on primarily fixed rates in the post-1973 period (Ecuador, which floated only in 1983, El Salvador, Haiti, and Honduras) and two were on floating rates (Israel and Tunisia).

Overall, the post-1973 period is characterized by increases in the volatility of real exchange rates; this corroborates findings by Stockman (1983), Mussa (1986), and others. Countries on fixed rates (or cooperative schemes like the EMS) appear as likely as those with pure floats or other intermediate regimes to experience these increases in volatility, though Stockman provides evidence that the magnitude of the increase in volatility is larger for floating-rate countries. Of the thirty countries with significant increases in real exchange-rate variability, only ten had increases in export and/or import volatility. Of the seven non-OECD countries with no increase in real exchange-rate variability, two had significant increases in real trade volatility. About one-third of the countries experienced significant increases in volatility of exports or imports, but this proportion does not seem to be related either to the exchange-rate system or to an increase in real exchange-rate variability.

Tables 6 and 7 summarize our findings on the relation between the volatility of real trade, the volatility of the real exchange rate, and the exchange-rate system. (These tables include only countries for which data were

Table 6
Real exchange-rate variability.^a

	Increase	No change	Decrease
Increase	Italy (EMS)(X, M) Greece (*) (M) Japan (*) (X) Switzerland (*) (X, M) U.K. (*) (M) Sweden (C)(X, M) Costa Rica (\$/ *) (M) Mexico (*) (M) Paraguay (\$) (X) Peru (\$/ *) (M) Venezuela (\$) (X) Egypt (\$) (M) Somalia (\$/ *) (X, M)	El Salvador (\$/ *) (M) Honduras (\$) (M) Israel (\$) (M) Tunisia (C)(X)	
No change	Germany (EMS) France (EMS) Denmark (EMS) Australia (*) Canada (*) Netherlands (EMS) Ireland (£, EMS) = C Spain (*) Portugal (*) S. Africa (\$/ *) = C Dominican R. (\$) Guatemala (\$) Malaysia (C)	Iceland (*) Finland (C) Turkey (*) Haiti (\$)	India (*) Philippines (*) Liberia (\$)
Decrease	New Zealand (*) (X, M) Korea (*) (M)		

^aHow to read table: Country name → (Exchange-rate system post-1973 (see table 4 for key)) → (X = export variability changed, M = import variability changed). E.g., Mexico (*) (M) means Mexico was on a floating-rate system after 1973 (*) and had a significant change in import variability (M).

available on both variables.) The most striking fact about these two tables is that changes in real trade variability and real exchange-rate variability appear to be independent of each other. This is not to say that the pre-1973 and post-1973 time periods are similar; the tables show clearly the increases in real exchange-rate variability and real trade variability that characterize the post-1973 period. However, changes in trade variability and real exchange-rate variability appear to be independent of the exchange-rate system. The only notable differences are (1) the magnitudes of the increasing in real exchange-rate volatility, as noted above, and (2) the lower tendency of OECD members than non-OECD members to experience increases in real trade variability.

Table 7
Real exchange-rate variability.

	Increase	No change	Decrease
Increase	13 OECD: 6 Non-OECD: 7 Fixed: 3 Fixed/float post-1981: 3 Float: 5 EMS: 1 Combination: 1	4 OECD: 0 Non-OECD: 4 Fixed: 1 Fixed/float: 1 Float: 1 EMS: 0 Combination: 1	0
No change	13 OECD: 9 Non-OECD: 4 Fixed: 2 Fixed/float post-1981: 0 Float: 4 EMS: 4 Combination: 3	4 OECD: 3 Non-OECD: 3 Fixed: 1 Fixed/float post-1981: 0 Float: 2 EMS: 0 Combination: 1	3 OECD: 0 Non-OECD: 3 Fixed: 1 Fixed/float: 0 Float: 2 EMS: 0 Combination: 0
Decrease	2 OECD: 1 Non-OECD: 1 Fixed: 0 Fixed/float: 0 Float: 2 EMS: 0 Combination: 0	0	0 Real trade variability Increase No change Decrease

^aNumber in upper-left corner shows number of countries in the cell (refer to table 6). Entries below show breakdown by OECD/non-OECD and by exchange-rate regime.

2.5. Government consumption

The exchange-rate system may affect the response of macroeconomic and international trade aggregates to external disturbances, but governments may have altered their macroeconomic policies in the post-1973 period in ways that eliminated the systematic differences in macroeconomic performance that we have sought to uncover. There have been clear differences in some government policies over the periods we have associated with pegged and floating exchange rates. The differences across exchange-rate systems in the behavior of nominal variables has been studied elsewhere [see, e.g., Darby and Lothian (1988)]. We examine the behavior of annual real government consumption (as reported by the OECD, and deflated by consumer price indexes) for twenty-two of our

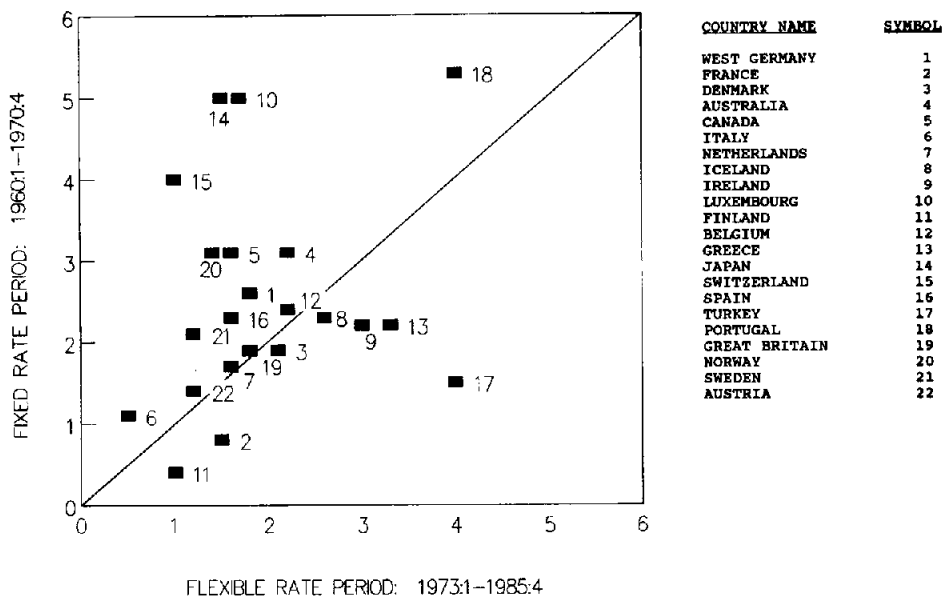


Fig. 6. Standard deviation of government consumption; first difference filter.

countries, over the periods 1960–72 and 1973–85. Fig. 6 plots the standard deviations of the growth rates of real government consumption in the fixed- and floating-rate periods. In fifteen of the twenty-two countries, the standard deviation fell in the floating-rate period.

Fig. 7 plots the average correlation between the growth rate of real government consumption in each country with the growth rates of real government consumption in the other twenty-one countries. For every country in the sample this correlation increased in the post-1973 period. This may reflect increases in government spending intended to offset the effects of the oil price shock.⁶ However, an important question for future research is whether the change in the cross-country correlation of the government consumption helped offset other effects of the change in exchange-rate system.

Greater correlation across countries in government consumption in the post-1973 period seems incapable of accounting for our earlier finding that output fluctuations become less correlated internationally in the post-1973 period. These two facts taken together present a puzzle that merits further investigation.

⁶ Visual inspection of plots of government consumption suggests that large increases in spending during 1973–75 may be responsible for the increased correlatedness in the post-1973 period.

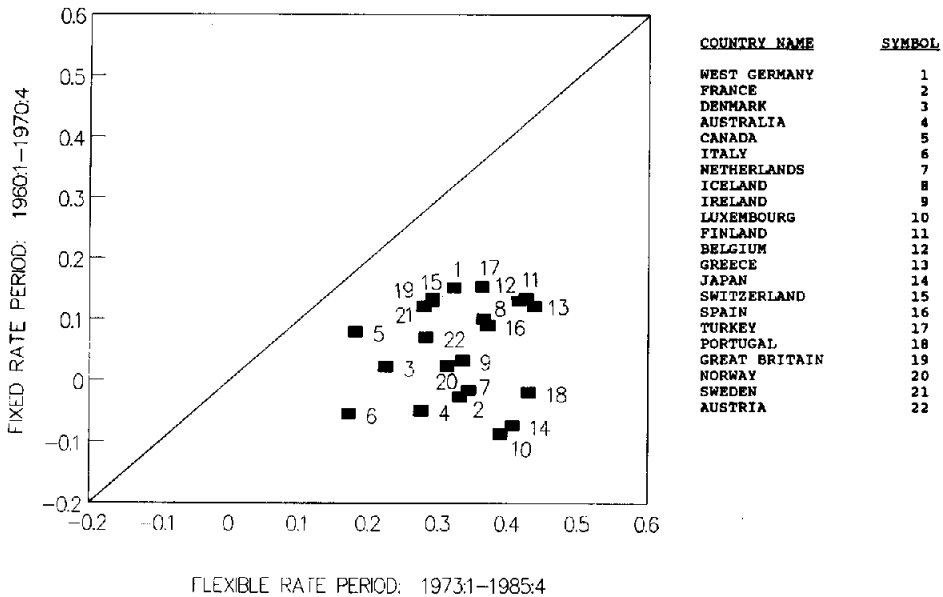


Fig. 7. Average correlation of government consumption with government consumption of other countries.

3. Two episodes of change in the exchange-rate system

This section examines two episodes of change in the exchange-rate system which did not occur in 1973. These two episodes are (i) the switch in the currency to which Ireland pegged, from the U.K. before 1979 to Germany (via the EMS) after 1979, and (ii) the Canadian float against the U.S. dollar from 1951-62, which resumed in 1970.

3.1. Ireland

Ireland pegged its currency to the British pound until January 1979, when it joined the joint float of continental currencies that became the European Monetary System in March 1979.⁷ After January 1979, the Irish pound floated with respect to the British pound but was effectively tied, within EMS limits, to the German mark. Fig. 8 shows the nominal exchange rate between Ireland and Britain from 1960 through 1985 and the real exchange rate calculated as the exchange-rate-adjusted ratio of consumer price indexes in the two countries. (Using alternative price indexes has virtually no impact on the results.)

⁷Mussa (1986) uses this episode as evidence on the relationship between the exchange-rate system and the variability of the real exchange rate.

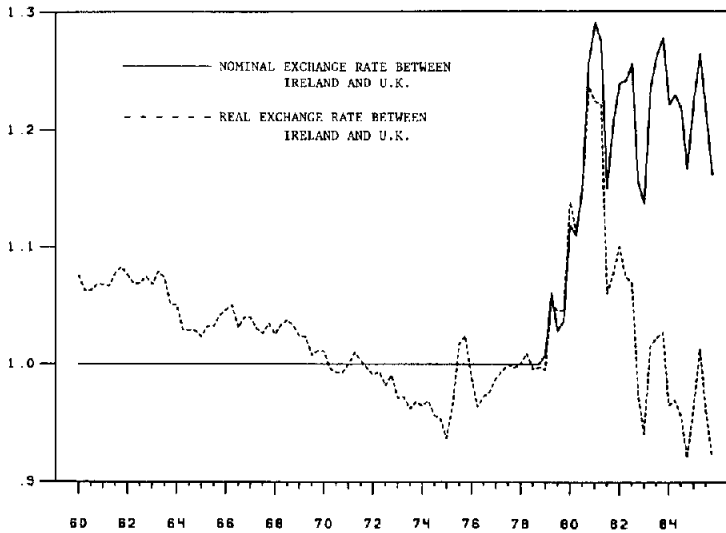


Fig. 8. Nominal and real exchange rates between Ireland and U.K.

The real and nominal exchange rates behave similarly, especially after 1979, and the variability of the real exchange rate is much greater when the two currencies float against each other. Fig. 9 shows the real and nominal exchange rates between Ireland and Germany. Again, the real and nominal exchange rates tend to mirror each other, though the relationship is less strong in the post-1979 period when Ireland was pegging to Germany.

Table 8 shows the standard deviation of the real exchange rate of Ireland vs. the U.K. and vs. Germany. The post-1973 period as a whole is characterized by much higher volatility of real exchange rates. In levels or linearly detrended, the standard deviation of the Ireland–U.K. real exchange rate did not rise much in the 1973–78 bilateral-peg period. The Ireland–U.K. real exchange rate shows much more volatility in the bilateral floating-rate period of 1979–85 than in earlier periods. Using levels or data filtered by a linear trend, the Irish–German real exchange rate actually shows greater variability after 1979 (when Ireland joined the EMS) than during the floating-rate period from 1973–78. However, this conclusion is reversed if the differencing filter is used.

These results reinforce the view that volatility of the real exchange rate is linked to exchange-rate systems and that the 1979 Irish experience was typical insofar as the real exchange rate is concerned. A natural next question is whether the increased volatility in the real exchange rate is mirrored in real quantities. Table 9 gives the standard deviation of Ireland's real exports and imports for linearly detrended and differenced data. For the differenced data,

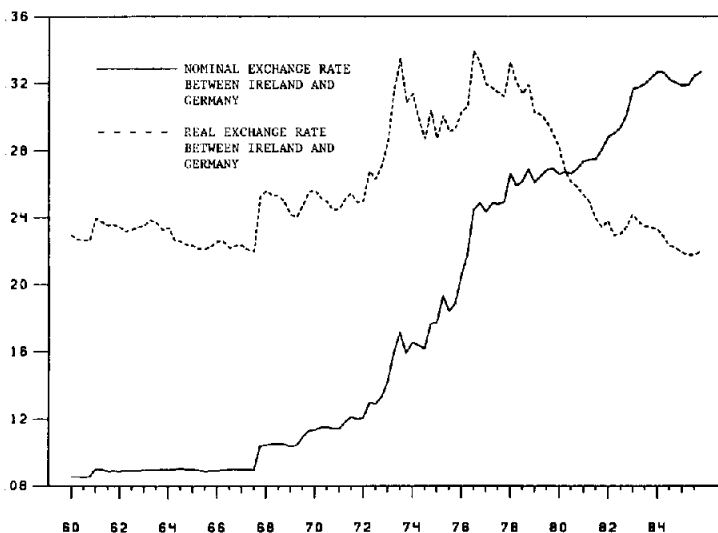


Fig. 9. Nominal and real exchange rates between Ireland and Germany.

Table 8

Standard deviation of real exchange rate of Ireland vs. U.K. and of Ireland vs. Germany; percent per quarter.

	1960:1-1970:4	1973:3-1978:4	1979:1-1985:4	1973:3-1985:4
	<i>Ireland vs. U.K.</i>			
Levels	2.4	2.2	8.9	7.5
Differencing	0.8	1.8	5.0	3.9
Linear trend	2.0	2.4	8.7	7.6
	<i>Ireland vs. Germany</i>			
Levels	1.1	1.5	2.6	3.9
Differencing	2.6	4.6	1.9	3.4
Linear trend	1.0	1.4	2.9	4.4

the volatility of real imports and exports appears to be the same in all time periods, perhaps declining somewhat after 1979. For the linearly detrended data, the post-1973 period shows higher volatility of both imports and exports, with the post-1979 period showing a large increase in volatility. Any conclusion about changes in trade volatility, therefore, depends critically on the filter used.

Continuing with the line of investigation pursued in earlier sections, we investigate the cross-country variation and correlatedness of industrial produc-

Table 9
Standard deviation of Ireland's real exports and imports; percent per quarter.

	1960:1-1970:4	1973:3-1978:4	1979:1-1985:4	1973:3-1985:4
<i>Linear trend</i>				
Real exports	30	29	35	33
Real imports	26	37	59	50
<i>Differencing</i>				
Real exports	10	11	9	10
Real imports	9	9	8	8

Table 10
Standard deviations and correlations of industrial production; standard deviations are percent per quarter.

	1960:1-1970:4	1973:3-1978:4	1979:1-1985:4	1973:3-1985:4
<i>Linear trend</i>				
Standard deviations				
Germany	9	7	7	9
Ireland	6	6	7	7
U.K.	7	6	7	7
Correlations between				
Ireland and U.K.	0.48	0.39	0.61	0.59
Ireland and Germany	0.75	0.64	0.68	0.70
<i>Differencing</i>				
Standard deviations				
Germany	9	11	8	9
Ireland	7	7	7	7
U.K.	7	8	7	7
Correlations between				
Ireland and U.K.	0.31	0.30	0.36	0.32
Ireland and Germany	0.74	0.74	0.68	0.70

tion. Table 10 gives standard deviations of industrial production and cross-country correlations, by subperiod, for linearly detrended and differenced data. The standard deviations of industrial production for the three countries are roughly equal and do not seem to vary over the three subperiods studied. This result is independent of the detrending method. The correlation between industrial production in Ireland and in Germany is higher than the correlation between Ireland and the U.K. for every time period and for both detrending methods. Further, when Ireland switched from pegging against the U.K. to pegging against Germany, the correlation between Irish and British industrial

production actually rose (more dramatically for linearly detrended data), while the correlations between Ireland and Germany remained essentially unchanged. These results might suggest that floating raises the cross-country correlation of industrial production. While some models might predict this, it is the opposite of our earlier finding that such correlations with the U.S. fell in the post-1973 period.

Industrial production indexes in Ireland, Germany, and the U.K. have properties that differ across detrending methods. But relative industrial production, defined as the log of industrial production in Ireland minus the log of industrial production in either Germany or the U.K., has interesting properties that are independent of the detrending method. As reported in our longer working paper, detrended relative industrial production between Ireland and Germany can be well modeled from 1961 through 1978 as a second-order autoregressive process. There is no evidence of structural shift in the process during this period. Estimation over the longer period that includes 1979–85, however, shows clear evidence of a structural shift in relative industrial production. But the most likely timing of this structural shift can be shown to be in 1984, five years after the change in the exchange-rate system. Consequently, although there is clear evidence of a structural change in the process describing relative industrial production between Ireland and Germany, it was probably unconnected with the change in the exchange-rate system. This is consistent with the absence of a structural shift in the process in 1973, when Ireland and Germany started floating bilaterally.

A similar model of detrended relative industrial production between Ireland and the U.K. also shows evidence of a structural break after 1973. However, examination of the likelihood function shows that the most likely time of a structural change was the fourth quarter of 1976, two years before Ireland changed its exchange-rate system. One interpretation of this result is that some changes occurred around 1976 that altered the real economic connections between Ireland and the U.K., that these changes show up as a structural break in the statistical process describing relative industrial production, and that these changes contributed to the decision by Ireland to abandon its pegged exchange rate with the U.K.

3.2. Canada

The Canadian float from 1951 to 1962 provides another experiment with floating exchange rates aside from the post-1973 float. Stockman (1983) and Mussa (1986) have used this episode to help distinguish the changes in real exchange-rate variability that coincide with a change in the exchange-rate system from the effects of other disturbances around and after 1973. The Canadian dollar resumed its float against the U.S. dollar in the first quarter of 1970. If models in which the exchange-rate system plays an important role are

correct, we should expect to find changes in the behavior of trade and macroeconomic variables in Canada at both of these dates. We focus on the variability of the trade balance and find that there is little evidence of changes in the variability of the trade balance at times when the exchange-rate system changed (again, see our working paper for details). While the periods prior to 1962 and after 1970 may be characterized by a different variance of the trade balance, there is no evidence of similarity between the first and second floating-rate periods in this series. There is little indication that changes over time in the variability of the trade balance are due to changes in the exchange-rate system. Nor is there any evidence of a structural break around 1962 or 1970 in relative industrial production between Canada and the U.S.

These two case studies reinforce the results from the earlier sections. The volatility of the real exchange rate is higher under flexible rates than under fixed rates. But the behavior of real aggregates such as industrial production and trade flows do not appear to change in any systematic way as a result of a change in the exchange-rate system.

4. Conclusions

This purpose of this paper was to document the ways in which the statistical character of international business cycles differ across exchange-rate regimes. We have been unable to find evidence that the cyclic behavior of real macroeconomic aggregates depends systematically on the exchange-rate regime. The only exception is the well-known case of the real exchange rate.

Much of our evidence comes from comparing pre-1973 to post-1973 behavior, and we have uncovered evidence that these two time periods were different in many ways. However, we have been unable to link these differences to the country's choice of exchange-rate regime. The differences that we have found are as follows: the international correlation of output fluctuations generally decreased in the post-1973 period compared with the earlier (Bretton Woods) period. Further, the correlation between national consumption and national output generally increased in the post-1973 period. Finally, the international correlation between government purchases increased in the 1973 period for every country that we studied. As discussed earlier, it is difficult to explain all three of these observations within a single model. Taken together, these findings form a puzzle worthy of future research.

Continuing our comparison of the pre- and post-1973 periods, we found that the volatility of exports, imports, and the real exchange rate increased in the post-1973 period for most of the countries in our sample. However, these increases were no more common in countries on a floating-rate regime after 1973 than in countries which chose to fix their exchange rates. One interpretation of this result is that the choice of an exchange-rate regime does not matter

for trade volatility. Another interpretation is that an individual country cannot really decide to unilaterally adopt a fixed-rate regime in a world characterized by generalized floating, since the country to which it fixes its currency is itself probably floating against the rest of the world.

In order to isolate differences due only to the exchange-rate regime and not due solely to a 'post-1973' effect, we studied two episodes of countries which changed their exchange-rate regime at other times. In both cases we found results that reinforced our earlier conclusions: any changes in real behavior in these countries could not be traced to the exchange-rate regime. Again, the exception is the real exchange rate.

Clearly, there is much additional work that needs to be done on documenting the statistical character of international business cycles and the way in which these cycles depend on the exchange-rate regime. In particular, studying patterns of bilateral trade across exchange-rate regimes could well uncover differences which cannot be found in aggregate trade measures. This is an important avenue for future research.

Our results stand as a challenge to traditional theories of transmission under alternative exchange-rate regimes. Our results also suggest that real (nonmonetary) models of the international determination of output, consumption, investment, and interest rates may be able to explain important aspects of international business cycles.

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