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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 seek to develop a set of facts about the character of international business cycles that can help guide subsequent international evidence on output, consumption, trade flows, and real exchange rates and we compare the behavior of these series under the Bretton Woods pegged exchange rate system with that under the (limited) floating rate system that has prevailed since 1973. Then we examine particular episodes in which a country changed its exchange rate system at a time other than 1971–73.

The study of business cycles and their international transmission is one of the oldest topics in economics; the first detailed statistical analyses of business cycles were undertaken in the 1920s by the National Bureau of Economic Research under the leadership of Wesley Clair Mitchell. Eschewing traditional statistical methodology, Mitchell and his collaborators developed new methods for summarizing business cycle phenomena. They found that the empirical regularities of economic fluctuations lay not in the length of cycle or its amplitude, but rather in the patterns of comovement and relative amplitude of economic variables.

Mitchell investigated the international correlation of business cycles in his book Business Cycles: The Problem and Its Setting (1927). He concluded that business cycles are positively correlated across countries and especially countries with highly developed economies, and particularly those with well developed financial markets. He also found that business cycles were becoming more highly correlated across countries over time and he attributed this result to the growth in international financial linkages.

Oskar Morgenstern (1959) carried out detailed analyses of international business cycles, focusing specifically on financial markets, and raised the question of whether the international character and transmission of cycles depended on the exchange rate system. At that time, experiences with alternative exchange rate systems were considerably more limited than now, with data from the 1970s and 1980s available.

More recently, the neoclassical approach to studying business cycles was motivated by the perspective that "*business cycles are all alike*".[1] Lucas states that "There is, so far as I know, no need to qualify these observations [about cycles] by restricting them to particular countries or time periods: they appear to be regularities common to all decentralized market economies."[2] Explaining these patterns of co-movement and relative amplitude has become the chief aim of neoclassical business cycle theory. Neoclassical business cycle research has also sought to improve on the methods of Mitchell and his collaborators, by using formal statistical procedures, so that "results are replicatable and criticizable at a level at which Mitchell's are not." Lucas (1981, p.236, ff. 4). Development of statistical procedures and stylized facts has led naturally to efforts to develop quantitatively restricted models that can reproduce the observed covariation of economic aggregates.[3]

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[1]Lucas (1981), p. 218. Italics in original.

[2]ibid, page 218.

[3]See, for example, Hodrick and Prescott (1980), Kydland and Prescott (1982), Long and Plosser (1983), Hansen (1985), Prescott (1986), and King, Plosser, and Rebelo (1987).

In this paper, we follow the original NBER strategy of describing the character of cycles while abstaining from imposition of a specific theoretical structure, but we employ modern time series methods. Specifically, the paper asks whether, from a statistical point of view, it makes sense to consider the fixed and flexible-rate systems as a single unit when processing the data for comparison with theoretical models. Many theories of the international transmission of shocks (real shocks or shocks due to monetary policy) have the implication that the transmission process depends critically on the exchange rate system in place. An empirical implication of these theories is that—holding constant the sources of exogenous shocks and their stochastic processes—the variances and covariances of economic aggregates will depend on the exchange rate system. While some attention has been paid to the empirical relations between the variability of real exchange rates and the exchange rate system,[4] we know of no systematic empirical studies of the relationship between the exchange rate system and other macroeconomic variables.

The paper proceeds as follows. Section II uses data from twenty-three OECD countries and twenty-one non-OECD countries to examine whether the statistical behavior of economic aggregates differs systematically across exchange rate systems. We ask, first, whether pre-1973 behavior—corresponding roughly to a period of pegged exchange rates—differs from post-1973 behavior—corresponding to a period of floating rates, albeit with some government intervention. Second, we ask whether countries on fixed

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[4]See, for example, Stockman (1983) and Mussa (1987).

rates, or cooperative schemes such as the EMS, behave differently in the post-1973 period than countries on floating rates during this period.

This section has three main components. First, we examine the statistical behavior of industrial production in the OECD countries. Next, we study consumption and its correlation with output as measured by industrial production. Finally, for the entire group of countries we examine the behavior of real exports, imports, and the terms of trade.

Many of the time series we examine are nonstationary, with trend or growth components. For the calculations we report in this paper, the data must be transformed to achieve stationarity. We consider some alternative methods of detrending the data to accomplish this. We find that the detrending procedure matters a great deal for measures of relative volatility and correlation with output. Whether one concludes that particular statistical properties of the data have changed across exchange rate systems sometimes depends critically on the detrending procedure employed. Clearly, one would like to have a theory that implied a particular method of achieving stationarity was the appropriate one; such a theory, however, is presently unavailable.[5] Without such a unified theory in hand, we proceed by analyzing the results for a number of common detrending procedures.

Because the industrialized nations adopted floating exchange rates nearly simultaneously, and roughly coincident with some major world macroeconomic disturbances such as the oil price change, it is difficult to discriminate

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[5]There is promising recent work in closed-economy macroeconomics which attempts a unified explanation of economic time series without requiring an arbitrary classification into "growth" and "cyclical" components.

between the effects of changes in the exchange rate system and of other real disturbances. Section III discusses two episodes of changes in the exchange rate system that did not occur at this time: the Canadian float against the US dollar in the 1950s and again beginning in 1970, and the abandonment of the peg between the Irish pound and the British pound in 1979. These episodes provide additional evidence on the relation between the exchange rate system and the behavior of real economic aggregates. Section IV concludes the paper; it briefly reviews the empirical results, and discusses avenues for further research.

II. International Evidence on Economic Aggregates Before and After 1973

This section examines international evidence on the question of whether the statistical properties of economic aggregates are related in a systematic way to the exchange rate system. We first examine whether the volatility of detrended industrial production in fourteen OECD countries has undergone a shift in volatility in the post-1973 floating exchange rate period, and whether the correlation of a country's industrial production with that of the U.S. has changed in this period.[6] Because the countries in the EMS, while not on a fixed-rate system per se, are following policies that limit exchange-rate movements and require international cooperation, we examine whether the EMS countries as a group behave differently in the post-1973 period from the non-EMS countries.

Second, for a smaller set of OECD countries, we examine the cross-regime volatility of consumption and the changes in the cross-correlation between

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

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 the previously-analyzed OECD countries together with about twenty additional countries, most of which are LDC's. Because the post-1973 sample includes countries on both fixed and flexible rates, we can potentially 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.

We consider three common detrending procedures, though we do not always report results with all three procedures except where those results differ substantially. The three procedures are (i) taking differences (growth rates), (ii) removing deterministic linear trends, and (iii) using the Hodrick-Prescott (1980) filter. Figure 1 plots the squared gain (transfer function) for these filters against frequency. For time-series with positive serial correlation (as in our data) most of the power is at the lowest frequencies. The differencing filter permits the smallest proportion of low frequency components to pass through, with the HP filter transferring more, and the linear trend filter transferring the most. For highly autocorrelated series the power is concentrated at the low frequencies where the differencing filter and HP filter are very similar, and results using that filter are not reported here.

Industrial Production

Table 1 and Figures 2 and 3 give the standard deviation of detrended industrial production for fourteen OECD countries and the correlation of

these countries' industrial production with that of the U.S. Two detrending methods are used: a single linear trend and differencing. For the question of whether volatility has changed, the two filters give the same answer: volatility has generally increased. In the post-1973 period, about three-quarters of the countries experienced an increase in the volatility of industrial production. The increase was as likely to occur in previously high volatility countries as in low volatility countries.

Figures 4 and 5 plot the correlations of industrial production in each country with that of the U.S., and yield somewhat different conclusions depending on the detrending method. With a linear trend removed, it appears that there is no significant change in the average correlation with the U.S.: the countries plot about equally on either side of the 45 degree line.

For the differenced data, however, there is a marked tendency for this correlation to fall in the post-1973 period; only Japan and Greece experienced an increase in correlation with the U.S. (and the Japanese result may be due to that country's recent lowering of barriers to trade.) 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.[7]

Figure 6 shows 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.

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

The conclusion of no change in correlatedness arising from the linear trend filter likely stems from the common worldwide change in the low frequency components of the data, i.e., the common "slowdown". We suspect that at the higher frequencies typically considered business cycle frequencies (e.g., Sargent's[8] definition of 2–4 years for NBER minor cycles), the cross–country correlation has decreased. Thus, business cycles in the post–1973 period appear to be more of a country–specific phenomenon than in the pre–1973 period. This mirrors the results from the U.S. data and is surprising since it is contrary to Mitchell's findings that correlatedness tended to rise over time, and be positively associated with openness of financial markets. It also appears to be contrary to theoretical predictions that, other things equal, increased openness of financial markets should lead to increased international correlation of business cycles. Two things that may have changed in the post–1973 period are: (i) the source of shocks to the country, with the shocks becoming 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. We examine one policy difference below: government consumption purchases became less variable and more highly correlated across countries in the post–1973 period.

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[8]Sargent (1979).

Consumption

We turn next to investigation of consumption in twelve OECD countries and its relationship to industrial production. Table 2 gives summary statistics for the two exchange rate regimes for three detrending methods: a single linear trend, separate linear trends for the two systems, and differencing. Table 2 shows that most countries experienced an increase in the volatility of consumption in the flexible rate period: seven of the twelve increased with a single linear trend removed or with the differencing filter, and ten of twelve increased when separate linear trends are removed. Curiously, however, some countries which show increases in consumption volatility under one detrending method register decreases with others. For example, Sweden shows a decreases from the fixed rate period to the flexible rate period with both of the linear trends, but shows a dramatic increase in volatility if the consumption data are differenced. The reverse pattern holds for Germany, France, and the Netherlands. Nor do the linearly detrended series behave similarly, but differently than the differenced series: for Japan and Switzerland, the flexible rate period shows a decline in volatility when a single linear trend or differencing filter is used, but a rise in volatility when separate linear trends are removed.

The lack of similarity of results from different detrending methods suggests that the source of the change in volatility is different across the countries in the sample. Because the different filters emphasize different frequencies, it appears that the shifts occurred at different frequencies in different countries. This contrasts with the results for industrial production, where the results across countries for a given detrending method (for a given frequency band) were much more similar.

Finally, the average growth rates of consumption in the fixed and flexible rate periods mirror the earlier results for industrial production: there is a marked slowdown in the post–1973 period.

Tables 3 and 4 show the cross–correlations of consumption with industrial production for the single linear trend filter and the differencing filter. As with the U.S. data, 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 a high of .989 for Japan to a low of .348 for France. A similarly wide range is observed for the differenced data. Comparing the fixed and flexible rate systems, a general increase in correlatedness in the flexible rate period is observed between consumption and industrial production for both detrending methods. For linearly detrended data, six of the eight countries experienced increases in correlatedness, while for the differenced data, seven of the eight experienced increases. Further, in the case of the linearly detrended data, the correlation between consumption and lagged output seems more persistent in the flexible rate period: large correlation coefficients are found in many countries as far back as seven lags (almost two years).

These results reinforce the emerging picture of the post–1973 period as a period in which cyclic movements are more country–specific than in the previous, fixed–rate period. As mentioned earlier, this is surprising in view of the world–wide oil shocks of the 1970's. It is also surprising since the flexible–rate period has been characterized by dramatic increases in the openness and liquidity of international financial markets. Yet the

within-country correlation of consumption and output has actually risen during this period for most of the countries examined.

While differences in national policies may help explain the decline in cross-country correlatedness in output, it does not explain the increase in the correlation between cyclic movements in consumption and changes in output. To the extent that cyclic movements in national output are temporary and in particular because cross-country correlation of output has decreased (so that the world interest rate should not be highly correlated with a single country's output), one would expect a decreased correlation of within-country consumption and output. Yet we find exactly the opposite.

Exports, imports, and the real exchange rate

We turn next to analysis of exports, imports, and the real exchange rate. The sample of OECD countries is expanded to include about twenty other countries, many of them LDC's. Table 5 catalogues exchange rate systems by country and by year. Of the 49 countries in the post-1973 sample period, 14 were fixed to the dollar throughout, 17 floated throughout[9], 7 are members of the EMS, and 11 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).

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[9]Some countries which actively intervened in the market for their currency are nonetheless included in the "floating rate" group. All countries manage their exchange rates to some degree, so the division between "floating" and "adjustable peg" is, to a large extent, arbitrary. We have chosen to classify countries according to their stated policies, as reported to the International Monetary Fund.

Table 6 presents means and standard deviations of quarterly growth rates of real exports and imports (deflated by the country's CPI) separately for the pre- and post-1973 periods. Since the growth rates in the trade data are roughly serially uncorrelated, we compute F-statistics to test the hypothesis of no change in the variance of the trade statistics across the two time periods of interest. These F-statistics are presented in Table 7. 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. Of the OECD countries, four (19%) experienced 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 really the case. Of the four OECD countries experiencing a rise in export volatility, each one also experienced an increase in import volatility. But of the five non-OECD countries experiencing increases in export volatility, only one experienced a significant increase in import volatility as well. This is puzzling; the explanation may have something to do with the specialized export bases of the non-OECD countries.

Table 8 presents t-tests for the hypothesis that the mean growth rates of exports and imports is unchanged across the two systems. Only two countries show (marginally) significant differences: Japan, in exports and in imports, and Spain, in imports only. Thus the flexible rate period has been

characterized by an increase in the volatility of trade, with 44% of the countries in the sample having 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.

Real Trade Volatility and the Exchange Rate System

A natural next question is whether the change in 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 been pegged to the dollar throughout the post-1973 period (Paraguay, Venezuela, and Ethiopia), and two (Somalia and Tunisia) have followed a variety of policies in the post-1973 period (refer to Table 5 for the details of each country's exchange arrangements.) Interestingly, not one of the non-OECD countries on floating rates after 1973 experienced a significant increase in export volatility.

Five OECD countries had significant increases in import volatility after 1973, with one (again, Italy) being an EMS country. Of the nine non-OECD countries with increases in import 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 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 strong correlation between the choice of post-1973 exchange rate system and the volatility of imports and exports during that period. Countries choosing to remain fixed to the dollar seem somewhat more likely to experience increased trade volatility than countries choosing to allow their exchange rate to float. This is surprising since real exchange rates have become more volatile in the post-1973 period, and the 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 relationship to the exchange rate system and volatility in real exports and imports.

Table 9 displays F-statistics for the hypothesis of no significant change in the volatility of the real exchange rate between the fixed and flexible rate periods. A country's real exchange rate is calculated 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 in real exchange rate variability, none is a member of the EMS. Of the seven non-OECD countries with no significant change in real exchange rate variability, 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).

Table 10 contains t-tests for the hypothesis of no change in the growth rate of the terms of trade pre-and post-1973. Only two countries show significant changes, both decreases: El Salvador and Guatemala. Both countries were fixed to the dollar for most of the post-1973 period.

Thus, the post-1973 period is one characterized by general increases in volatility of countries' real exchange rates; this corroborates findings by Mussa (1986) and many 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 (1973) 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. Thus, 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 11 and 12 summarize our findings on the relationship between the volatility of real trade activity, volatility of the real exchange rate, and the exchange rate system. (These tables only include countries for which

data were available both for real trade activity and the real exchange rate.) 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. Further, changes in trade variability and real exchange rate variability appear to be independent of the exchange rate system. The only notable difference is that OECD members appear slightly less likely than non-OECD members to have increases in real trade variability.

Government Consumption

It is possible that the exchange rate system affects the response of macroeconomic and international trade aggregates to external disturbances, but that governments altered their macroeconomic policies in just the right way so as to eliminate the systematic differences in macroeconomic performance, across exchange rate systems, 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 such as monetary aggregates and nominal price levels has been studied elsewhere (see, e.g. Darby and Lothian, 1988). We examined the behavior of annual real government consumption (as reported by the OECD, and deflated by consumer price indexes) for 22 of our countries, over the periods 1960-72 and 1973-85. Table 13 shows the standard deviations of the growth rates of real government consumption in the pegged exchange rate period (SDPEG), the floating rate period (SDFLT), and the difference between these two (SDDIF). In 16 of the 22 countries, the standard deviation fell in the floating rate period. The average fall, excluding the two largest changes (France and

Denmark), was .0067, which is a fall of about 1/4 from the mean under pegged rates of .026.

Table 14 reports, and Figure 7 graphs, a dramatic change across these periods in 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 22 countries. Growth rates in real government consumption became much more highly correlated across countries in the flexible exchange rate period. The average correlation in the pegged-rate period was .04, while the average correlation in the floating rate period was .30, and, except for Switzerland, each country showed a positive average correlation (and the average correlation rose for every country except Switzerland). Whether this change in the cross-country correlation of the government consumption growth rates had little effect on the macroeconomic aggregates we have studied, or whether it had effects that helped offset the effects of the change in exchange rate system, is an important question for future research. Greater correlation across countries in government consumption spending would seem unable to account, however, for our earlier finding that business fluctuations seem to have become more nation-specific. If anything, our results on government consumption magnify the problem.

III. Two Episodes of Change in the Exchange Rate System

This section studies two episodes of change in the exchange rate system that did not occur in the 1971-73 period. These two episodes are (i) the switch in the currency to which Ireland pegged its currency, from the U.K. before 1979, and Germany (via the EMS) after 1979, and (ii) the Canadian float against the U.S. dollar from 1951-62, which began again in 1970.

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.[10] After January 1979, the Irish pound floated with respect to the British pound but was effectively tied, within EMS limits, to the German mark. Figure 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.) 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. Figure 9 shows the real and nominal exchange rates between between Ireland and Germany. Again, the real and nominal exchange rates tend to mirror each other, but the relationship is less strong in the post-1979 period when Ireland was pegging to Germany.

Table 15 shows the standard deviation of the real exchange rate (in levels) 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 rate.

The precise conclusions one draws about changes in real exchange rate variability depend on the filter used. Because the proper model for the real exchange rate is subject to controversy, we report results for several alternatives. Looking at levels of real exchange rates or using data with linear trends removed, the standard deviation for Ireland vs. the U.K. is

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

higher than that for Ireland vs. Germany for every time period. With the difference filter, only during the period 1973–78 during which Ireland floated against Germany is this reversed. With levels or a single time trend removed, the standard deviation for the Irish–U.K. case did not rise much in the 1973–78 period with a bilateral peg, though it rose more substantially if the differencing filter or separate time trends are employed. For the Ireland–U.K. case, the floating rate period of 1979–85 is characterized by much greater volatility than during earlier periods. Using levels or data filtered by a single time 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. This conclusion, though, is reversed if the differencing filter is used.

Figure 10 shows quarterly growth rates of the real exchange rates between Ireland and Germany (the solid line) and between Ireland and the U.K. (the dashed line.) The growth rate of the real exchange rate of Ireland against both countries is more volatile in the post–1973 period. Within the period from 1973–1979, when Ireland was pegging to the U.K., the real exchange growth rate for Ireland vs. the U.K. is less volatile than that computed for Ireland vs. Germany. In the post–1979 period, when Ireland was effectively pegged to Germany, the ordering is reversed: the volatility of Ireland vs. Germany is smaller than for Ireland vs. the U.K. Thus, volatility in the real exchange rate is clearly linked to exchange rate regime.

A natural next question is whether the increased volatility in the real exchange rate is mirrored in other real quantities. Table 16 gives the standard deviation of Ireland's real exports and imports for linearly detrended and log–differenced data. For the differenced data, the volatility

of real imports and exports appears to be the same in all time periods. For the linearly detrended data, the flexible-rate period is characterized by increased volatility in both imports and exports, with the post-1979 period being characterized by a large increase in volatility, especially in imports. This mirrors the post-1979 increase in volatility of the real exchange rates discussed above. But when a single linear trend is removed, real exchange rate volatility appears to increase post-1979 for Ireland against both Germany and the U.K. . These results casts doubt on the hypothesis that the increases in real exchange rate volatility and trade volatility (in the detrended case) in the post-1979 period were a result of the switch in the exchange rate system. However, this conclusion (as discussed above) depends critically on the filter used for the real exchange rate.

Continuing with the line of investigation pursued in earlier sections, we investigate the cross-country variation and correlatedness of industrial production. Many theoretical models predict that the exchange rate system affects the macroeconomic effects of various government policies. The Mundell-Fleming model, for example, predicts different effects of government policies under pegged and floating exchange rate systems. Many of these maodels can be formulated to predict that the exchange rate system between two nations affects the relative behavior of real output in those nations, unless government policies are altered in very special ways to precisely offset the effects of the change in the exchange rate system. We proceed now to examine the relative behavior of real output in pairs of coutnries that have changed exchange rate systems, to determine whether there is any associated change in relative output growth rates. A finding that there was no structural change in the process determining relative levels of real output does not necessarily imply that the exchange rate system is irrelevant

for relative output, because it is possible that government policies were adjusted precisely so as to offset the effects of the exchange rate system on real output. Although a more complete model of the output effects of various policies and a description of their changes when the exchange rate system changes would be required to examine this issue, the data analysis we conduct in this paper is of interest because it places restrictions on the effects of the exchange rate system, the output effects of government policies, and the changes in policies across exchange rate systems. Table 17 gives standard deviations of industrial production and cross-country correlations by subperiod, for linearly-detrended and log- differenced data. The standard deviations of industrial production for the three countries seem roughly equal and do not seem to vary over the three subperiods studied. This result is independent of the detrending method. The correlation between the industrial production measures for Ireland and Germany are 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 industrial production and U.K. industrial production actually rose (more dramatically for linearly detrended data), while the correlations between Ireland and Germany remained essentially unchanged.

To investigate this further, we examine the difference between the growth rates of industrial production in Ireland and in Germany, denoted y(I,G). It can be well represented by a second-order autoregressive process with seasonal dummies over the initial period of pegged exchange rates, 1961I through 1972IV,

$$y(I,G,t) = \underset{(.01)}{-.05} - \underset{(.14)}{.18}\, y(I,G,t-1) \underset{(.14)}{-.38}\, y(I,G,t-2) \qquad (1)$$

$$\text{adj.}R^2=.60 \qquad DW=2.10 \qquad se=.038$$

(where seasonal dummy variables were also included in the estimated equation). This equation is stable over the 1961–72 period. The residuals show no signs of autocorrelation; the chi–square statistic for testing the hypothesis that the first four autocorrelation coefficients of the residuals are zero is 4.14, which is well below the critical value of the chi–square statistic with four degrees of freedom at the 10 percent level. Similarly, the residuals show no signs of heteroscedasticity, and chi–square tests indicate the absence of ARCH effects, for any number of lags in the ARCH specification, at the 10 percent level. There is, however, indication that the disturbances are not Gaussian because of excess kurtosis. The same coefficient estimates, to two decimal places, are obtained if the difference in growth rates of output is replaced with the difference in deviations of the log of output from linear trends, because the two filters give measures of relative output that have a simple correlation coefficient of .9999. While linear detrending, rather than taking growth rates, affects the time series properties of output in each country alone, relative output in the two countries is virtually unaffected by which of these filters is employed.

When the equation above is estimated over the longer period 1961I through 1978IV, which includes both the initial pegged exchange rate period and the period during which the Irish pound and British pound were pegged to each other but were jointly floating against the Deutschmark, the results are (also with seasonal dummies included)

$$y(I,G,t) = \underset{(.01)}{-.05} - \underset{(.11)}{.24}\, y(I,G,t-1) \underset{(.11)}{-.35}\, y(I,G,t-2) \qquad (2)$$

$$\text{adj.}R^2=.70 \qquad DW=2.10 \qquad se=.035$$

and a chi-square test for the hypothesis that the six coefficients are identical across the sample periods 1960I-72IV and 1973I-78IV yields a test statistic of 6.17, which is well below the critical value of the chi-square statistic with six degrees of freedom at the 10 percent level. Equation (2) passes other specification tests as well: there is no indication of heteroscedasticity, and a chi-square test based on the third and fourth moments of the distribution of residuals yields a statistic of 3.30, which is below the 10 percent critical value of the chi-square statistic with two degrees of freedom. Tests for higher-order autocorrelation of residuals also indicate absence of serial correlation in the residuals. In summary, equation (2) gives a statistical representation of relative real output growth rates (or deviations from trend) in Ireland and Germany that is stable over the time period from 1960 to the end of 1978, wihch includes periods with both exchange rate systems.

However, when the equation is estimated over the entire period 1960I-85IV, the estimated coefficients change substantially, and a chi-square test for the hypothesis that the six coefficients are identical over the periods 1960I-78IV and 1979I-85IV yields a statistic of 22.53, which is above the critical value of the chi-square with six degrees of freedom even at the .001 level. There is, as a consequence, evidence of a structural shift in the time series process describing relative output in Ireland and Germany around the time when Ireland joined the EMS with limited exchange rate

flexibility against Germany. Whether this shift is an effect of the change in exchange rate system, a cause of its change, or unconnected with the exchange rate system cannot be determined from this work. However, we can investigate issues of timing by studying when the break in the relative output process occurred. For a given sample, consider a test of the hypothesis that the next observation is generated by the same process as the preceeding observations, which is a Chow test with the second subperiod consisting of a single observation. Consider a sequence of these test statistics. Figure 11 shows a graph of this sequence, normalized so that the 5 percent critical value can be represented as a constant. The structural breaks in the relative output process appear to occur <u>after</u> the change in the exchange rate system, and the change in the structure is dominated by observations after 1984II. Similarly, a sequence of Chow test statistics, each for testing the hypothesis that all of the remaining observations through 1986IV are drawn from the same process that generated the previous observations, reaches a peak in 1984II. Consequently, although there is evidence of a structural break in the process describing relative real output in Ireland and Germany, the evidence suggests that this break occurred around 1984, and so was probably unconnected with the change in the exchange rate system in the first quarter of 1979. This conclusion is also consistent with the evidence indicating the absence of a structural change in the process around 1973, when the first change in the exchange rate system occurred.

Now turn to the difference between quarterly growth rates of industrial production in Ireland and Great Britain, denoted y(I,GB). The time series representation of this series shows clear signs of structural change during the period 1962I–1985IV. For the subperiod with pegged exchange rates before 1973, y(I,GB) can be well represented by the process

1962I–1972IV

$$y(I,GB,t) = \underset{(.002)}{.008} - \underset{(.15)}{.57}\, y(I,GB,t-1) - \underset{(.16)}{.63}\, y(I,GB,t-2) - \underset{(.15)}{.56}\, y(I,GB,t-3) + \underset{(.17)}{.36}\, y(I,GB,t-4) + e(t) - \underset{(.20)}{.30}\, e(t-4) \qquad (3a)$$

$adj.R^2$=.84 DW=2.01 se=.034,

while estimation of the same equation from 1973 through 1985 yields

1973I–1985IV

$$y(I,GB,t) = \underset{(.002)}{.008} - \underset{(.10)}{.51}\, y(I,GB,t-1) - \underset{(.11)}{.43}\, y(I,GB,t-2) - \underset{(.11)}{.46}\, y(I,GB,t-3) + \underset{(.11)}{.59}\, y(I,GB,t-4) + e(t) - \underset{(.17)}{.91}\, e(t-4) \qquad (3b)$$

$adj.R^2$=.84 DW=1.96 se=.034,

and estimation for the period 1979I–1985IV, during which the bilateral exchange rate floated, yields

1979I–1985IV

$$y(I,GB,t) = \underset{(.006)}{.010} - \underset{(.13)}{.33}\, y(I,GB,t-1) - \underset{(.14)}{.23}\, y(I,GB,t-2) - \underset{(.13)}{.25}\, y(I,GB,t-3) + \underset{(.14)}{.75}\, y(I,GB,t-4) + e(t) - \underset{(.29)}{.86}\, e(t-4) \qquad (3c)$$

$adj.R^2$=.86 DW=1.65 se=.030,

or, including another autoregressive term,

1979I–1985IV

$$y(I,GB,t) = \underset{(.012)}{.010} - \underset{(.11)}{.21}\, y(I,GB,t-1) - \underset{(.13)}{.04}\, y(I,GB,t-2) \qquad (3d)$$
$$- \underset{(.12)}{.06}\, y(I,GB,t-3) + \underset{(.18)}{.44}\, y(I,GB,t-4) + \underset{(.18)}{.46}\, y(I,GB,t-8)$$
$$+ e(t) - \underset{(.28)}{.88}\, e(t-4)$$

$$\text{adj.}R^2 = .89 \qquad DW = 1.90 \qquad se = .027.$$

There is substantial evidence of a break in the statistical process describing the relative output growth rate in Ireland and Great Britain. Figure 12 shows a plot of the log likelihood assuming that there is a single break in the process, with models of the form (3a) prior to the break and (3d) after the break. The figure provides some evidence that a break in the process occurred about two years before the change in the exchange rate system. The peak of the likelihood function occurs in the fourth quarter of 1976. A test of the hypothesis that a break occurred in 1976IV yeilds an F statistic of 2.931, which exceeds the critical value of the F distribution with 6 and 90 degrees of freedom at the .02 level. Then the relative output growth rate is described by the models

1962I–1976III

$$y(I,GB,t) = \underset{(.002)}{.008} - \underset{(.12)}{.56}\, y(I,GB,t-1) - \underset{(.13)}{.62}\, y(I,GB,t-2) \qquad (4a)$$
$$- \underset{(.13)}{.55}\, y(I,GB,t-3) + \underset{(.14)}{.39}\, y(I,GB,t-4) + e(t) - \underset{(.17)}{.57}\, e(t-4)$$

$$\text{adj.}R^2 = .83 \qquad DW = 1.98 \qquad se = .036,$$

and

1976IV–1985IV

$$y(I,GB,t) = \underset{(.004)}{.009} - \underset{(.10)}{.34}\, y(I,GB,t-1) - \underset{(.11)}{.18}\, y(I,GB,t-2) - \underset{(.10)}{.21}\, y(I,GB,t-3) + \underset{(.16)}{.42}\, y(I,GB,t-4) + \underset{(.16)}{.31}\, y(I,GB,t-8) + e(t) - \underset{(.24)}{.92}\, e(t-4) \qquad (4b)$$

adj.R^2=.91 DW=1.65 se=.026.

The estimated residuals from equations (4a) and (4b) show no signs of autocorrelation or heteroscedasticity, and the equations show no signs of parameter instability when estimated recursively. One interpretation of these results is that some changes occurred around 1976 that altered the real economic connections between Ireland and Britain, that these changes show up as a break in the statistical process describing relative output growth in the two countries, and that these changes contributed to the decision by Ireland to abandon the pegged exchange rate with Great Britain.

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 US 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. The change in the Canadian trade balance (in Canadian dollars) is shown in Figure 13, and the

change divided by the level of Canadian exports is shown in Figure 14. There is little evidence of changes in the variability of the trade balance at times when the exchange rate system changed. While the periods prior to 1962 and after 1970 may be characterized by a different variance of the change in the trade balance, the relation is not monotonic. This is, there is no evidence of similarity between the first and second floating-rate periods in this series. There is little evidence to support the hypothesis that changes over time in the variability of the trade balance are due to changes in the exchange rate system.

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, as the Irish case clearly shows. But the behavior of real aggregates such as industrial production and trade flows do not appear to change as a result of a change in the exchange rate system.

VI. Conclusions

There is evidence that business cycles have become more nation-specific and less worldwide since 1973. Real exchange rates have become more volatile. Some other series, such as some trade series and industrial production, have also become more volatile in the latter period, though the magnitude of the increase is much smaller. Real government consumption spending has become more highly correlated across countries. But – aside from real exchange rates – there is little indication that these changes are related to the choice of exchange rate system. Evidence from the Irish and Canadian episodes suggest little connection between the exchange rate system and changes in the stochastic properties of economic aggregates. A large class of theoretical models implies that the exchange rate system has

important effects on a number of macroeconomic quantities; however, we have found little evidence of quantities for which the exchange rate system is an important determinant.

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Table 1

Industrial Production

Country	Fixed Rate Period: Standard deviation (%) detrending method: linear trend	Fixed Rate Period: Standard deviation (%) detrending method: differencing	Fixed Rate Period: Correlation w/U.S.I.P. detrending method: linear trend	Fixed Rate Period: Correlation w/U.S.I.P. detrending method: differencing	Fixed Rate Period: Average growth rate (%)	Flexible Rate Period: Standard deviation (%) detrending method: linear trend	Flexible Rate Period: Standard deviation (%) detrending method: differencing	Flexible Rate Period: Correlation w/U.S.I.P. detrending method: linear trend	Flexible Rate Period: Correlation w/U.S.I.P. detrending method: differencing	Flexible Rate Period: Average growth rate (%)
U.S.	8.0	2.3	1.06	1.00	1.02	6.9	2.8	1.0	1.0	.62
France	9.9	14.9	.38	.47	1.37	12.7	14.2	.50	- .16	.36
Canada	8.3	3.6	.95	.70	1.41	11.4	5.7	.80	.06	.53
Italy	10.8	9.0	.78	.49	1.71	10.5	6.9	.67	.07	.31
Netherlands	10.4	8.8	.66	.48	1.98	16.4	14.1	.57	- .18	.36
Ireland	6.3	7.3	.57	.47	1.78	6.7	7.2	.77	.25	1.05
Luxembourg	6.1	4.5	.34	.51	0.40	11.6	9.7	.53	.01	.39
Yugoslavia	8.2	9.0	.48	.45	2.31	9.3	8.4	.52	- .08	1.30
Finland	8.2	11.0	.36	.49	1.76	10.8	13.6	.31	- .22	.82
Japan	17.3	8.8	.77	- .10	2.59	13.9	2.7	.80	.18	.74
UK	6.5	2.4	.68	.12	3.13	7.2	3.4	.57	.60	.87
Sweden	14.8	7.7	.65	.52	2.69	14.9	11.2	.35	- .13	.69
Greece	10.0	7.2	.63	.45	0.66	16.4	7.2	.70	- .18	.23
Spain	14.7	18.2	.87	.51	1.54	19.9	19.6	.62	- .15	.31

Table 2

Consumption: 12 OECD countries

	single linear trend		separate linear trends		log differences			
	fixed	flexible	fixed	flexible	fixed		flexible	
Country	σ	σ	σ	σ	μ	σ	μ	σ
Germany	3.5	4.6	2.2	2.9	1.2	1.2	0.4	1.0
France	3.0	4.8	1.5	2.1	1.4	1.7	0.7	0.8
Australia	0.5	2.0	0.1	1.0	1.2	0.2	0.7	0.9
Canada	2.1	17.1	1.5	18.8	1.1	1.1	2.4	11.5
Italy	0.9	2.5	0.5	2.3	1.1	0.9	0.6	1.1
Netherlands	4.9	12.7	4.7	8.5	3.0	7.6	1.7	4.5
Finland	4.9	3.8	3.6	3.2	4.2	8.1	0.5	4.4
Japan	6.9	5.3	0.9	1.8	2.1	1.0	0.8	1.3
Switzerland	3.8	3.4	1.1	1.8	1.2	1.5	0.3	1.4
U. K.	1.6	3.2	1.3	2.7	0.6	1.1	0.5	1.4
Sweden	7.1	7.0	6.2	5.6	1.3	1.2	0.4	8.8
Austria	10.9	8.5	0.4	8.5	9.5	0.7	0.7	14.0

Table 3

Cross-correlations of consumption with ind. prod'n: 8 OECD countries
Linear trend removed

CTRY		-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
Germany	FIXED	.026	.260	.316	.534	.648	.760	.725	.742	.618	.423	.295	.094	-.010	-.176	-.232
	FLEX	.353	.406	.456	.536	.542	.575	.648	.747	.677	.607	.570	.473	.382	.289	.239
	SE:FIX	.223														
	SE:FLX	.146														
France	FIXED	.053	.094	-.071	-.003	.252	.236	.149	.348	.433	.332	.131	.068	.279	.237	.003
	FLEX	.418	.416	.449	.528	.544	.563	.608	.699	.644	.576	.546	.467	.396	.328	.295
	SE:FIX	.204														
	SE:FLX	.140														
Canada	FIXED	.660	.703	.736	.793	.825	.802	.782	.766	.735	.670	.611	.573	.491	.412	.366
	FLEX	.659	.687	.731	.763	.788	.814	.850	.871	.833	.782	.733	.666	.595	.528	.481
	SE:FIX	.150														
	SE:FLX	.138														
Nether-lands	FIXED	-.061	.307	-.218	.375	.053	.436	-.187	.507	.012	.337	-.313	.310	-.092	.263	-.352
	FLEX	.644	.620	.556	.713	.671	.629	.537	.707	.601	.539	.374	.441	.347	.298	.135
	SE:FIX	.176														
	SE:FLX	.140														
Japan	FIXED	.127	.226	.343	.476	.601	.731	.859	.989	.898	.767	.651	.521	.380	.250	.131
	FLEX	.496	.523	.535	.554	.593	.592	.672	.743	.649	.528	.437	.354	.242	.167	.162
	SE:FIX															
	SE:FLX															
Switzer-lant	FIXED	-.235	-.039	.070	.361	.361	.597	.698	.921	.686	.587	.395	.333	.067	-.084	-.174
	FLEX	.197	.251	.389	.465	.599	.663	.754	.825	.787	.683	.593	.487	.395	.276	.161
	SE:FIX	.250														
	SE:FLX	.138														
Sweden	FIXED	-.112	.485	-.481	.449	-.039	.673	-.469	.600	-.019	.727	-.462	.477	-.118	.573	-.504
	FLEX	.309	.608	-.015	.715	.263	.608	-.105	.696	.173	.525	-.212	.518	.033	.361	-.327
	SE:FIX	.176														
	SE:FLX	.138														
United Kingdom	FIXED	.052	.117	.129	.146	.250	.290	.400	.474	.553	.527	.503	.532	.518	.470	.429
	FLEX	.238	.314	.369	.436	.476	.523	.558	.614	.490	.396	.358	.235	.145	.053	.036
	SE:FIX	.150														
	SE:FLX	.138														

Table 4

Cross-correlation of consumption with ind. prod'n: 8 OECD countries

Log-differences

CTRY		-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
Germany	FIXED	-.118	.126	-.066	.060	.145	-.043	.180	-.077	.287	-.144	.233	-.297	.236	-.314	.238
	FLEX	-.045	-.042	.068	.031	-.037	-.015	-.026	.135	-.036	-.025	.103	.076	-.004	-.060	.063
	SE:FIX	.229														
	SE:FLX	.146														
France	FIXED	.202	.052	-.074	-.242	.332	-.088	-.141	-.006	.276	-.064	.014	-.338	.269	.036	-.033
	FLEX	.054	-.087	.065	-.091	.020	-.092	.028	.072	.065	-.057	.101	.002	-.007	-.026	.020
	SE:FIX	.208														
	SE:FLX	.140														
Canada	FIXED	.093	.053	-.055	-.143	.252	-.021	-.026	.056	.152	.012	-.135	.128	-.008	-.153	.050
	FLEX	.007	-.019	-.139	-.006	-.098	.033	.047	.216	.105	.053	.113	.002	-.109	-.125	.004
	SE:FIX	.152														
	SE:FLX	.138														
Nether-lands	FIXED	-.428	.596	-.722	.582	-.440	.660	-.863	.702	-.492	.699	-.854	.644	-.472	.612	-.737
	FLEX	-.102	.251	-.645	.512	-.134	.309	-.727	.555	-.120	.386	-.769	.488	-.110	.430	-.737
	SE:FIX	.179														
	SE:FLX	.140														
Japan	FIXED	.127	-.048	-.061	-.228	.181	.024	-.170	.156	-.013	.263	-.155	.212	.012	.030	-.213
	FLEX	-.051	-.042	-.012	-.050	.065	-.016	-.117	.175	.125	-.041	.024	.414	-.167	-.130	.013
	SE:FIX															
	SE:FLX															
Switzer-land	FIXED	-.364	.364	-.470	.488	-.345	.266	-.323	.442	-.284	.088	-.016	.137	-.035	-.220	.306
	FLEX	.069	-.127	.018	-.034	.093	-.006	-.002	.054	.145	-.009	-.040	.013	.027	.057	-.124
	SE:FIX	.258														
	SE:FLX	.138														
Sweden	FIXED	-.393	.601	-.736	.566	-.477	.719	-.872	.660	-.537	.762	-.842	.606	-.508	.692	-.745
	FLEX	-.435	.555	-.830	.735	-.502	.644	-.918	.801	-.531	.675	-.903	.731	-.493	.632	-.840
	SE:FIX	.179														
	SE:FLX	.138														
United Kingdom	FIXED	-.025	.045	.016	-.111	.074	-.118	.071	-.038	.113	-.017	.001	.030	.050	-.063	.077
	FLEX	.000	.052	-.042	.097	.006	.039	-.034	.197	-.024	-.047	.077	.002	-.037	-.089	.013
	SE:FIX	.152														
	SE:FLX	.138														

TABLE 5

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
Equador	*	*	*	$	$	$		$	$	$	$		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
UK	*	*	*	*	*	*		*	*	*	*		*	*	F	F	F
USA	*	*	*	*	*	*		*	*	*	*		*	F	F	F	F
Venezuela	$	$	$	$	$	$		$	$	$	$		F	F	F	F	F

Lebanon also $ lev. pre '73

pegged to		flexible	*	Korea flexible 64-68 also	
dollar	$	mutual exchange agreement	M		
pound	£	fixed	F		
combination	C	index of indicators	I		
peg to basket					

Table 6

Growth Rates of Real Exports and Imports

Country	Exports				Imports			
	Fixed		Flexible		Fixed		Flexible	
	μ(%)	σ(%)	μ(%)	σ(%)	μ(%)	σ(%)	μ(%)	σ(%)
Germany	2.0	3.6	0.5	5.2	2.0	3.5	0.6	4.9
France	1.6	6.5	0.5	4.5	1.9	5.0	0.6	4.9
Denmark	1.4	3.4	0.6	5.6	1.5	4.7	0.2	6.3
Australia	1.2	7.7	1.1	5.7	1.1	9.4	1.8	7.4
Canada	1.7	4.3	0.7	3.8	1.1	3.9	0.7	4.7
Italy	2.5	3.5	1.1	7.0	2.2	5.3	0.9	8.5
Netherlands	2.1	3.3	0.6	5.7	---	---	---	---
New Zealand	4.3	28.6	1.7	10.6	4.9	26.7	2.7	9.9
Iceland	1.9	14.2	0.3	13.9	- 0.2	18.2	0.2	10.7
Ireland	1.8	6.1	1.5	5.8	1.8	6.0	1.0	7.1
Finland	1.7	9.7	1.0	8.1	1.8	9.4	0.7	8.6
Greece	2.0	12.0	1.2	18.1	2.0	9.1	0.8	24.8
Japan	3.2	3.3	1.6	5.3	2.8	4.3	0.7	5.7
Switzerland	1.9	1.8	5.9	2.2	2.2	3.1	0.5	6.4
Spain	2.4	10.5	1.4	8.8	4.0	8.3	0.5	8.0
Turkey	3.1	21.6	2.0	17.8	3.3	15.1	1.9	15.3
Portugal	2.2	8.1	0.3	9.7	2.0	11.6	0.0	13.3
UK	0.8	5.1	0.7	6.2	0.7	3.3	0.5	5.3
Sweden	1.7	3.9	0.2	8.6	1.5	3.9	0.2	6.4
S. Africa	0.2	7.2	1.6	8.4	1.1	7.6	1.0	9.3
Costa Rica	1.1	35.7	1.4	22.2	2.2	16.0	0.0	11.9
Dom. Rep.	0.2	26.4	0.6	39.1	1.5	23.2	1.5	18.4
El Salvador	8.6	79.7	- 2.2	117.3	1.1	9.0	- 3.1	117.5
Guatemala	0.7	50.5	0.0	28.7	1.2	11.0	- 0.6	14.5
Haiti	- 0.7	38.4	0.6	24.6	0.8	17.4	2.6	12.6
Honduras	1.3	28.4	-14.8	80.1	1.6	10.9	-17.4	115.0
Mexico	0.2	15.7	3.6	15.3	0.6	7.3	1.7	15.3
Paraguay	2.2	39.5	0.0	62.9	2.5	19.7	2.1	28.2
Peru	1.2	14.0	1.8	18.0	0.0	10.5	0.5	17.6
Venezuela	0.4	8.7	1.1	18.3	0.6	16.8	0.8	12.9
Egypt	0.0	44.4	0.6	42.8	0.4	10.0	2.2	48.3
India	0.4	12.5	0.7	14.7	- 0.4	14.0	2.7	16.9
Korea	11.9	10.2	3.9	14.0	12.9	14.5	3.4	12.5
Malaysia	0.9	7.7	2.4	8.0	1.1	5.5	2.0	7.7
Philippines	2.5	15.9	0.7	13.0	2.1	13.9	0.4	11.4
Thailand	0.6	16.4	- 4.0	179.3	2.0	4.3	3.1	6.2
Ethiopia	- 4.0	46.1	- 0.6	37.1	- 0.6	12.3	0.7	24.7
Libera	0.2	9.4	- 1.2	13.6	0.6	14.6	- 1.0	16.1
Somalia	- 0.7	25.4	3.1	65.3	- 1.3	17.2	- 4.4	49.0
Tunisia	0.8	16.7	2.6	27.2	2.0	16.5	2.4	16.7
Israel	---	---	---	---	1.3	23.2	4.9	50.3

Table 7

Tests for Change in Volatility of Exports and Imports
from pre-1970 to post-1973

Country	Tests for Decrease in Volatility Exports	Imports	Tests for Increase in Volatility Exports	Imports
Germany	0.48	0.51	2.07	1.95
France	2.10	0.83	0.48	1.20
Denmark	0.37	0.56	2.69	1.78
Australia	1.77	1.56	0.57	0.64
Canada	1.29	0.69	0.78	1.44
Italy	0.25	0.39	3.97**	2.55*
Netherlands	0.34	NA	2.96	NA
New Zealand	7.05**	7.04**	0.14	0.14
Iceland	1.05	2.91	0.95	0.34
Ireland	1.11	0.72	0.90	1.39
Finland	1.44	1.20	0.69	0.83
Greece	0.44	1.36	1.26	7.38**
Japan	0.39	0.57	2.56*	1.74
Switzerland	0.09	0.24	10.67**	1.23**
Spain	1.43	1.08	0.70	0.92
Turkey	1.48	0.98	0.68	1.02
Portugal	0.70	0.77	1.43	1.31
UK	0.68	0.39	1.47	2.56*
Sweden	0.21	0.37	4.83**	2.67*
S. Africa	0.73	0.67	1.37	1.50
Costa Rica	2.56	0.25	0.39	3.97**
Dom. Rep.	0.45	1.59	2.20	0.63
El Salvador	0.46	0.01	2.19	170.69**
Gutemala	3.08	0.57	0.32	1.74
Haiti	2.43	1.93	0.41	0.52
Honduras	0.13	0.01	7.10	111.93**
Mexico	1.05	0.23	0.95	4.40**
Paraguay	0.39	0.49	2.54*	2.05
Peru	0.60	0.46	1.66	2.82*
Venezuela	0.23	1.69	4.44**	0.59
Egypt	1.07	0.17	0.93	5.85**
India	0.72	0.68	1.39	1.46
Korea	1.53	3.78*	0.65	0.26
Malaysia	0.92	0.51	1.08	1.96
Philippines	1.49	1.48	0.67	0.67
Thailand	0.01	0.49	113.33**	2.03
Ethiopia	1.66	0.27	0.60	3.76**
Liberia	0.53	0.91	1.89	1.01
Somalia	0.16	0.13	6.43**	7.89**
Tunisia	0.38	0.98	2.66*	1.02
Israel	NA	0.22	NA	4.54**

*Significant at 5% level
**Significant at 1% level

Table 8

F-tests for Differences in Mean Growth Rates of Exports and Imports

Country	Test Statistics: Exports	Imports
Germany	1.57	1.54
France	0.95	1.17
Denmark	0.81	1.10
Australia	0.06	- 0.32
Canada	1.18	0.44
Italy	1.18	0.86
Netherlands	1.50	NA
New Zealand	0.44	0.40
Iceland	0.54	- 0.13
Ireland	0.24	0.58
Finland	0.37	0.58
Greece	0.24	0.30
Japan	1.70*	1.95*
Switzerland	1.38	1.57
Spain	0.49	2.03**
Turkey	0.26	0.44
Portugal	1.00	0.76
UK	0.08	0.21
Sweden	1.04	1.15
S. Africa	- 0.91	0.06
Costa Rica	- 0.05	1.18
Dom. Rep.	- 0.06	0.00
El Salvador	0.56	0.26
Guatemala	0.09	0.72
Haiti	- 0.21	- 0.48
Honduras	1.28	0.21
Mexico	- 1.12	- 0.47
Paraguay	0.22	- 0.02
Peru	- 0.19	- 0.18
Venezuela	- 0.25	- 0.07
Egypt	- 0.07	- 0.34
India	- 0.11	- 1.02
Korea	0.96	1.25
Malaysia	- 0.98	- 0.69
Philippines	0.63	0.68
Thailand	0.12	- 0.72
Ethiopia	- 0.31	- 0.21
Liberia	0.37	0.34
Somalia	- 0.29	0.32
Tunisia	- 0.41	- 0.12
Israel	NA	- 0.35

*Significant at 5% level
**Significant at 1% level

Table 9

F-tests for Change in Real Exhange Rate Volatility
(log-differenced real exchange rate data)
pre-70:4 vs post-73:3

Country	Decrease	Increase
Germany	0.05	21.16**
France	0.12	8.07**
Denmark	0.09	10.67**
Australia	0.03	28.86**
Canada	0.33	3.04*
Italy	0.03	35.76**
Netherlands	0.07	14.42**
New Zealand	0.39	22.55*
Iceland	2.27	0.44
Ireland	0.21	44.77**
Yugoslavia	2.42*	0.41
Finland	1.01	0.99
Belgium	0.01	88.89**
Greece	0.04	24.83**
Japan	0.03	29.55**
Switzerland	0.01	78.23**
Spain	0.26	3.882**
Turkey	0.64	1.55
Portugal	0.08	12.37**
UK	0.21	4.84*
Sweden	0.03	30.65**
Austria	0.28	36.11**
S. Africa	0.01	93.96**
Costa Rica	0.02	55.46**
Dom. Rep.	0.03	39.49**
Ecuador	0.48	2.08
El Salvador	0.42	2.38
Guatemala	0.30	3.34*
Haiti	1.28	0.78
Honduras	1.28	0.78
Mexico	0.02	66.35**
Paraguay	0.06	16.49**
Peru	0.40	2.54*
Venezuela	0.31	3.25*
Israel	0.49	2.02
Egypt	0.16	6.42**
India	2.68*	0.37
Korea	0.32	3.12*
Malaysia	0.12	8.49**
Philippines	2.86*	0.35
Liberia	3.20*	0.31
Somalia	0.07	12.84**

*Significant at 5% level
**Significant at 1% level

Table 10

F-test for Change in mean growth rate of real exchange Rate

Country	Test Statistic
Germany	1.17
France	0.65
Denmark	1.06
Australia	0.34
Canada	0.82
Italy	0.71
Netherlands	0.92
New Zealand	- 0.18
Iceland	- 0.19
Ireland	0.21
Yugoslavia	0.34
Finland	.00
Belgium	0.03
Greece	0.64
Japan	0.32
Switzerland	0.27
Spain	0.69
Turkey	0.10
Portugal	0.84
UK	0.23
Sweden	1.41
Austria	- 0.33
S. Africa	1.38
Costa Rica	0.46
Dom. Rep.	0.22
Ecuador	- 0.33
El Salvador	- 6.07**
Guatemala	- 2.26**
Haiti	- 1.26
Honduras	- 1.26
Mexico	0.78
Paraguay	- 0.38
Peru	0.88
Venezuela	- 0.24
Israel	0.34
Egypt	- 0.32
India	0.76
Korea	0.00
Malaysia	0.00
Philippines	- 0.86
Liberia	- 0.28
Somalia	- 0.23
Tunisia	0.53

**Significant at 1% level

Table 11

Real Exchange Rate Variability

Real Trade Variability \ Real Exchange Rate Variability	Increase	No Change	Decrease
Increase	Italy (EMS(X,M) Greece (*)(M) Japan (*)(X) Switzerland (*)(X,M) UK (*)(M) Sweden (C)(X,M) Costa Rica ($/*)(M) Mexico (*)(M) Paraguay ($)(X) Peru ($/*)(M) Venezuela ($)(X) Eqypt ($)(M) Somalia ($/*)(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 Dom. Rep. ($) Guatemala ($) Malaysia (C)	Iceland (*) Finalnd (C) Turkey (*) Haiti ($)	India (*) Philippines (*) Liberia ($)
Decrease	New Zealand (*)(X,M) Korea (*)(M)		

How to read table:

Country Name [exchange rate system post-'73: see Table 14 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)

Table 12

Real Exchange Rate Variability

Real Trade Variability

	Increase	No Change	Decrease
Increase	13| OECD: 6 Non-OECD: 7 --- fixed: 3 fixed/float post-'81: 3 float: 5 EMS: 1 combo: 1	4| OECD: ϕ Non OECD: 4 --- fixed: 1 fixed/float: 1 float: 1 EMS: ϕ combo: 1	ϕ|
No Change	13| OECD: 9 Non-OECD: 4 --- fixed: 2 fixed/float post-'81: ϕ float: 4 EMS: 4 combo: 3	4| OECD: 3 Non-OECD: 3 --- fixed: 1 fixed/float post-'81 ϕ float: 2 EMS: ϕ combo: 1	3| OECD: ϕ Non-OECD: 3 --- fixed: 1 fixed/float: ϕ float: 2 EMS: ϕ combo: ϕ
Decrease	2| OECD: 1 Non-OECD: 1 --- fixed: ϕ fixed/float: ϕ float: 2 EMS: ϕ combo: ϕ	ϕ|	ϕ|

Number in upper-left corner shows number of countries in the cell (refer to Table 19)

Entries below show breakdown by OECD/non-OECD, and by exchange rate regime

Table 13

Standard Deviations of Real Government Consumption
Growth Rates - 1960-72 and 1973-85

Country	SDPEG	SDFLT	SDDIF
Germany	0.026	0.018	-.008
France	0.008	0.642	0.634
Denmark	0.123	0.021	-.102
Australia	0.031	0.022	-.009
Canada	0.031	0.016	-.015
Italy	0.011	0.005	-.006
Netherlands	0.017	0.016	-.001
Iceland	0.023	0.026	0.003
Ireland	0.022	0.030	0.008
Luxembourg	0.050	0.017	-.033
Finland	0.004	0.010	0.006
Belgium	0.024	0.022	-.002
Greece	0.022	0.033	0.011
Japan	0.050	0.015	-.035
Switzerland	0.040	0.010	-.030
Spain	0.023	0.016	-.007
Turkey	0.015	0.040	0.025
Portugal	0.053	0.040	-.013
Great Britain	0.019	0.018	-.001
Norway	0.031	0.014	-.017
Sweden	0.021	0.012	-.009
Austria	0.014	0.012	-.002

Table 14

Average Correlations of Real Government Consumption Growth Rates with Other Countries - 1960-72 and 1973-85

Obs	AVGPEG	AVGFLT
1	0.152	0.321
2	-.036	0.106
3	-.092	0.224
4	-.049	0.275
5	-.054	0.171
6	-.016	0.343
7	0.101	0.364
8	0.033	0.334
9	-.087	0.389
10	0.134	0.425
11	0.131	0.414
12	0.122	0.437
13	-.073	0.406
14	0.134	0.290
15	0.091	-.098
16	0.154	0.362
17	-.019	0.429
18	0.024	0.312
19	0.122	0.278
20	0.071	0.281

Table 15

Standard Deviations of Real Exchange Rates of
Ireland vs. U.K. or vs. Germany (various filters)

(percent per quarter)

	60:1–70:4	73:3–78:4	79:1–85:4	73:3–85:4
Ireland vs. UK				
levels	2.4	2.2	8.9	7.5
differenced	.8	1.8	5.0	3.9
single trend	2.0	2.4	8.7	7.6
different trends	1.1	1.7	6.9	7.4
Ireland vs. Germany				
levels	1.1	1.5	2.6	3.9
differenced	2.6	4.6	1.9	3.4
single trend	1.0	1.4	2.9	4.4
different trends	1.0	1.4	1.1	1.9

Table 16

Standard deviation of Ireland's Real Exports and Imports

(percent per quarter)

	60:1–70:4	73:3–78:4	79:1–85:4	73:3–85:4
linear trend removed				
real exports	30	29	35	33
real imports	31	37	59	50
log–differenced				
real exports	10	11	9	10
real imports	9	9	7	8
separate trends removed				
real exports	10	20	33	30
real imports	14	32	34	49

Table 17

Standard deviation and correlations of industrial production

(standard deviations are percent per quarter)

	60:1–70:4	73:3–78:4	79:1–85:4	73:3–85:4
linear trend removed				
standard deviation: Germany	9	7	7	9
standard deviation: Ireland	6	6	7	7
standard deviation: U.K.	7	6	7	7
Correlation between Ireland and U.K.	.48	.39	.61	.59
Correlation between Ireland and Germany	.75	.64	.68	.70
log–differenced				
standard deviation: Germany	9	11	8	9
standard deviation: Ireland	7	7	7	7
standard deviation: U.K.	7	8	7	7
Correlation between Ireland and U.K.	.31	.30	.36	.32
Correlation between Ireland and Germany	.74	.74	.68	.70

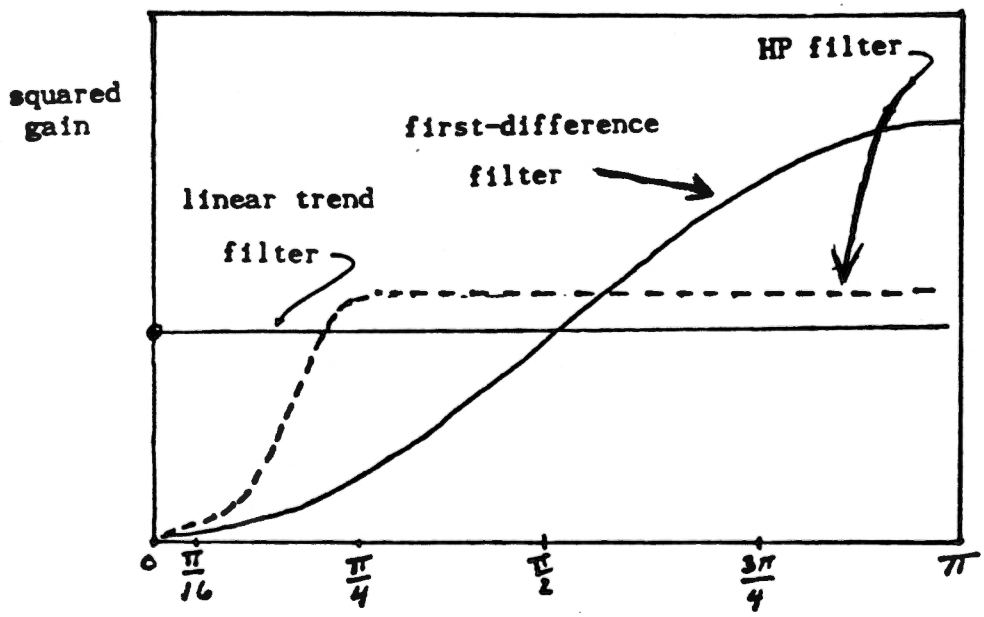
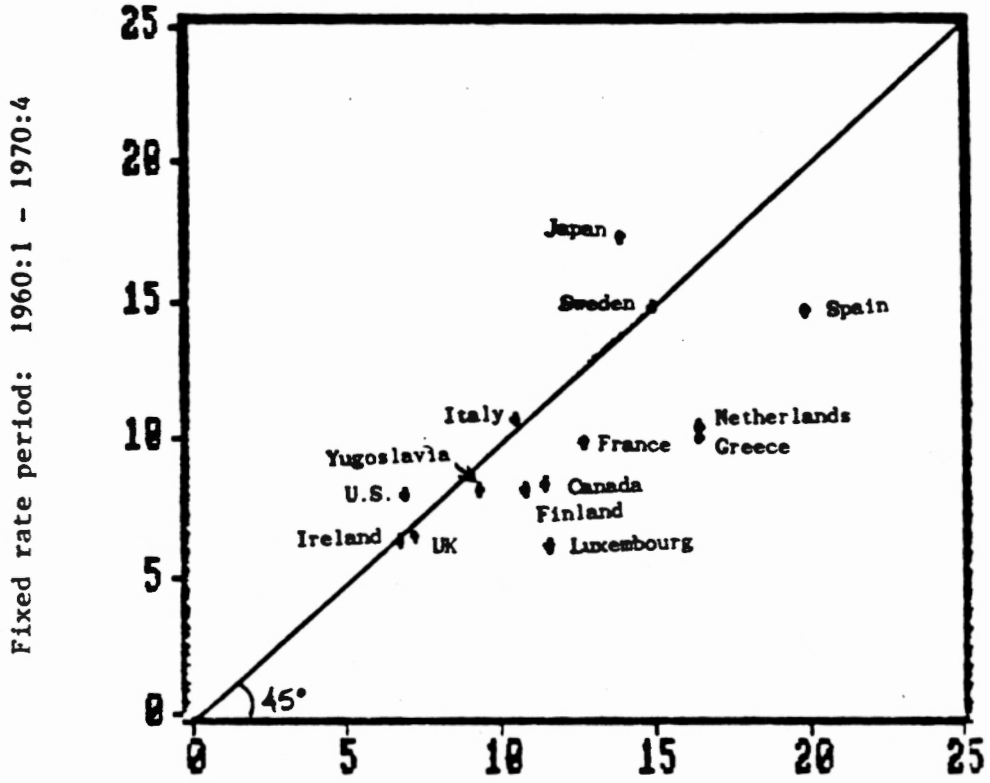

squared gain
HP filter
first-difference filter
linear trend filter
0
π/16
π/4
π/2
3π/4
π

FIGURE 1

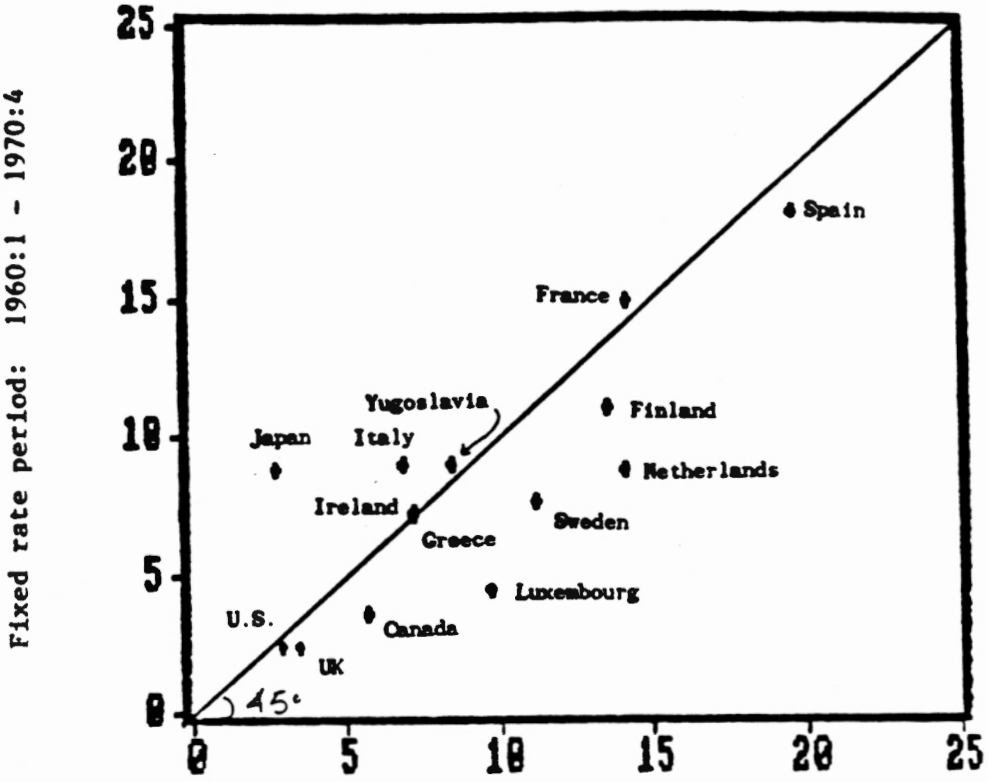


Flexible rate period: 1973:1-1985:4

STANDARD DEVIATION OF LOG INDUSTRIAL PRODUCTION: (%)
LINEAR TREND REMOVED

14 OECD COUNTRIES

FIGURE 2

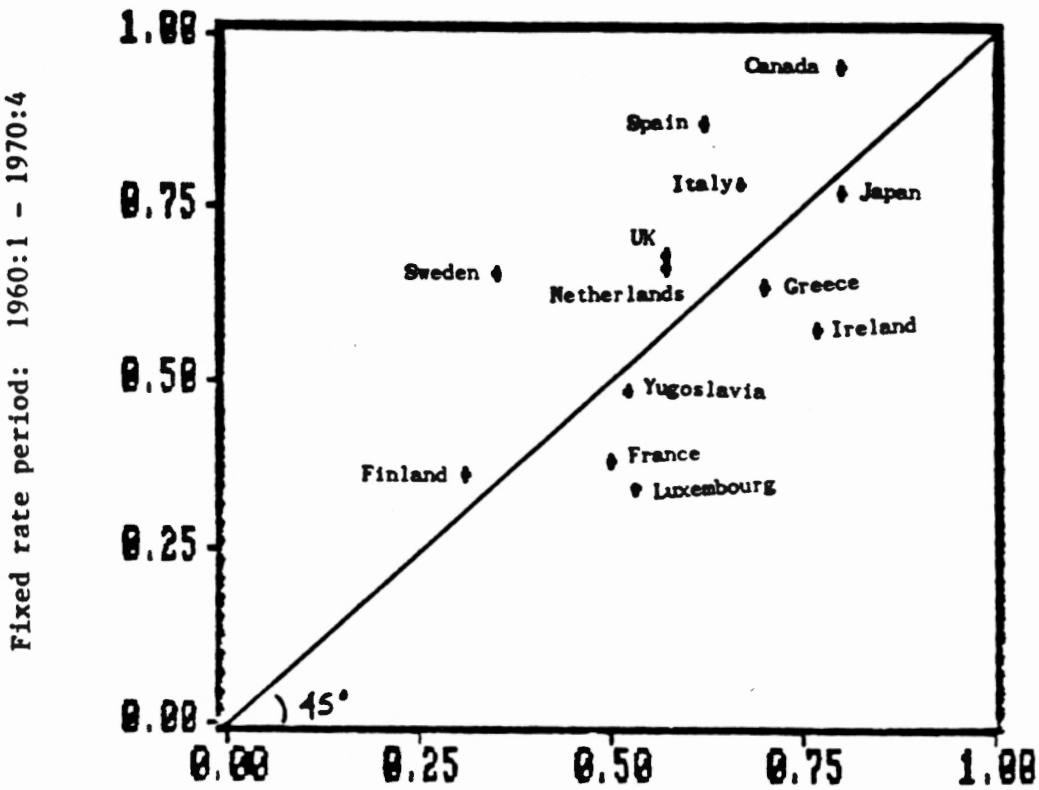


Flexible rate period: 1973:1-1985:4

STANDARD DEVIATION OF QUARTERLY GROWTH RATES OF INDUSTRIAL PRODUCTION (% per qtr.)

14 OECD COUNTRIES

FIGURE 3

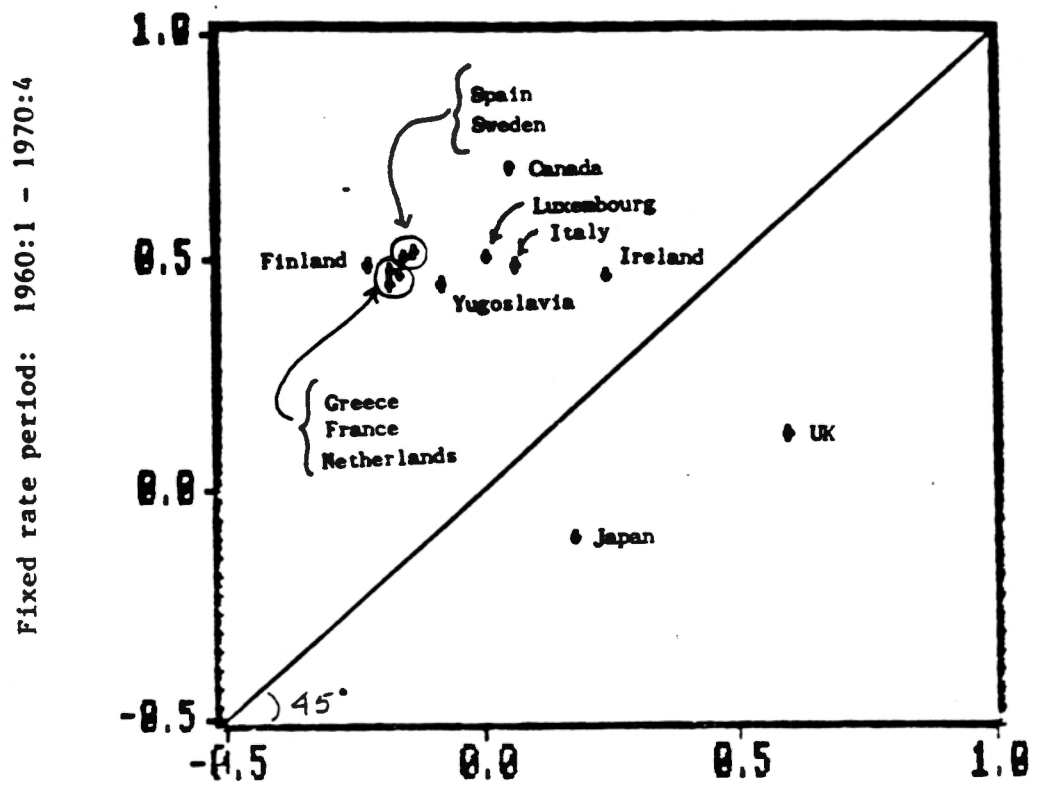


Flexible rate period: 1973:1 - 1985:4

CORRELATION OF LOG INDUSTRIAL PRODUCTION WITH LOG OF U.S. INDUSTRIAL PRODUCTION: LINEAR TREND REMOVED.

14 OECD COUNTRIES

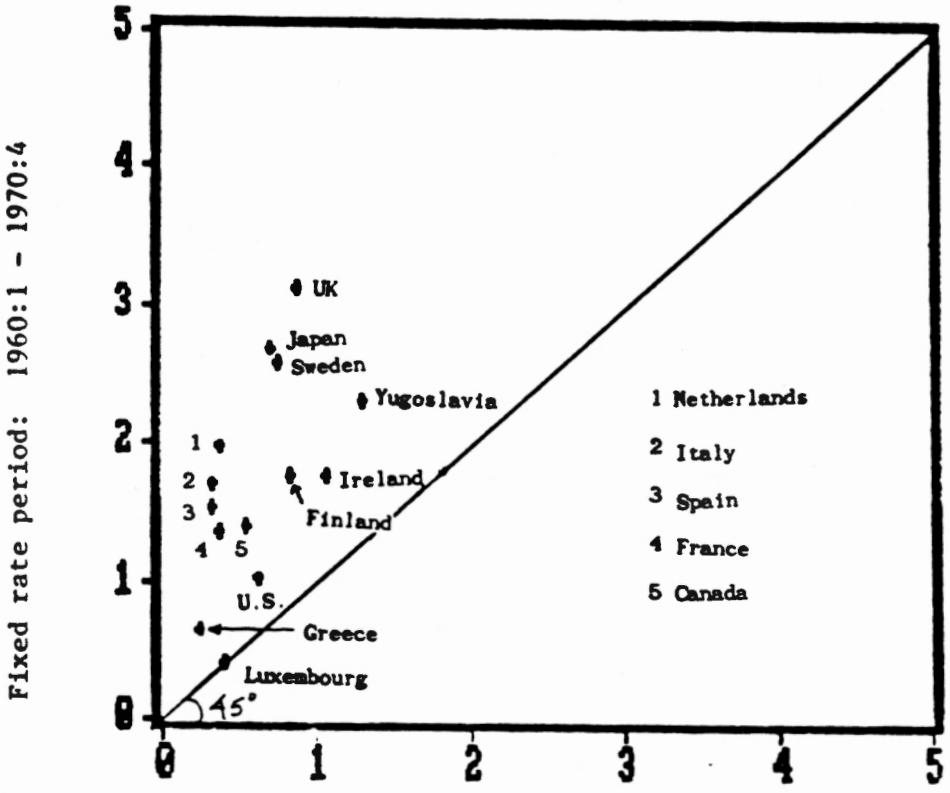
FIGURE 4



Flexible rate period: 1973:1-1985:4

CORRELATION OF QUARTERLY GROWTH RATES OF INDUSTRIAL PRODUCTION WITH U.S. GROWTH RATE: 13 OECD COUNTRIES

FIGURE 5



QUARTERLY GROWTH RATES OF INDUSTRIAL PRODUCTION: % per qtr.

14 OECD COUNTRIES

FIGURE 6

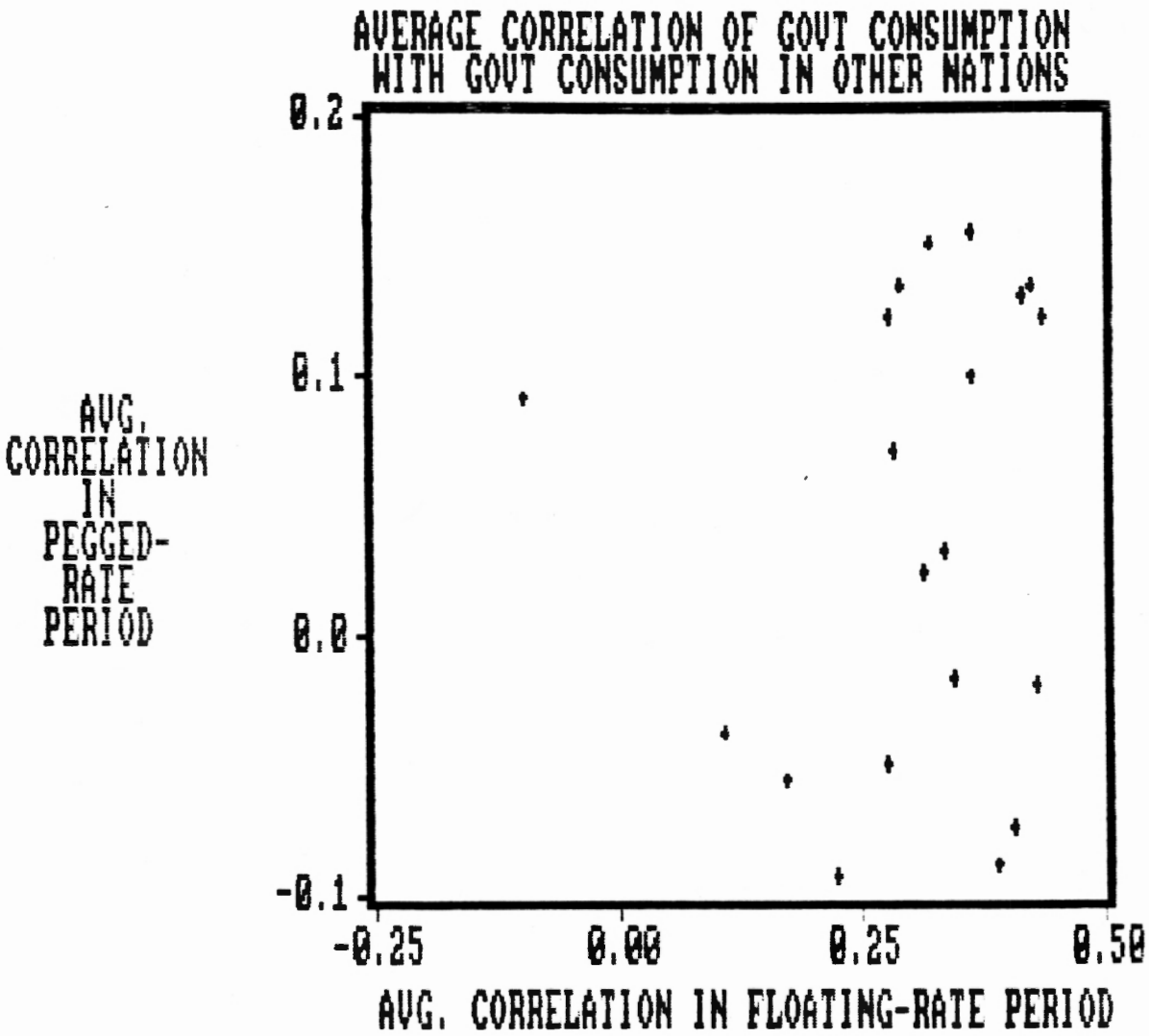

AVERAGE CORRELATION OF GOVT CONSUMPTION
WITH GOVT CONSUMPTION IN OTHER NATIONS
AVG. CORRELATION IN PEGGED-RATE PERIOD
0.2
0.1
0.0
-0.1
-0.25
0.00
0.25
0.50
AVG. CORRELATION IN FLOATING-RATE PERIOD

FIGURE 7

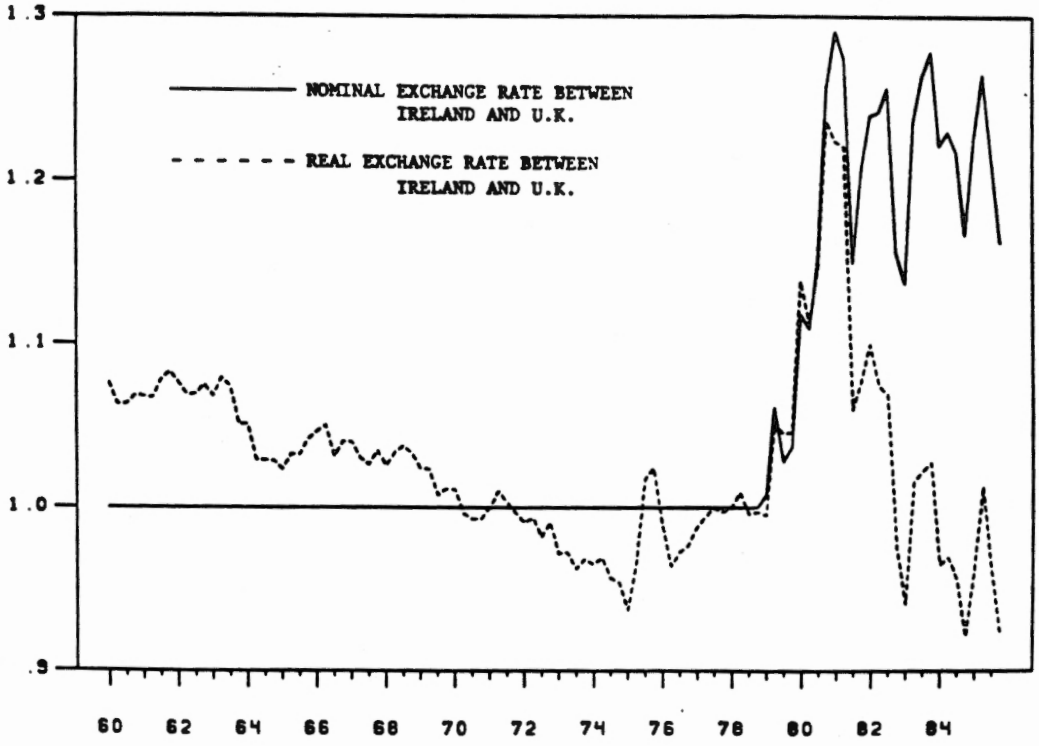


FIGURE 8

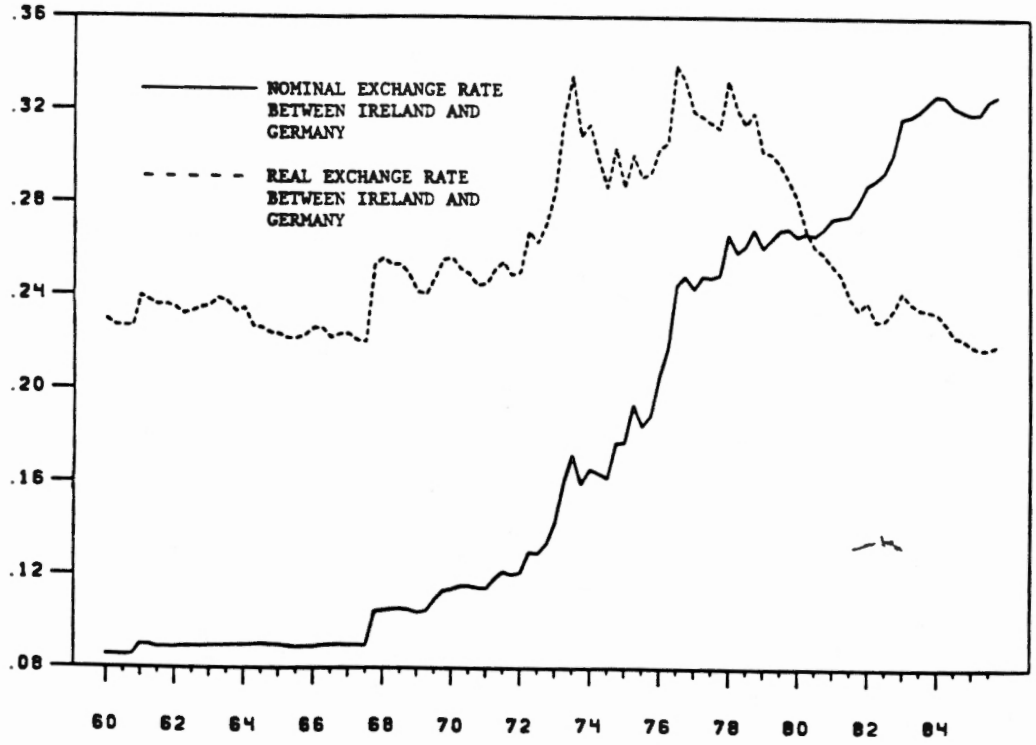
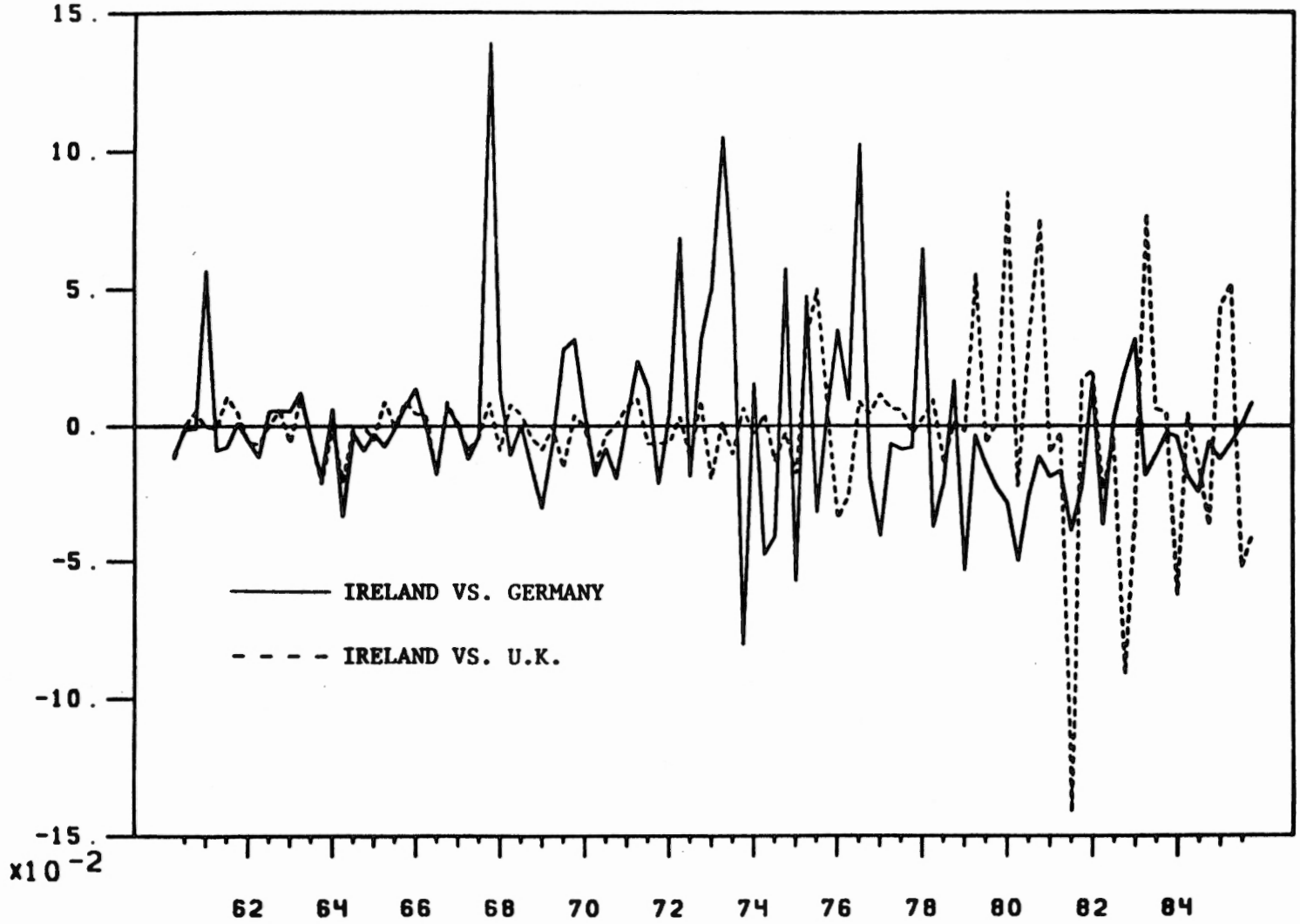


FIGURE 9



Growth rates of real exchange rates
(percent per quarter)

FIGURE 10

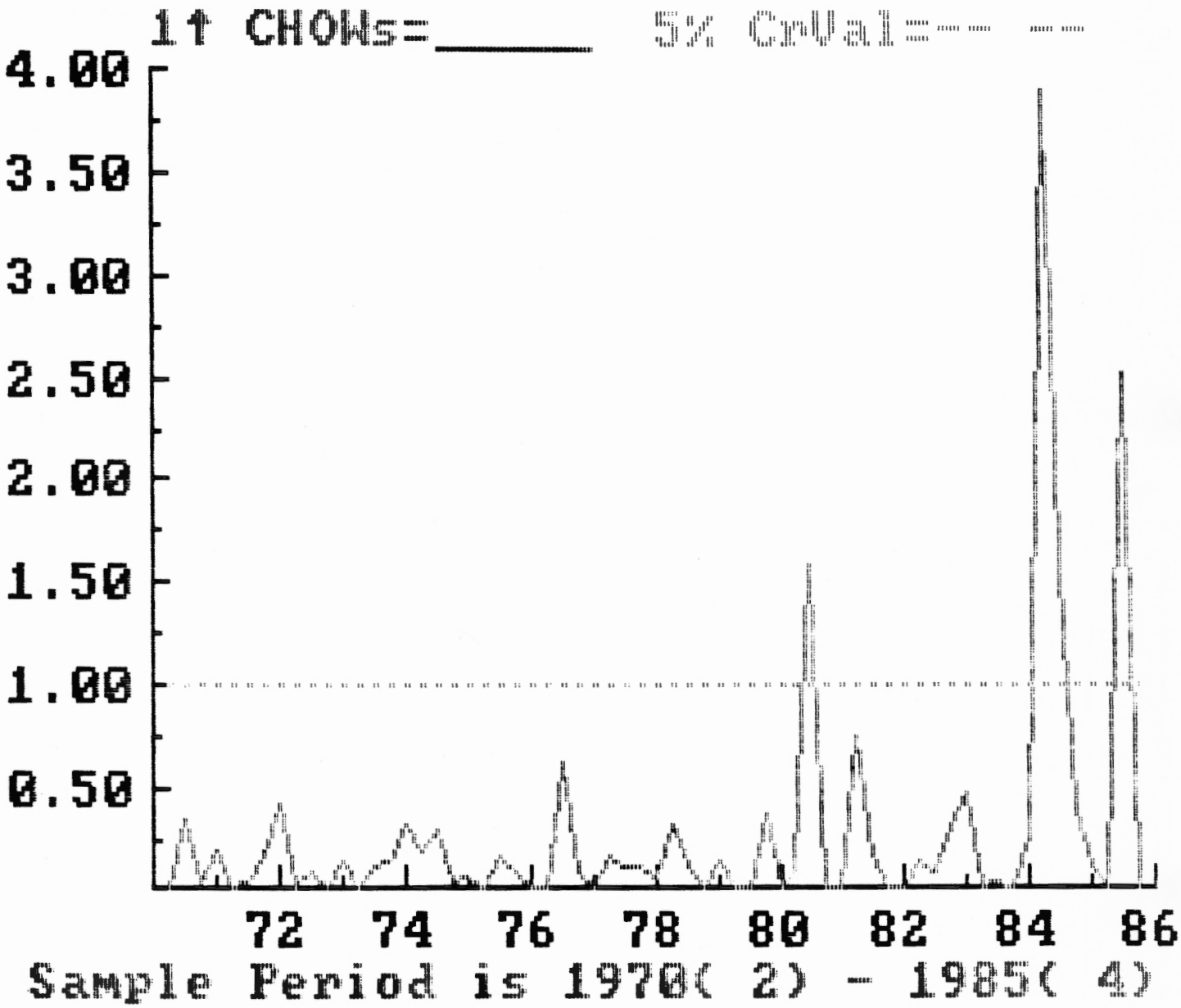


Figure 11

Sequence of Test Statistics, Relative to .05 Critical Value, for Hypothesis of No Structural Change in Relative IP: Ireland-Germany

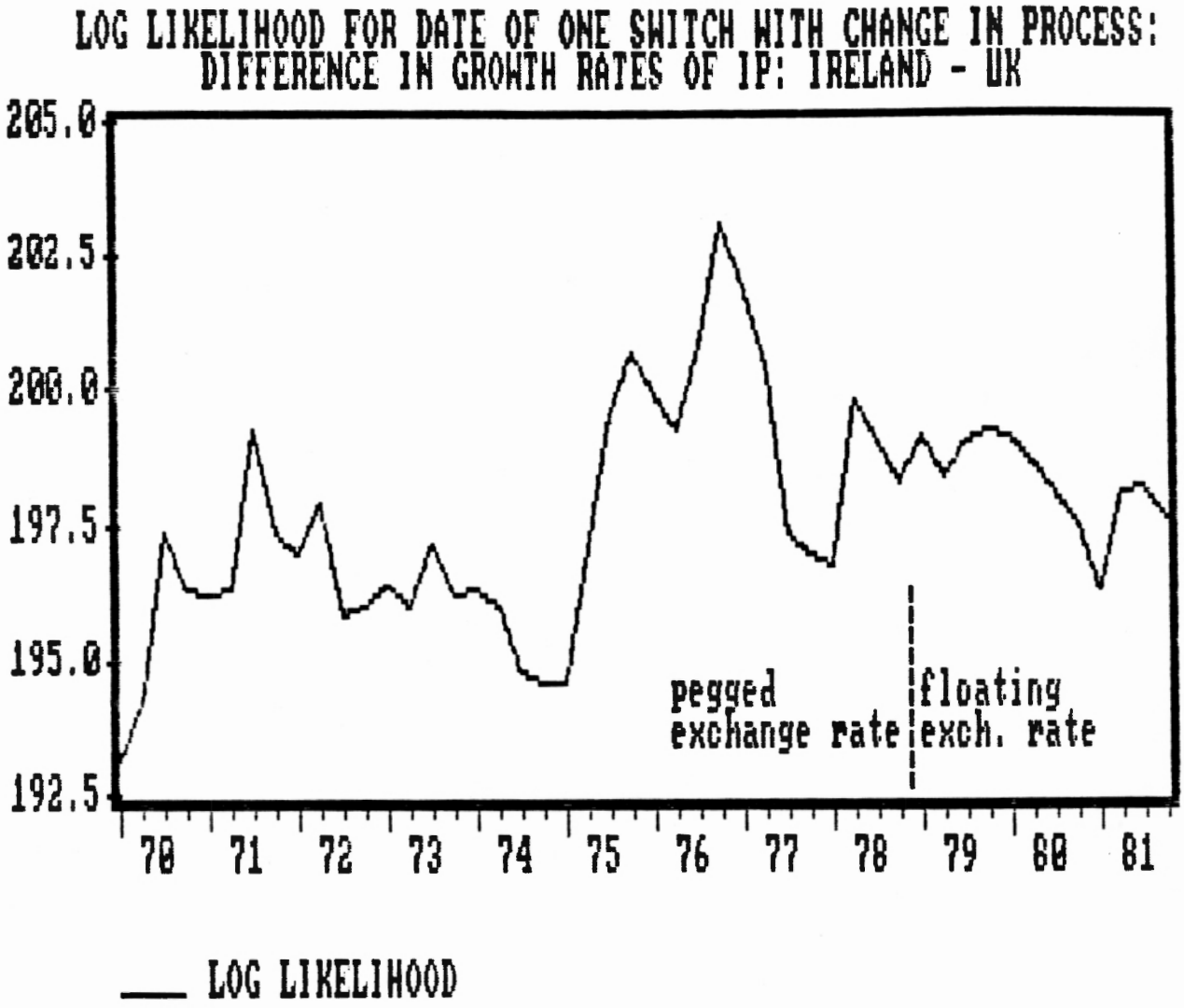

LOG LIKELIHOOD FOR DATE OF ONE SWITCH WITH CHANGE IN PROCESS:
DIFFERENCE IN GROWTH RATES OF IP: IRELAND - UK
205.0
202.5
200.0
197.5
195.0
192.5
pegged
exchange rate
floating
exch. rate
70
71
72
73
74
75
76
77
78
79
80
81
LOG LIKELIHOOD

Figure 12

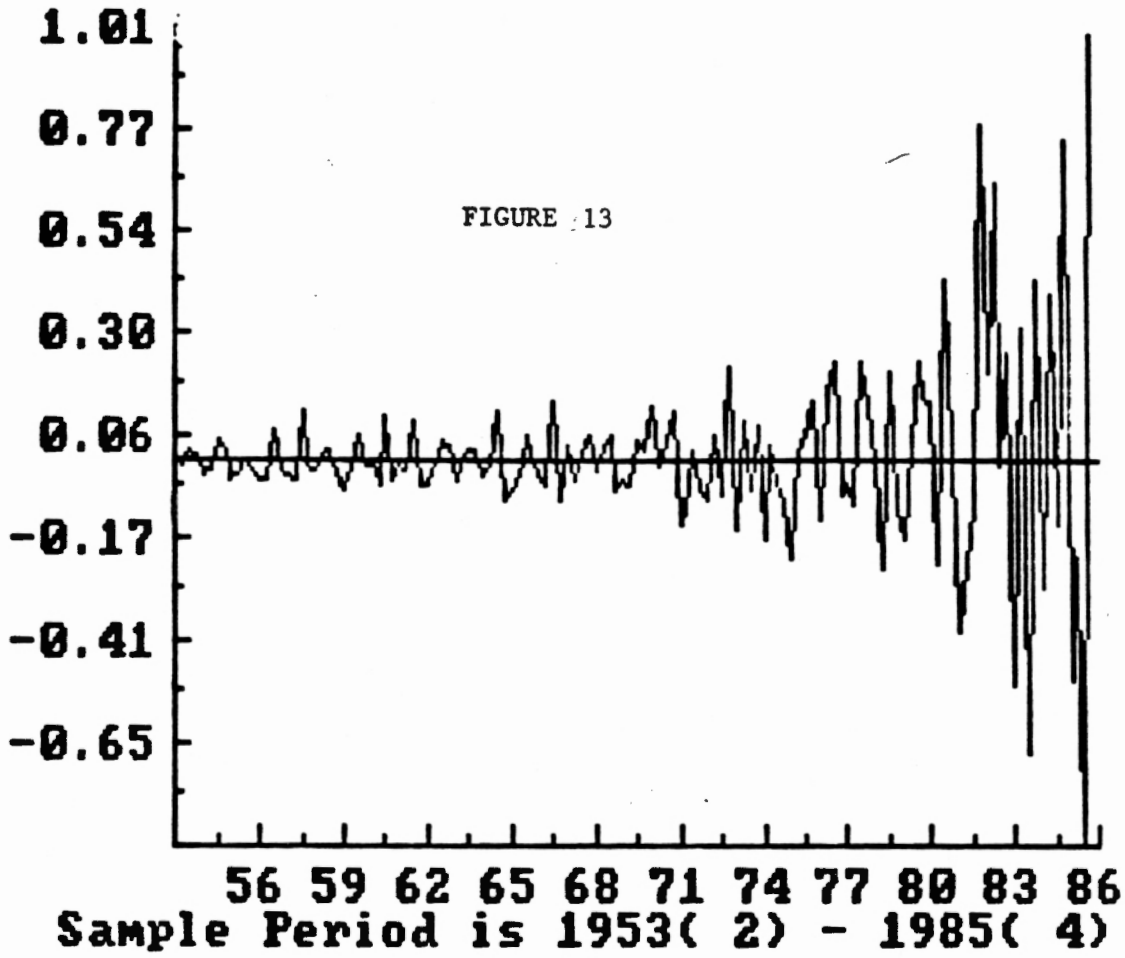


FIGURE 13

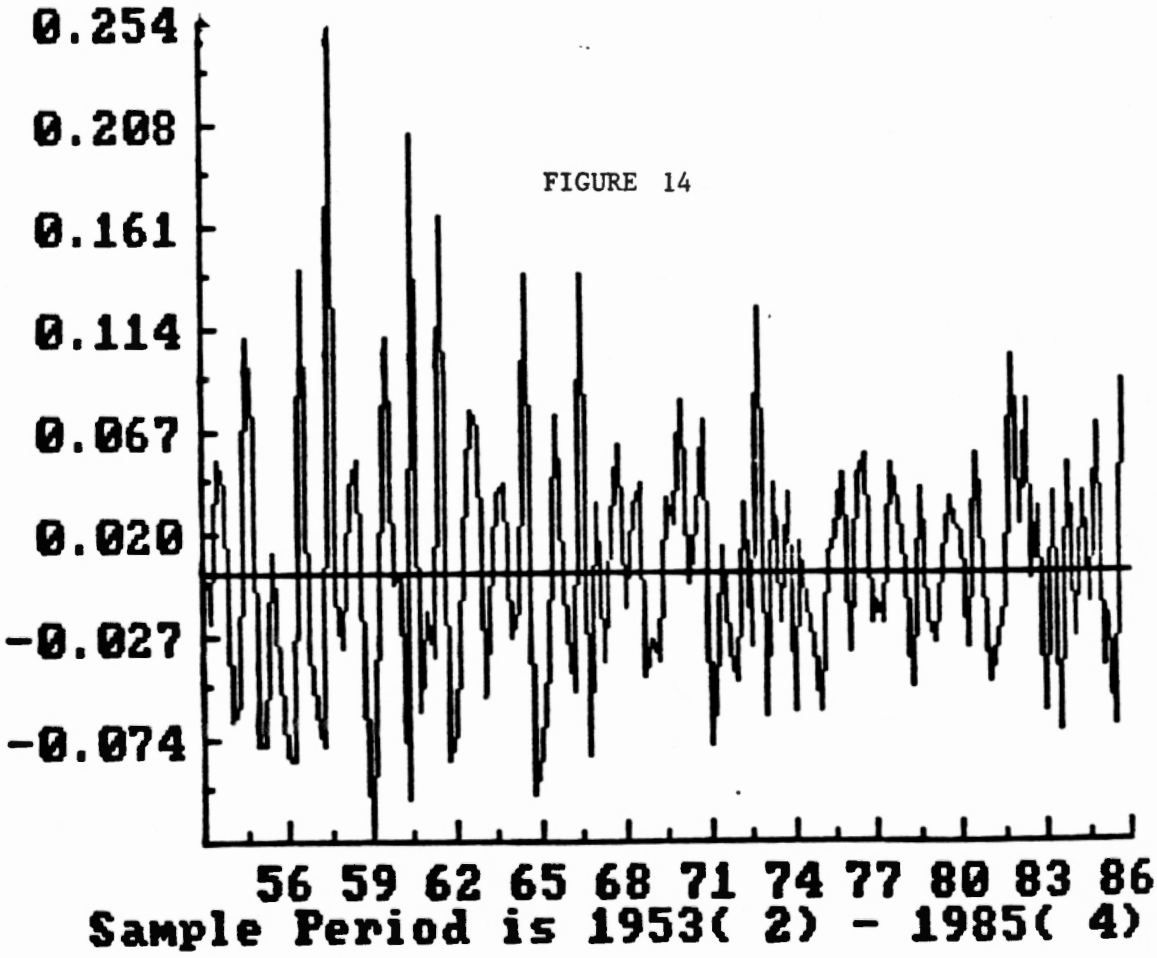


FIGURE 14

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