Do Stable Exchange Rates Lead to Stable Economies?

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The purpose of this paper is to empirically investigate whether or not there is a relationship between the exchange rate regime and the economic stability. This paper applies a conditional variance analysis and a change point analysis. The result shows that the exchange rate volatility is associated with the freedom of the float. However, the effect of the exchange rate regime on other variables is not clear and varies across countries. Although there are volatility changes in economic variables accompanying the regime shift, the changes are not necessarily attributable to the regime shift occurred in the beginning of the 1970s. (*JEL* Classification: G20)

I. Introduction

A popular belief among international economists is that the transition from fixed to flexible exchange rate regimes, which occurred in the beginning of the 1970s has brought about a structural change in the behavior of economic variables. One of the most well-known empirical studies was done by Mussa (1986), who found that there are important and systematic differences in the behavior of exchange rates between fixed and flexible exchange rate regimes. Recent studies of the EMS experience, including Giavazzi and Pagano (1988), have also asserted that the EMS itself has reduced inflation, as well as the exchange rate fluctuations.

On the other hand, many studies claim that the shift in the exchange rate regime is not necessarily accompanied by a structural change in the economy. Theoretical models that embody the neutrality of the nominal exchange rate regime (Frenkel 1978; Stockman 1980) carry

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this implication. The empirical studies on the EMS by Rogoff (1985), Collins (1988), and Fratianni and von Hagen (1990) also support this position.

Thus, it is questionable whether the exchange rate regime affects the behavior of macroeconomic variables. The question must ultimately be answered on the basis of empirical grounds. Though there are many empirical studies on the EMS experience, there are only a few systematic empirical studies on the Bretton Woods/post Bretton Woods era experience. One of the few exceptions is Gerlach (1988), who found that the variances in the monthly growth rates are typically higher in the flexible exchange rate period than in the fixed exchange rate period. On the other hand, Baxter and Stockman (1988) found little evidence of systematic differences in the behavior of macroeconomic aggregates, with the exception of the exchange rate under alternative exchange rate regimes. Eichengreen (1994) also argued that empirical evidence on macroeconomic performance under different exchange rate regimes challenges the conventional wisdom that periods of fixed exchange rates are associated with output stability and that exchange rate flexibility minimizes the international transmission of business-cycle disturbances.

The purpose of this study is to empirically investigate the relationship between the exchange rate regime and the volatility of macroeconomic variables under alternative exchange rate regimes since World War II. In this sense, it is in line with Eichengreen (1994), whose analysis is based on the comparison of unconditional variances under different regimes. His approach, however, is fraught with pitfalls because it does not show the influence of unanticipated disturbances, which economists are more concerned with (Rogoff 1985), and because economists are far from certain about the correct statistical distribution of exchange rate changes. This paper intends to resolve these problems by adding an uncertainty comparison and by applying a non-parametric test for structural change. In particular, we focus on whether the stabilization of exchange rates is associated with the stabilization of other macroeconomic variables,.

In Section II, we first present the results from examining the usual unconditional variances under alternative exchange rate regimes. This is followed by the uncertainty comparison through conditional variances. In Section III, we provide the results of a non-parametric test for structural change and examine whether the structural change of a variable coincides with the regime shift. Section IV draws some conclu-

sions from these results.

II. The Volatility of Macroeconomic Variables

A. Unconditional Variances

A simple way to examine the differences in the volatility of economic variables under alternative exchange rate regimes would be through a purely descriptive, statistical approach.

Table 1 reports variances of real interest rates and log-differenced nominal exchange rates, prices, and output.[1] It appears that exchange rates and prices are more volatile under flexible than fixed exchange rate regimes, while interest rates and output do not show a clear pattern.[2]

The assertion that the fluctuation of exchange rates and prices is regime-dependent can be criticized in the following way. If the time series processes vary with respective exchange rate regimes, then variances of the variables may not be a valid indication of their volatility. To deal with the problem of variation in time series processes, we added two analyses. First, we excluded the periods, 1973: III through 1975: IV and 1979: I through 1981: IV, when the influence of the supply shocks was prevalent. Second, the EMS evidence was also examined.

These additional analyses[3] all support the hypothesis that the difference in the exchange rate volatility is so substantial and systematic under different exchange regimes that exact statistical characterization

[1]The period covered in the table is from 1957 to 1993. There are two popular methods of detrending nonstationary variables: taking differences and removing deterministic linear trends of the log-variables. Baxter and Stockman (1988) show that the results from different detrending methods do not substantially differ. See the appendix for data description.

[2]Unlike this result, Baxter and Stockman (1988) reported that in the post Bretton Woods era, about three-quarters of the countries in their sample experienced an increase in the volatility of industrial production. However, when we carefully look at the result, the conclusion is not as strong as they derived. Among fourteen countries, eight countries show an increase in volatility. Out of those eight countries, only one country (Luxembourg) showed a significant increase in volatility. In the other seven countries, the hypothesis of no change in volatility was not rejected at five percent significance level.

[3]The result of these analyses is not reported but available from the author upon request.

TABLE 1-a

VARIANCE OF NOMINAL EXCHANGE RATE CHANGES ($\times 10^{-3}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	0.000	0.867	0.097	0.001	0.000	0.224	0.255
FLEX	0.244	2.705	2.788	2.712	2.555	3.001	1.066
P-value	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**

TABLE 1-b

VARIANCE OF INTEREST RATES ($\times 10^{-5}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	1.763	13.600	4.638	n.a.	13.600	7.190	1.794
FLEX	7.707	8.434	4.615	18.700	14.500	26.000	6.039
P-value	0.000**	0.022*	0.485	n.a.	0.403	0.000**	0.000**

TABLE 1-c

VARIANCE OF INFLATION RATES ($\times 10^{-4}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	0.183	1.361	0.402	0.668	1.120	0.868	0.446
FLEX	0.856	1.040	0.399	2.260	2.110	2.890	0.719
P-value	0.000**	0.127	0.480	0.000**	0.005**	0.000**	0.023*

TABLE 1-d

VARIANCE OF OUTPUT GROWTH RATES ($\times 10^{-4}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	0.736	6.280	1.810	2.440	2.100	1.110	0.901
FLEX	1.430	0.404	1.070	0.876	2.350	1.370	0.965
P-value	0.021*	0.000**	0.019*	0.000**	0.328	0.199	0.388

Notes: P-value is the marginal significance level of rejecting the equality of variances between the fixed(FIX) and flexible(FLEX) regimes. 0.000 implies that P-value is less than 0.001. * and ** imply statistical significance at 5 and 1 percent levels respectively.

Source: IFS.

of these differences is not necessary to address the relationship of the exchange rates with the regime. However, the regime-dependence of inflation rates has been significantly weakened. First, when the turbulent periods of the first and second oil shocks were disregarded, Japan and the U.S.A. no longer showed increases and, in fact, France and the U.S.A. experienced significant *reductions* in price volatility in the post-

Bretton Woods era. Second, the vast empirical literature[4] on the EMS experience found that the disinflationary force of the EMS seemed less evident than commonly believed. The empirical evidence is "consistent with the view that inflation rates in the OECD countries declined after 1980 in a common response to two main factors which are independent of the EMS: ... The EMS, in contrast, may have been neutral with respect to reducing the rate of inflation."[5] Thus, it is difficult to support with confidence the regime dependent theory, which states that the volatility difference of economic variables is attributable to the exchange rate regime, except exchange rates.

B. Conditional Variances

Rogoff (1985) noted that in most macromodels, unanticipated disturbances have far greater effects than anticipated disturbances. Thus, it is of greater interest to compare different exchange rate regimes through conditional variances rather than unconditional variances of the variables. To measure unanticipated movements (or uncertainty) in the variables, a specific forecasting model is required. Following Rogoff, we used a VAR (vector autoregression),[6] which includes exchange rates, money, interest rates, prices, output, and government expenditure. The VAR includes contemporaneous values and two lags of each variable.[7]

Table 2 shows the conditional variances of exchange rates, interest rates, inflation rates, and output growth rates, derived from the estimated prediction errors of the VAR. The uncertainty of exchange rates is greater under flexible than fixed exchange rate regimes. Interest and inflation uncertainties have also significantly increased in most countries in the post Bretton Woods era, while there was no change in Japan and the U.S.A. On the other hand, output uncertainty was significantly larger in Canada, while it was significantly smaller in France,

[4]For example, see Rogoff (1985) and Fratianni and von Hagen (1990).

[5]Fratianni and von Hagen (1990).

[6]Some studies, including Artis and Taylor (1988) and Fratianni and von Hagen (1990), use an ARCH (autoregressive conditional heteroscedastic) model instead of a VAR to forecast unanticipated errors. The two methods produce similar results.

[7]Rogoff (1985) includes the real exchange rate, the interest rate differential, the inflation rate differential, and the difference between the home and the foreign trade balance in his VAR. His VAR also incorporates up to two lags of each variable.

TABLE 2-a

CONDITIONAL VARIANCE OF NOMINAL EXCHANGE RATE CHANGES ($\times 10^{-3}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FIEX	0.194	2.052	2.045	2.196	2.092	2.412	0.830
P-value	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**

TABLE 2-b

CONDITIONAL VARIANCE OF INTEREST RATES ($\times 10^{-5}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	1.061	0.771	1.719	n.a.	8.746	6.361	1.177
FLEX	2.912	2.181	2.743	5.317	7.865	13.889	1.661
P-value	0.001**	0.000**	0.031*	n.a.	0.323	0.001**	0.074

TABLE 2-c

CONDITIONAL VARIANCE OF INFLATION RATES ($\times 10^{-4}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	0.135	0.085	0.149	0.456	0.838	0.618	0.122
FIEX	0.294	0.214	0.239	0.706	0.820	1.312	0.176
P-value	0.009**	0.029*	0.030*	0.040*	0.457	0.001**	0.062

TABLE 2-d

CONDITIONAL VARIANCE OF OUTPUT GROWTH RATES ($\times 10^{-4}$)

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
FIX	0.504	2.189	1.383	2.336	1.508	0.839	0.665
FLEX	1.071	0.210	0.804	0.505	2.126	1.037	0.680
P-value	0.011*	0.000**	0.016*	0.000**	0.084	0.198	0.464

Notes; 0.000 implies that P-value is less than 0.001. * and ** imply statistical significance at 5 and 1 percent level respectively.
Source: IFS.

Germany, and Italy in the post Bretton Woods era.[8]

But the difference in the uncertainty between fixed and flexible regimes may also be due to different experiences under different regimes. To handle the effect of different experiences, which may be

[8]This result is similar to those of Bordo (1993) and Eichengreen (1994). They found that output volatility fell with the transition from Bretton Woods to floating, when the first-difference filter was used.

independent of the exchange rate regime, we again carried out two analyses as in the previous sub-section. The analyses also support that the exchange rate uncertainty is associated with the exchange rate regime. When we ignore the oil shock periods, however, the significant increase in inflation uncertainty in Germany and the U.K. then disappears and inflation uncertainty decreases significantly in Japan after the regime shift. This result leads to the conclusion that exchange rate uncertainty is associated with the freedom of the exchange rate float, while the uncertainty in other macrovariables cannot clearly be related to the exchange rate regime.

III. A Non-parametric Test for Volatility Change

The analysis in Section II tends to be rather descriptive in nature, without rigorously testing an existence of structural change. In this section, we present a formal test result on whether there has been a volatility change in a variable's process and examine whether the change, if any, is associated with the exchange rate regime shift.

Common assumptions of the empirical literature on the comparison of alternative exchange rate regimes are that the distribution of macroeconomic variables and the timing of structural change in their behavior are known a priori. Unfortunately, in practice, the distribution of economic variables is not generally known and neither is the timing of their structural change. When we are ignorant of the distribution and the change point, the following statistical test and inference would not be meaningful. Also, the identification of whether the structural change in economic variables is due either to the regime shift or to the experience of different shocks irrelevant to the regime itself (for example, oil shocks) would not be possible.

In order to circumvent these problems, Artis and Taylor (1988) carried out a non-parametric test for volatility shift in exchange rates in the EMS. Their appreach assumes, however, that there is a structural shift, if any, corresponding to the shift of the exchange rate regime. Since it is not clear when a structural change of an economic variable occurs, this paper undertakes a non-parametric analysis, borrowing the technique used in the change point problem literature in which the change point is assumed to be unknown a priori.

A. The Methodology

Consider a set of economic time series data, $x_1,\ldots,x_T$ In the absence of knowledge of the distributions of the data, it seems unrealistic to test a structural change postulating specific distributional forms of the data. The following procedure does not assume any specific distributional forms except that the distribution function is continuous.

The data is said to have a change point at t ($1 \leq t \leq T$) if $x_1, \ldots, x_t$ have a common distribution function F_1 while the distribution of $x_{t+1},\ldots, x_T$ is F_2. F_1 and F_2 are assumed continuous but are otherwise unspecified. For any fixed integer t, H_0: $F_1 = F_2$ that there is no change at time t is to be tested against H_1: $F_1 \neq F_2$ that there is a change at time t. Let

$$u_t = \sum_{i=1}^{t} \sum_{j=t+1}^{T} D_{ij} \tag{1}$$

where $D_{ij} = sign(x_i - x_j)$ where $sign(x) = 1$ if $x > 0$, 0 if $x = 0$, and -1 if $x < 0$. For the test of changes in either direction, Pettitt (1979) proposed the use of the statistic which is a version of Mann-Whitney two sample test statistic[9]

$$K_T = \max_{1 \leq t < T} | u_t | \tag{2}$$

and for changes in one direction, the statistic

$$K_T^+ = \max_{1 \leq t < T}(u_t), \tag{3}$$

$$K_T^- = -\max_{1 \leq t < T}(u_t). \tag{4}$$

One would expect to find K^+ (or K^-) large if $F_1 \leq F_2$ (or $F_1 \geq F_2$). Under the null hypothesis H_0, $E(D_{ij}) = 0$ and the distribution of u_t is symmetric about zero for each t. Thus K's have a small null distribution.[10]

[9]There are other kinds of rank statistics used for testing structural change. For example, Lombard (1986) uses

$$u_t^2 = \frac{\left\{\sum_{i=1}^{t} \cos\left(\frac{2\pi r_i}{T}\right)\right\}^2 + \left\{\sum_{i=1}^{t} \sin\left(\frac{2\pi r_i}{T}\right)\right\}^2}{t(T-t)} \qquad t = 1,\ldots, T-1,$$

where r_i denotes the number of x's which are less than or equal to x_i. For a literature review, see Wolfe and Schechtman (1984).

[10]The significance probabilities associated with $K = k$'s are approximately given by $p = 2 \exp\{-6K^2/(T^3+T^2)\}$ and $p = \exp\{-6k^2/(T^3+T^2)\}$ respectively, for K_T

An intuitively sensible estimate $\hat{t}$ of a single, unknown change point is the t for which u_t is most significant. If there is only one change point, a graph of u_t against t will typically exhibit a single prominent maximum. On the other hand, the presence of several prominent local maxima at widely separated values of t is usually an indication that multiple change points are present.[11]

Using K_T and $\hat{t}$, the issue of whether the shift from fixed to flexible regimes accompanies an increase or decrease in the volatility of macroeconomic variables can be examined. If the assertion that the shift from fixed to flexible regimes accompanies a rise in volatility is to be true, it needs to pass the following three tests. First, K_T should be significant, which implies that there was a significant structural change. Second, u_t corresponding to K_T should be positive, which implies that the volatility increased after the change. Third, $\hat{t}$ should coincide with the time of the exchange rate regime shift, which implies that the volatility change accompanies the exchange rate regime shift.

B. Empirical Evidence

Table 3 shows the empirical results of the analysis. Based on the table, we can examine whether the results satisfy the above conditions.

The values of K_T for exchange rates in Table 3-a are very large in all countries. The approximate significance probabilities are all less than 0.001. This indicates that exchange rates have experienced a structural change. The last row of the table shows the time when u_t obtains the maximum value of K_T In all cases the timing of a structural change in exchange rates matches the date of the exchange rate regime shift. This result is confirmed using a plot of u_t. Figure 1 plots the u_t's for exchange rates. The figure shows a very clear peak in every country, which implies that there is a clear structural change in the behavior of exchange rates. The peak times correspond to the dates when those countries shifted the exchange rate regimes.

Interest rates also show an increase in volatility in all countries except Japan where the volatility decreased. Unlike the regime dependent theory argument, however, it is not the exchange rate regime shift that caused the volatility change in interest rates. In most countries, K_T's were obtained around the beginning of the 1980s (Figure 2). This

and K_T^+ (or K_T^-). See Pettitt (1979).

[11]Hinkley (1970) introduces a parametric method to estimate $\hat{t}$

TABLE 3-a

K_T FOR EXCHANGE RATE CHANGES

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
K_T	3,376	4,448	4,782	5,100	5,130	4,174	5,072
P-value	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
TIME	70: I	71: IV	71: I	71: III	71: II	71: II	74: II

TABLE 3-b

K_T FOR INTEREST RATE

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
K_T	3,936	3,886	2,628	1,346	-1,634	2,652	2,218
P-value	0.000**	0.000**	0.000**	0.000**	0.007**	0.000**	0.000**
TIME	80: III	81: III	80: I	83: I	64: III	73: I	79: I

TABLE 3-c

K_T FOR INFLATION RATES

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
K_T	-1,976	1,609	-939	-2,354	1,116	-1,133	-2,037
P-value	0.000**	0.008**	0.191	0.000**	0.008**	0.090	0.000**
TIME	82: III	73: II	82: I	83: I	72: IV	80: II	83: I

TABLE 3-d

K_T FOR OUTPUT GROWTH RATES

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.
K_T	768	-570	-524	-1,790	-1,438	-1,342	-1,758
P-value	0.331	0.281	0.514	0.000**	0.021*	0.034*	0.003**
TIME	80: I	73: I	70: II	78: III	75: II	81: III	84: II

Notes: 1. K_T is the non-parametric test statistic for testing a structural change introduced in Equation (2) of the text. P-value, calculated from the expression in footnote 10, is the marginal significance level of rejecting 'no structural change' in a variable. * and ** imply statistical significance at 5 and 1 percent level respectively. TIME is the period when K_T is obtained.

2. Each country changed its exchange rate rete regime in the following period: Canada (1962: III from flexible to fixed, 1970: II from fixed to flexible), France (1971: IV), Germany (1971: II), Italy (1971: III), Japan (1971: III), the U.K. (1971: III), and the U.S. (1974: III).

Source: IFS.

suggests that financial innovations, capital flow liberalization, and monetary policy changes of the 1980s may have influenced the behav-

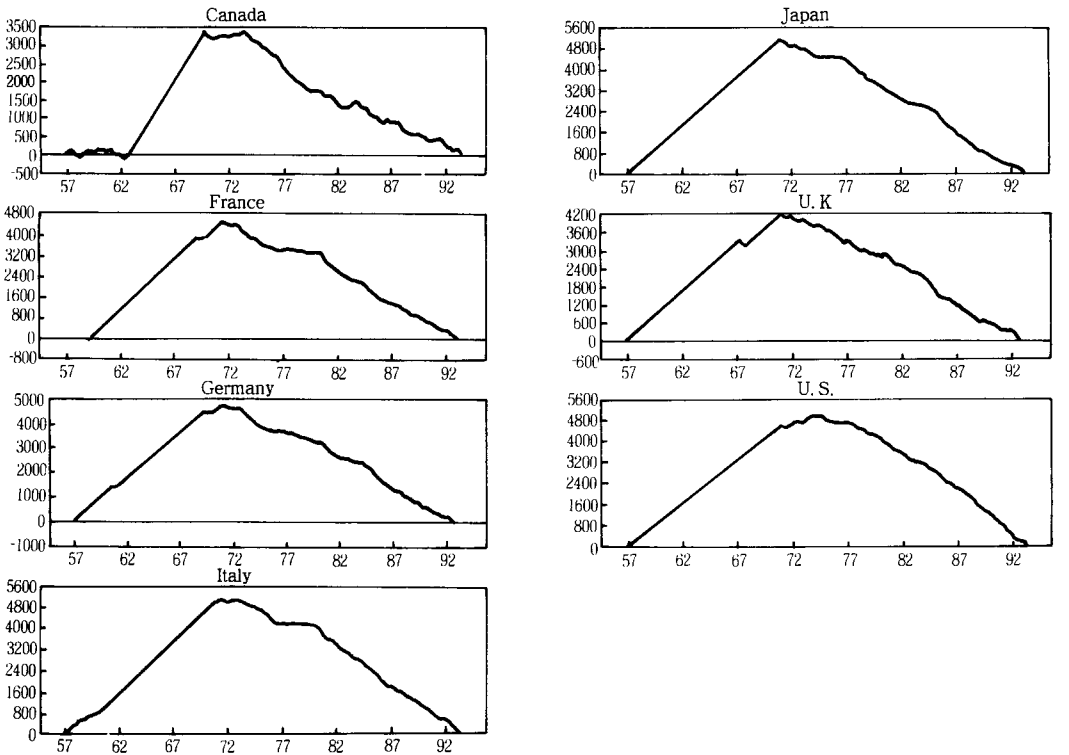

FIGURE 1

U_t: EXCHANGE RATE

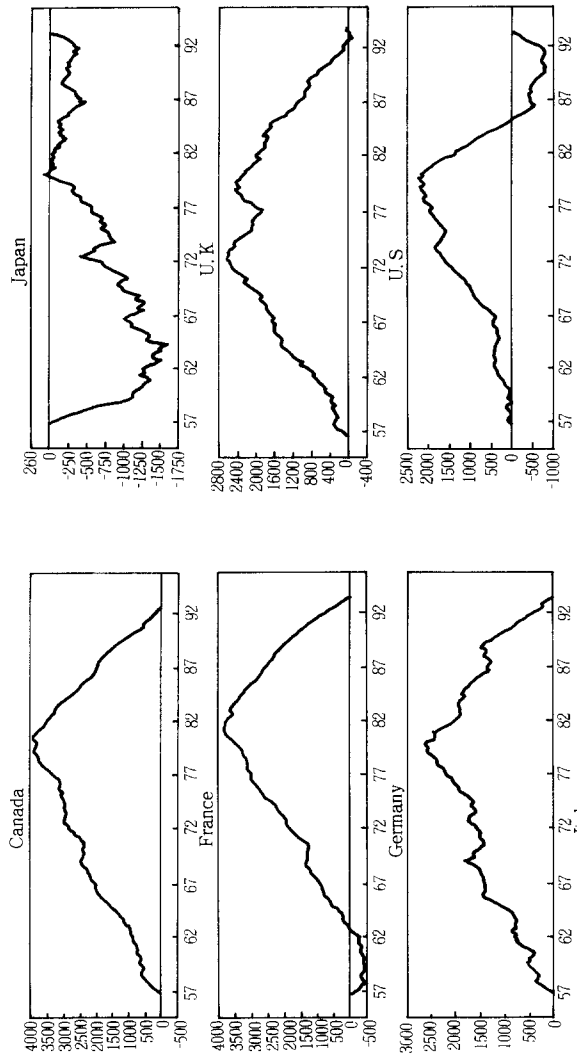

FIGURE 2

U_t: INTEREST RATE

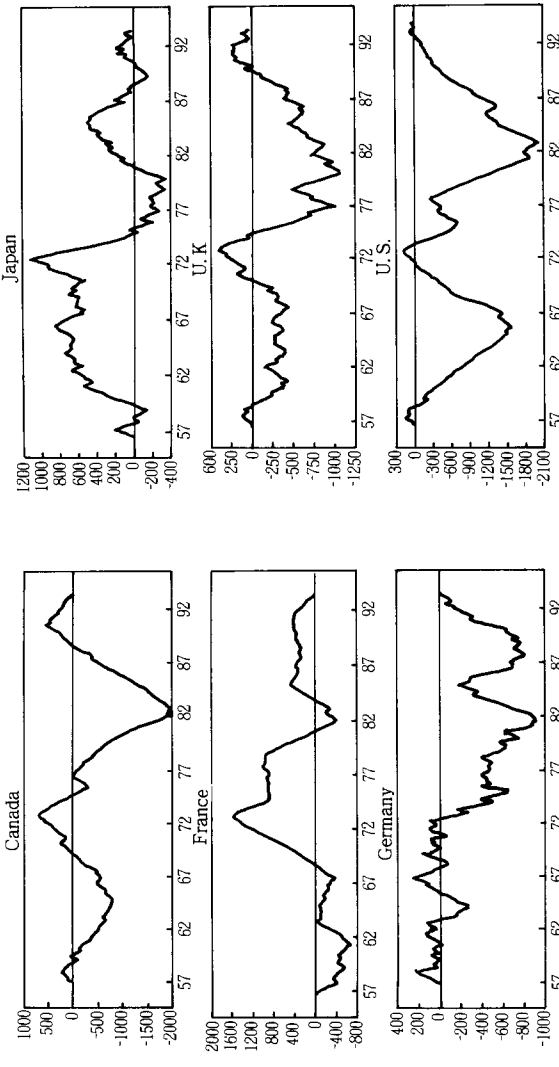

FIGURE 3
U_t: INFLATION

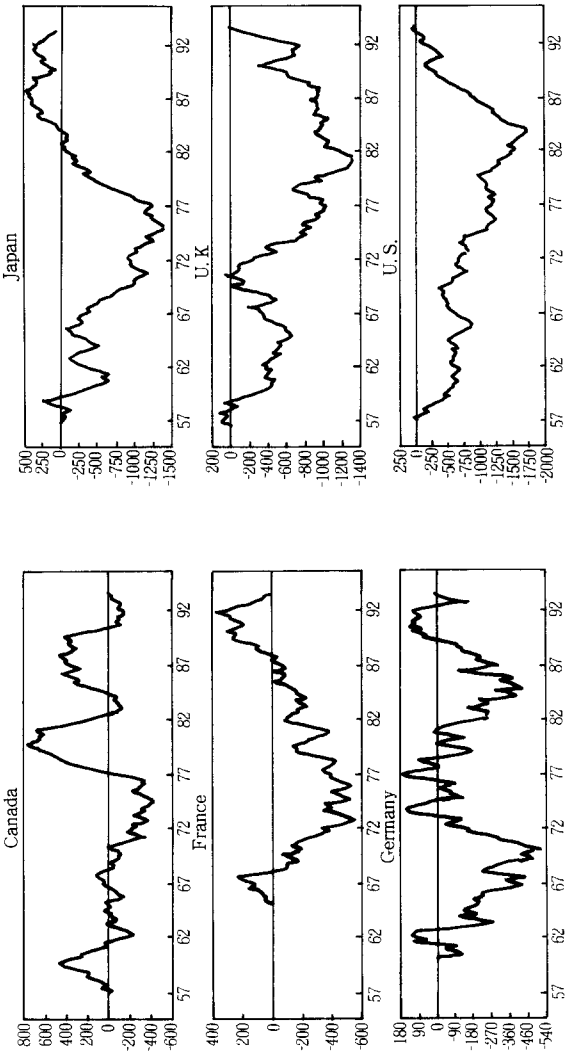

FIGURE 4
U_t: OUTPUT

ior of interest rates.

K_Ts for inflation rates in Table 3-c are also significant in most countries. The hypothesis that there was no structural change in the inflation series was not rejected in only Germany and the U.K. This does not, however, imply that the exchange rate regime shift may lead to an increase in price volatility. The suggested timing of change occurs after the second oil shocks in five countries and the corresponding u_t's are not positive but negative (Figure 3). Together with Table 1-c and 2-c, the result suggests that the most significant factor influencing price volatility is the oil shocks. Thus, the bigger variance and uncertainty in Table 1-c and 2-c under the flexible regime was obtained not because exchange rates became flexible, but because the oil shocks are unique in the post-Bretton Woods era.

In four countries, Italy, Japan, the U.K., and the U.S.A., output series have experienced significant structural changes (Table 3-d). The K_T values for these countries are large enough to have a statistical significance at 5 percent level while in other countries, the hypothesis of no change is not rejected. In the countries with significant changes, the corresponding u_t's are negative, which implies that output volatility has decreased after the structural change. In Italy, Japan, and the U.K., structural changes in output movements coincide with the oil shocks (Figure 4), while the change occurs in 1984 in the U.S.A. This may suggest that the oil shocks influenced the behavior of output in most countries. In the case of U.S.A., it employed an active anti-inflation policy for a while after the second oil shock and the economy was depressed longer, only to recover a stationary growth path in a few years around 1984. Thus, the regime dependent theory, which stipulates an association between the exchange rate regime and the volatility of output, is not supported by the data. As Eichengreen (1994) argues, "there is no evidence that output volatility increased with the shift from pegged to floating rate regimes after 1972; if anything, the opposite may have been true."

IV. Conclusion

This paper examined whether the shift of the exchange rate regime has implications on the behavior of economic variables. Major findings are as follows. The effect of the exchange rate regime on exchange rates is clear and universal: a flexible exchange rate regime leads to more flactuations in exchange rates. The effect of the exchange rate regime

on the volatility of other variables is not clear and varies across countries. The in-creased volatility of interest rates under flexible regimes may be due to financial innovations, capital flow liberalization, and monetary policy changes of the 1980s, rather than the exchange rate regime shift. The more volatile price in the post-Bretton Woods era is not attributable to the regime shift but to the oil shocks. Output volatility has not increased in the post Bretton Woods era; if anything, the opposite may have been true.

These findings have an important implication on the current debate on reforming the exchange rate regime. If the monetary authority is interested in the stability of key macroeconomic variables, the policy scope must extend beyond the choice of an exchange rate regime. This paper suggests that the choice between a fixed or a flexible regime would not make much difference. Although the current regime has exhibited many serious problems and the world economy may have been unstable under the current regime, this may reflect the misformulation of macroeconomic policies, not the malfunction of the exchange rate regime itself. Thus, a simple change of the regime may not be the way to achieve the objective of the authorities.

Appendix

All the date is from the IFS. The period covered in the empirical analysis is from 1957 to 1993.

Exchange rate: the quarterly average of the nominal bilateral exchange rate against the US dollar. For the U.S., it is against the SDR.

Money: M1.

Interest rate: the quarterly average of the treasury bill rate for Canada, the U.K., and the U.S.; and the quarterly average of the call money rate for France, Germany, Italy, and Japan.

Price: the quarterly average of the consumer price index with 1985 as the base year.

Income: the quarterly gross national product at the 1985 price for Canada, Germany, Japan, and the U.S. For France, Italy, and the U.K., it is the quarterly gross domestic product at the 1985 price.

Government expenditure: the quarterly government consumption.

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