Are international business cycles different under fixed and flexible exchange rate regimes?

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Introduction and summary

By the year's end, Europe will have taken the final step in the most ambitious monetary experiment of the postwar era by establishing a common currency area (the European Monetary Union [EMU]), an extreme form of fixed exchange rate regime in which member countries use the same currency. There is a widespread belief that countries tied to a fixed exchange rate regime are more susceptible to foreign disturbances, particularly monetary disturbances. In other words, there is a belief that flexible exchange rates offer greater insulation from foreign disturbances. A major concern surrounding the EMU and fixed exchange rate regimes, in general, is that business cycles of member countries may become more volatile under a common currency or fixed exchange rate because they are not only subject to domestic shocks but also have increased sensitivity to foreign disturbances.

This conventional view of fixed versus flexible exchange rate regimes stems more from anecdotal evidence than statistical evidence. Two recent events support this view. First is the experience of the United Kingdom (UK) and its continental counterparts in the 1990s. Member countries of the European Exchange Rate Mechanism (ERM), which stayed tied to the German mark (DM) after German reunification, were forced to tighten monetary policy and suffered a severe and persistent economic downturn that is only now abating. The UK chose to leave the ERM in 1992 and devalue against the DM rather than raise domestic interest rates to maintain its currency peg with the DM. Unlike its continental counterparts, the UK experienced a strong recovery in the early 1990s, which has carried through to the present. Second, severe economic downturns in Mexico in 1994 and Asia in 1997 came about because of massive capital outflows and banking collapses that flowed from currency crises involving a U.S. dollar exchange rate peg that was inconsistent with the market's desired level. Looking to the past, monetary historians like Eichengreen (1992) frequently argue that countries that abandoned the gold exchange standard experienced an economic downturn that was far less severe than that of countries which stayed pegged to the United States' currency during the depression of the 1930s.

One empirical observation that seems to be at odds with this view is the emergence of a stronger international business cycle after the abandonment of the fixed exchange rate regime (which had been established by the Bretton Woods agreement in July 1944) in the early 1970s. The key stylized fact supporting this is the observed higher correlations between national output fluctuations of the U.S. and other G7 (Group of Seven) countries in the flexible exchange rate period from 1973 to the present, or the post-Bretton Woods (PBW) period, relative to the Bretton Woods (BW) fixed exchange rate period from 1949 to 1971. This evidence works against the conventional view of fixed versus flexible regimes because cross-country correlations of output fluctuations rise if the importance of global or foreign shocks rises. Moreover, it questions the

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insulation properties of flexible exchange rates over fixed exchange rates. This evidence also suggests that the behavior of international business cycles may be intimately related to the exchange rate regime.

This article offers an exploratory analysis of the link between exchange rate regimes and the behavior of international business cycles. I estimate statistical models of the U.S. and its G7 counterparts over the postwar fixed and flexible exchange rate periods. I use these empirical models to get a better sense of the factors underlying the higher degree of business cycle comovement between the U.S. and the other G7 nations in the PBW period. There are essentially four factors that would lead to higher correlations of U.S. and G7 industrial production: 1) an increase in the volatility of global disturbances (such as oil prices); 2) an increase in the volatility of U.S. disturbances that affect the rest of the G7 and an increase in the volatility of G7 disturbances that affect the U.S.; 3) increased sensitivity to G7 disturbances for the U.S. and increased sensitivity to U.S. disturbances for the rest of the G7; and 4) a change in U.S. and G7 responses to global or foreign disturbances, so that they became more alike.

My empirical results suggest that higher comovement emerged in PBW due to a combination of factors 2 and 4. First, the sensitivity to U.S. monetary policy shocks for the rest of the G7 remained unchanged over the fixed and flexible exchange rate regimes, but the volatility of shocks to U.S. monetary policy increased significantly in the flexible exchange rate period. This made U.S. monetary policy disturbances a more important source of variation for G7 industrial production and, in the process, raised the correlation between U.S. and G7 output fluctuations. Second, the responses of the G7 to all shocks, global and domestic, changed in the flexible regime so that they were more alike than in the fixed exchange rate period. One of the important findings of this study is that G7 sensitivity to foreign and domestic monetary policy shocks remained unchanged over the fixed and flexible exchange rate periods. This result questions conventional wisdom, which argues that flexible exchange rates insulate countries against foreign monetary shocks. It also suggests that the domestic impact of monetary policy is invariant to the exchange rate regime.

Overview of U.S.–G7 exchange rate regimes

In July 1944, representatives from 44 countries met in Bretton Woods, New Hampshire, to draft and sign the Articles of Agreement that established the International Monetary Fund.[1] The system set up by the Bretton Woods agreement called for fixed exchange rates against the U.S. dollar and an unvarying dollar price of gold of $35 an ounce. Member countries held their official international reserves in gold or dollar assets and had the right to sell dollars to the Federal Reserve for gold at the official price. The system was thus a gold exchange standard, with the dollar as its principal reserve currency.

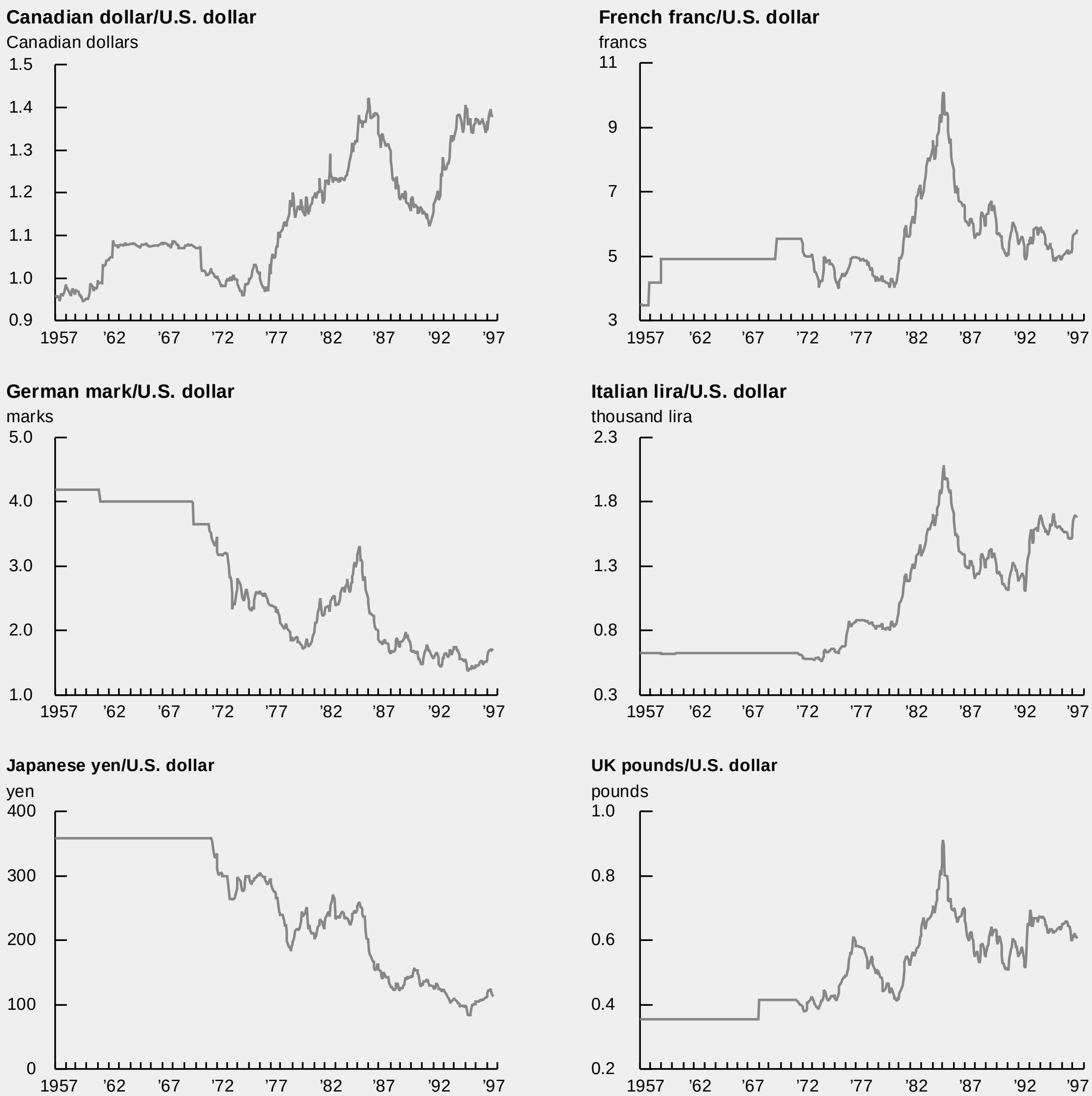
The earliest sign that BW was near collapse came in early 1968 when central bankers announced the creation of a two-tier gold market, with one private tier and the other official. Private traders traded freely on the London gold market and the gold price set there was allowed to fluctuate. In contrast, central banks would continue to transact with others in the official tier at the fixed price of $35 dollars an ounce. This came about because of speculation of a rise in the official gold conversion rate following the British pound's devaluation in November 1967. The gold exchange standard was intended to prevent inflation by tying down gold's dollar price. By severing the link between the supply of dollars and a fixed market price of gold, central bankers had removed the system's built-in safeguard against inflation.

The U.S. experienced a widening current account deficit in early 1971. This set off a massive private purchase of the DM, because most traders expected a revaluation of the DM against the dollar. By August 1971, the markets forced the U.S. to devalue the dollar and suspend gold convertibility with other central banks. Under the Smithsonian agreement in December 1971, the U.S. dollar was devalued roughly 8 percent against all other currencies. An ever-widening U.S. current account deficit led to further speculative attacks against the dollar in February 1973. By March, the U.S. dollar was floating against the currencies of Europe and Japan. This marked the official end of the fixed exchange period for the U.S., although one could argue that the U.S. abandoned fixed exchange rates in August 1971. In my analysis, I treat August 1971 as the end of the fixed exchange rate period and the period following January 1974 as the flexible exchange rate period, because all industrial countries had moved to flexible exchange systems by this date.

Over the last 100 years, the U.S. has participated in nine different exchange rate regimes with other G7 countries.[2] Many of these exchange arrangements emerged because of the disruption to currency markets caused by the two world wars. Exchange rate regimes are generally characterized as either fixed or floating. These labels are misleading as they suggest that fixed or floating regimes are perfectly homogeneous. In a fixed exchange rate system, currencies are pegged to some reserve currency. The pegged currency in the case of BW was the U.S. dollar. Alternatively, floating exchange rate regimes allow currencies to move freely against all currencies. Historically, exchange rate regimes have been somewhere in between these extremes. Figure 1 shows how the foreign currency / U.S. dollar rates of the UK, Germany, France, Italy, Japan, and Canada varied during the BW era. It is clear that the Canadian dollar / U.S. dollar rate was allowed to vary considerably over the period, while the other currencies were allowed large discrete devaluations / revaluations. Similarly, the regimes following BW were not pure floating regimes. What is immediately obvious from figure 1 is that exchange rate movements at all frequencies have been

FIGURE 1

Fixed versus flexible foreign exchange rates



Source: International Monetary Fund.

considerably more volatile under the flexible exchange rate regime.

Analyzing exchange rate regimes and international business cycles

There is a wealth of empirical research documenting the properties of macroeconomic time series from the postwar fixed and flexible exchange rate eras. For example, Baxter and Stockman (1989) investigate the differences in time-series behavior of key economic variables during the BW and PBW periods. Figure 2 shows selected data from Baxter and Stockman. In contrast to Baxter and Stockman, I find that the cross-country correlations of cyclical movements in U.S. and G7 industrial production are considerably higher in the flexible exchange rate period (see upper panel of figure 2).[3,4] The obvious exception is Canada. The correlation between Canadian and U.S. industrial production is roughly constant over the BW and PBW periods. Volatility statistics reported in the lower panel of figure 2 are similar to Baxter and Stockman's in suggesting that industrial production was more volatile in G7 countries in the flexible exchange rate period.

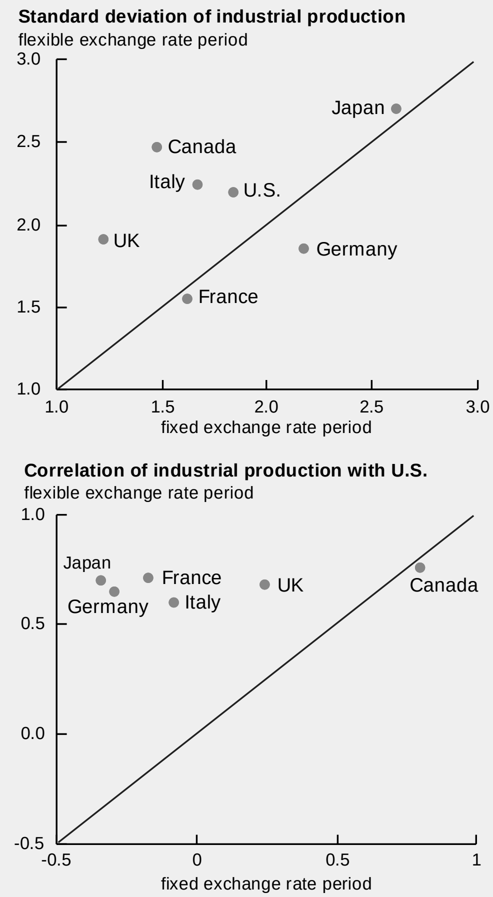
Given the relatively small sample size for the industrial output data, the correlations in the PBW period may be driven by one or two influential data points. I explore this issue in figure 3 by plotting cyclical fluctuations in G7 industrial production series over the fixed and flexible regimes. The low correlation between the U.S. and other G7 country industrial production (excluding Canada) is obvious in the BW period, the period before the solid vertical line. More importantly, the high correlation in the PBW period seems to be linked to the 1973–75 period, which coincides with the first oil price shock, and the 1979–83 period, which coincides with the second oil price shock and the period when the U.S. Federal Reserve experimented with direct targeting of monetary aggregates.

My findings add to similar results in the literature using other empirical techniques, such as frequency domain analysis. For example, Gerlach (1988) and Bowden and Martin (1995) find that the correlation between national output of the U.S. and that of various European countries has increased over so-called business cycle horizons ranging from one and a half years to eight years. Their analysis also suggests that the volatility of national output rose in the flexible period.

As many researchers have noted, work like that of Gerlach, Bowden and Martin, and Baxter and Stockman leaves open the question of whether the increased interdependence observed under the flexible exchange rates is attributable to a change in the response to underlying disturbances (which may have flowed from the move to a flexible exchange rate regime) or the changing nature of the underlying disturbances themselves. This question has been the focus of two different quantitative literatures.

FIGURE 2

International business cycles under fixed and flexible exchange rate systems



Note: Industrial production data filtered using the monthly business cycle band-pass filter described in Baxter and King (1995).

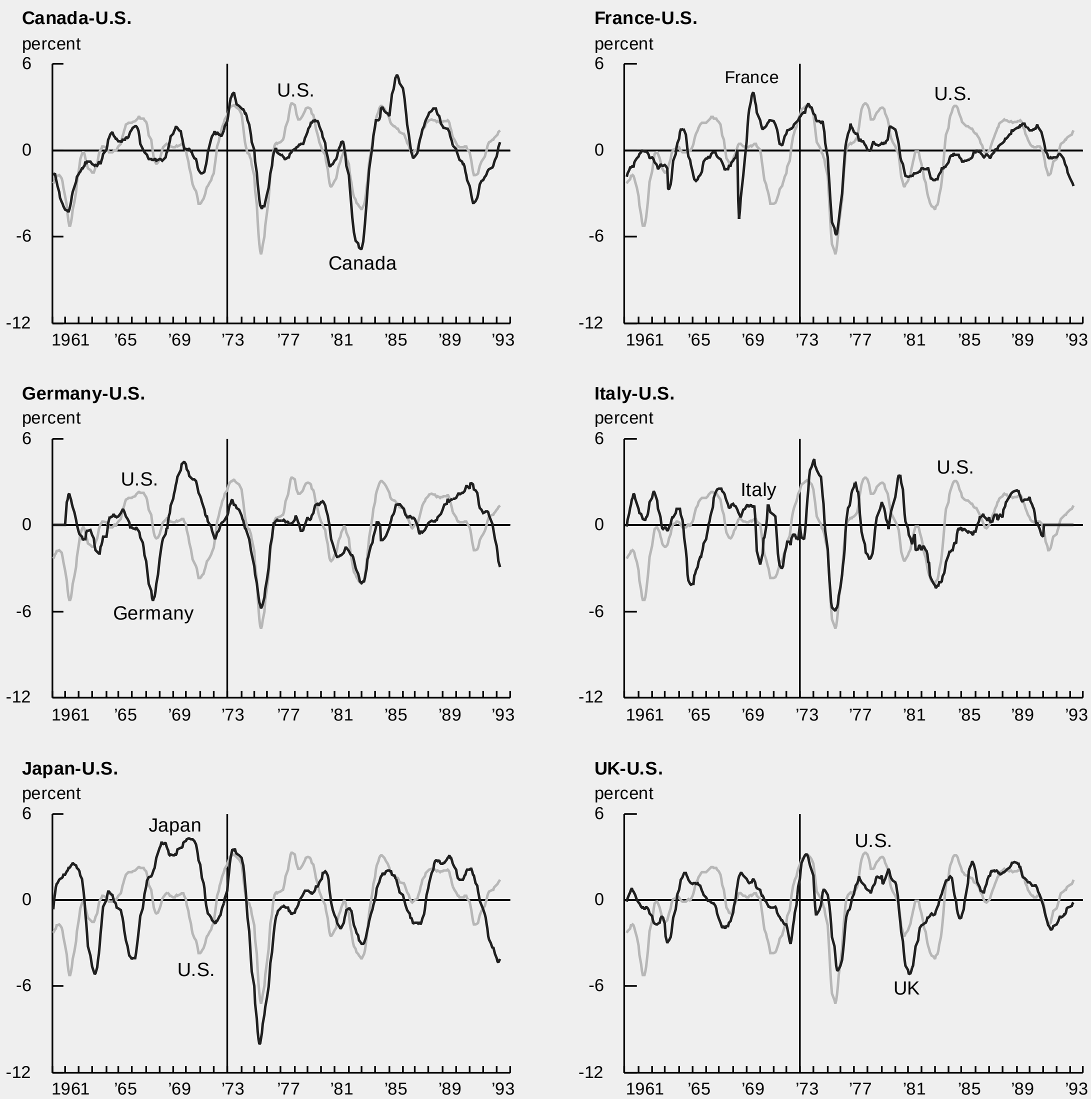
Source: Author's calculations using data from the International Monetary Fund.

Theoretical research on international business cycles

One branch has attempted to explain the international business cycle through quantitative theoretical models of international trade. So far these models are "real" in the sense that there is

FIGURE 3

Cyclical movements of U.S. and G7 industrial production



Note: Industrial production data filtered as in figure 2.
Source: Author's calculations using data from the International Monetary Fund.

no role for monetary disturbances. They completely ignore monetary aspects of the international business cycle by relying wholly on international business cycle transmission through real routes such as goods and asset trade. This literature was recently surveyed by Baxter (1995) and Backus, Kehoe, and Kydland (1995). They report that models that allow for realistic trade in capital are unable to generate international comovement. In contrast, less realistic models that ignore trade in capital goods, such as Stockman and Tesar (1995), have been shown to generate international comovement. Others (including Kouparitsas [1996]) have been successful at explaining positive output correlations between developing and industrial countries by allowing for trade in capital and intermediate goods. Unfortunately, the business cycle transmission mechanisms at work in these industrial and developing country trade models are absent in international trade between industrial countries. This analysis suggests that monetary or nominal factors may be an important component in explaining international business cycles of industrial countries.

Empirical research on international business cycles

Others have approached the issue by studying international business cycles within the context of structural econometric models.[5] For example, Hutchinson and Walsh's (1992) individual country analysis studies U.S.–Japanese business cycles over the fixed and flexible regimes. In addition, multicountry analyses, such as Ahmed et al. (1993) and Bayoumi and Eichengreen (1994), study U.S.–aggregate G7 business cycles. A common finding among these studies is that the nature of underlying disturbances changed over the fixed and flexible periods. In particular, global shocks became more volatile relative to national shocks. There is some disagreement over whether there was any change in the way the U.S. and G7 responded to these underlying disturbances when they shifted from fixed to floating rates. Ahmed et al. (1993) argue that there was no change in the response to shocks under the flexible regime. Hutchinson and Walsh (1992) and Bayoumi and Eichengreen (1994) argue that there were changes in the response to shocks in the flexible period. Hutchinson and Walsh find that flexible exchange rates afforded Japan some additional insulation from foreign disturbances, while Bayoumi and Eichengreen argue that the shift to flexible exchange rates steepened the aggregate demand curve of the G7, which tended to make prices more, and output less, sensitive to supply shocks.

My analysis is essentially a multicountry version of Hutchinson and Walsh (1992). I look at the behavior of U.S.–G7 business cycles by studying bivariate models for the six U.S.–G7 pairs. I adopt a slightly different structural model of the U.S. and G7 by drawing on the approach of Eichenbaum and Evans (1995), developed in their work on the link between monetary policy disturbances and exchange rate movements. Despite this difference, my results suggest that the findings from Hutchinson and Walsh's (1992) U.S.–Japan analysis extend to other G7 countries.

Methodology and data

One way of summarizing interactions among a set of variables is through a vector autoregression (VAR). A VAR is a statistical method that allows one to estimate how an unpredictable disturbance (or change) in one variable affects other variables in the economy. For example, one of the questions that is raised by theoretical research is whether a change in foreign monetary policy has a weaker effect on domestic industrial production under flexible exchange rates. A VAR can be used to answer this type of question, since it allows one to estimate the way that an unpredicted change in monetary policy affects domestic industrial production under a fixed or flexible exchange rate regime.

The choice of variables that one includes in a VAR depends on the questions one wants answered. There is a wide range of variables one can use in analyzing U.S.–G7 business cycles. I follow Hutchinson and Walsh (1992) by limiting my analysis of U.S.–G7 business cycles to six VARs, which essentially study interaction between the U.S. and a foreign country of interest, in this case Canada, France, Germany, Italy, Japan, or the UK. Each VAR is designed to study how unpredicted changes in world oil prices, U.S. and foreign industrial production, and U.S. monetary policy (ratio of nonborrowed reserves to total reserves) affect U.S. and foreign industrial production.[6]

One of the challenges facing researchers is that data for the BW period typically date back to 1960, which leaves a small sample of just under 12 years. I use January 1974 as the start date of the flexible period, because all of the G7 countries had moved to a flexible exchange rate system by then. PBW data run through to the present, so the sample size is over 20 years. Following Eichenbaum and Evans, I overcome these data limitations by using monthly data and restricting the VARs, so that they estimate relationships between the four variables with data from the previous six months. In other words, I estimate the link between movements in industrial production and oil price movements that occurred within the last six months.[7]

With these models in hand, I am able to address whether the higher degree of business cycle comovement between the U.S. and the other G7 nations in the PBW period is due to 1) an increase in the volatility of global disturbances (such as oil prices); 2) an increase in the volatility of U.S. disturbances that affect the rest of the G7 and an increase in the volatility of G7 disturbances that affect the U.S.; 3) increased sensitivity to G7 disturbances for the U.S. and increased sensitivity to U.S. disturbances for the rest of the G7; or 4) a change in U.S. and G7 responses to global or foreign disturbances, so that they became more alike. For instance, consider estimates of the VAR over the fixed and flexible exchange rate regimes. In this setting, differences in the relative volatility of disturbances across the two periods will be reflected in changes in the ratio of the standard deviations of unpredicted movements in oil prices, output, and monetary policy across the two periods. Differences in the way U.S. and foreign industrial production react to various disturbances will be embodied in the estimated parameters of the VAR and revealed through changes in the shape and size of the model's impulse response function. For a description of the methodology in greater detail, see the technical appendix.

Empirical results

I break my empirical analysis into three parts. First, I determine the sources of variation in industrial production of the U.S. and other G7 countries in the BW and PBW periods. Second, I highlight changes in the underlying disturbances by studying the variance of disturbances. Finally, I analyze whether the response to the disturbances changed over the BW to PBW period by comparing the shape of the impulse response functions from BW and PBW models.

Were foreign or global disturbances more important in the flexible exchange rate period?

Table 1 reports decompositions of forecast errors of industrial production for various U.S.–G7 pairs. These decompositions indicate the share of the error attributable to a particular disturbance for a given forecast horizon. The forecast error variance decompositions suggest that there was a change in the

TABLE 1

Forecast error variance decompositions for industrial production of G7 countries

U.S.–Canada model

U.S.

Months ahead	Oil prices Fixed	Oil prices Flexible	U.S. industrial production Fixed	U.S. industrial production Flexible	Canadian industrial production Fixed	Canadian industrial production Flexible	U.S. monetary policy Fixed	U.S. monetary policy Flexible
	Percentage of forecast error due to:							
3	5	0	92	98	1	2	2	1
6	4	0	93	90	1	8	2	2
12	5	2	77	63	9	10	9	25
24	18	10	27	26	19	4	36	60
36	26	12	15	16	29	2	30	70
60	36	13	7	10	42	3	15	74

Canada

Months ahead	Oil prices Fixed	Oil prices Flexible	U.S. industrial production Fixed	U.S. industrial production Flexible	Canadian industrial production Fixed	Canadian industrial production Flexible	U.S. monetary policy Fixed	U.S. monetary policy Flexible
	Percentage of forecast error due to:							
3	3	1	17	14	80	85	1	0
6	5	1	18	18	77	80	1	2
12	29	1	11	17	50	74	10	8
24	34	4	3	11	42	55	20	30
36	38	7	2	8	45	40	14	45
60	41	9	3	6	49	29	7	57

U.S.–Japan model

U.S.

Months ahead	Oil prices Fixed	Oil prices Flexible	U.S. industrial production Fixed	U.S. industrial production Flexible	Japanese industrial production Fixed	Japanese industrial production Flexible	U.S. monetary policy Fixed	U.S. monetary policy Flexible
	Percentage of forecast error due to:							
3	5	0	92	98	1	2	2	1
6	4	0	93	90	1	8	2	2
12	5	2	77	63	9	10	9	25
24	18	10	27	26	19	4	36	60
36	26	12	15	16	29	2	30	70
60	36	13	7	10	42	3	15	74

Japan

Months ahead	Oil prices Fixed	Oil prices Flexible	U.S. industrial production Fixed	U.S. industrial production Flexible	Japanese industrial production Fixed	Japanese industrial production Flexible	U.S. monetary policy Fixed	U.S. monetary policy Flexible
	Percentage of forecast error due to:							
3	4	1	0	8	95	91	0	0
6	2	0	0	12	97	88	1	1
12	1	1	1	11	98	83	0	6
24	2	6	7	6	89	57	2	31
36	4	9	23	4	62	39	12	48
60	5	11	31	4	38	30	26	55

Notes: The first column in each block refers to the number of months ($s = 3, 6, \ldots, 60$) ahead for the forecast. The upper panel of a block describes the decomposition of the forecast error for U.S. industrial production, while the lower panel of a block describes the decomposition of the forecast error for foreign country industrial production. Columns in the upper and lower panels indicate the percentage of the s step ahead forecast error arising from a particular structural disturbance in the fixed and flexible exchange rate models.

Source: Calculations from author's statistical model, using the following monthly data series: International Monetary Fund, world crude oil prices and G7 industrial production; and Federal Reserve Board of Governors, nonborrowed reserves and total reserves.

(Cont. on following page)

TABLE 1 (Cont.)

Forecast error variance decompositions for industrial production of G7 countries

U.S.–Germany model

U.S.

Months ahead	Oil prices: Fixed	Oil prices: Flexible	U.S. industrial production: Fixed	U.S. industrial production: Flexible	German industrial production: Fixed	German industrial production: Flexible	U.S. monetary policy: Fixed	U.S. monetary policy: Flexible
	Percentage of forecast error due to:							
3	5	0	92	98	1	2	2	1
6	4	0	93	90	1	8	2	2
12	5	2	77	63	9	10	9	25
24	18	10	27	26	19	4	36	60
36	26	12	15	16	29	2	30	70
60	36	13	7	10	42	3	15	74

Germany

Months ahead	Oil prices: Fixed	Oil prices: Flexible	U.S. industrial production: Fixed	U.S. industrial production: Flexible	German industrial production: Fixed	German industrial production: Flexible	U.S. monetary policy: Fixed	U.S. monetary policy: Flexible
	Percentage of forecast error due to:							
3	4	2	1	2	95	93	0	3
6	6	4	2	3	92	90	1	3
12	12	6	2	4	85	81	1	9
24	15	4	1	3	81	62	2	31
36	16	6	1	2	81	43	2	49
60	17	9	1	2	79	26	3	63

U.S.–UK model

U.S.

Months ahead	Oil prices: Fixed	Oil prices: Flexible	U.S. industrial production: Fixed	U.S. industrial production: Flexible	UK industrial production: Fixed	UK industrial production: Flexible	U.S. monetary policy: Fixed	U.S. monetary policy: Flexible
	Percentage of forecast error due to:							
3	5	0	92	98	1	2	2	1
6	4	0	93	90	1	8	2	2
12	5	2	77	63	9	10	9	25
24	18	10	27	26	19	4	36	60
36	26	12	15	16	29	2	30	70
60	36	13	7	10	42	3	15	74

UK

Months ahead	Oil prices: Fixed	Oil prices: Flexible	U.S. industrial production: Fixed	U.S. industrial production: Flexible	UK industrial production: Fixed	UK industrial production: Flexible	U.S. monetary policy: Fixed	U.S. monetary policy: Flexible
	Percentage of forecast error due to:							
3	0	3	2	5	97	91	0	1
6	1	5	3	5	96	89	0	1
12	11	5	9	7	77	80	3	9
24	12	6	11	4	60	54	17	35
36	12	8	12	3	57	38	19	51
60	12	11	15	3	50	25	23	62

(Cont. on following page)

relative importance of the various disturbances during the BW and PBW periods at forecast horizons of one to five years. The findings appear to be uniform across the six sets of bilateral pairs. From the perspective of the other G7 countries, foreign disturbances seem to play a larger role in the flexible exchange rate period. In particular, domestic industrial production disturbances clearly dominate shocks to oil prices, U.S. industrial production, and U.S. monetary policy in the fixed exchange rate period, but are a less important source of variation in the flexible exchange rate period. A similar result emerges for U.S. industrial production. Disturbances to U.S. industrial production are also a less important source of variation to U.S. industrial production in the flexible exchange rate period. The most striking result is the increased importance of U.S. monetary disturbances under the flexible exchange rate regime. Finally, in contrast to prior beliefs, the role of oil price disturbances is little changed across the two regimes. Overall, these results suggest that a greater share of the fluctuations in G7 industrial production seem to be driven by common sources of disturbance in the flexible exchange rate period. These findings are similar to those of Hutchinson and Walsh's (1992) Japanese study.

Forecast error variance decompositions point to the sources of variation in industrial output, but they do not answer the question of whether the changing character of the relative variance of disturbances or of the response to these disturbances is at the heart of the increased comovement of national outputs. To answer this question, I need to look at the variance of

TABLE 1 (Cont.)

Forecast error variance decompositions for industrial production of G7 countries

U.S.–France model

U.S.

Months ahead	Percentage of forecast error due to: Oil prices, Fixed	Oil prices, Flexible	U.S. industrial production, Fixed	U.S. industrial production, Flexible	French industrial production, Fixed	French industrial production, Flexible	U.S. monetary policy, Fixed	U.S. monetary policy, Flexible
3	5	0	92	98	1	2	2	1
6	4	0	93	90	1	8	2	2
12	5	2	77	63	9	10	9	25
24	18	10	27	26	19	4	36	60
36	26	12	15	16	29	2	30	70
60	36	13	7	10	42	3	15	74

France

Months ahead	Percentage of forecast error due to: Oil prices, Fixed	Oil prices, Flexible	U.S. industrial production, Fixed	U.S. industrial production, Flexible	French industrial production, Fixed	French industrial production, Flexible	U.S. monetary policy, Fixed	U.S. monetary policy, Flexible
3	1	4	1	6	96	90	2	0
6	2	8	1	8	93	82	4	2
12	4	11	1	11	91	71	4	7
24	5	9	5	10	85	54	4	27
36	7	11	9	7	76	40	8	42
60	8	15	14	5	65	29	14	52

U.S.–Italy model

U.S.

Months ahead	Percentage of forecast error due to: Oil prices, Fixed	Oil prices, Flexible	U.S. industrial production, Fixed	U.S. industrial production, Flexible	Italian industrial production, Fixed	Italian industrial production, Flexible	U.S. monetary policy, Fixed	U.S. monetary policy, Flexible
3	5	0	92	98	1	2	2	1
6	4	0	93	90	1	8	2	2
12	5	2	77	63	9	10	9	25
24	18	10	27	26	19	4	36	60
36	26	12	15	16	29	2	30	70
60	36	13	7	10	42	3	15	74

Italy

Months ahead	Percentage of forecast error due to: Oil prices, Fixed	Oil prices, Flexible	U.S. industrial production, Fixed	U.S. industrial production, Flexible	Italian industrial production, Fixed	Italian industrial production, Flexible	U.S. monetary policy, Fixed	U.S. monetary policy, Flexible
3	1	1	1	3	95	96	3	0
6	2	3	1	6	94	91	3	0
12	14	3	5	10	76	83	5	4
24	21	4	9	9	58	63	12	24
36	23	6	10	6	54	45	13	42
60	25	10	11	5	49	28	15	57

Note: See table 1, page 52 for notes and sources.

the disturbances and the impulse response functions of the models estimated over the fixed and flexible exchange rate periods.

Were global disturbances more volatile in the flexible exchange rate period?

Table 2 reports the ratio of the standard deviations of the various disturbances under the fixed and flexible exchange rate regimes. As expected, unexpected changes to oil prices are roughly ten times more volatile over the flexible period. In contrast, unexpected changes to U.S., Canadian, German, Italian, Japanese, and UK industrial production display roughly the same level of volatility across the periods, while unexpected changes to industrial production in France are considerably lower in the flexible period. Finally, unexpected changes to U.S. monetary policy are roughly twice as volatile in the flexible exchange rate period. Based on these findings, it is clear that for G7 countries (excluding the U.S.), foreign sources of disturbance became relatively more volatile in the flexible exchange rate period.[8] The question that remains is whether the G7's response to these disturbances changed with the move from fixed to flexible exchange rates.

Are responses to disturbances different under fixed and flexible exchange rate regimes?

Figures 4–7 compare the responses of the G7 countries over the fixed and flexible exchange rate periods to the four underlying disturbances—changes in oil prices, U.S. industrial production, G7 industrial production, and U.S. monetary policy. Note that the models' responses are standardized so that each figure plots the response to a 1 percent increase in a given disturbance. This allows

TABLE 2

Estimated percentage standard deviations of structural disturbances

Canada–U.S. model

Period	Oil prices	U.S. industrial production	Canadian industrial production	U.S. monetary policy
	Structural disturbance			
Fixed	1.0	0.7	0.9	0.7
Flexible	11.2	0.7	1.2	1.3
Ratio	11.0	1.0	1.3	1.8

France–U.S. model

Period	Oil prices	U.S. industrial production	French industrial production	U.S. monetary policy
	Structural disturbance			
Fixed	1.0	0.7	3.8	0.7
Flexible	11.2	0.7	1.3	1.3
Ratio	10.9	1.0	0.3	1.8

Germany–U.S. model

Period	Oil prices	U.S. industrial production	German industrial production	U.S. monetary policy
	Structural disturbance			
Fixed	1.0	0.7	1.7	0.7
Flexible	11.2	0.7	1.5	1.3
Ratio	11.1	1.0	0.9	1.8

Italy–U.S. model

Period	Oil prices	U.S. industrial production	Italian industrial production	U.S. monetary policy
	Structural disturbance			
Fixed	1.0	0.7	2.3	0.7
Flexible	11.3	0.7	2.3	1.3
Ratio	10.9	1.1	1.0	1.8

Japan–U.S. model

Period	Oil prices	U.S. industrial production	Japanese industrial production	U.S. monetary policy
	Structural disturbance			
Fixed	1.0	0.7	1.0	0.7
Flexible	11.3	0.7	1.1	1.3
Ratio	11.2	1.0	1.2	1.8

UK–U.S. model

Period	Oil prices	U.S. industrial production	UK industrial production	U.S. monetary policy
	Structural disturbance			
Fixed	1.0	0.7	1.1	0.7
Flexible	11.0	0.7	1.4	1.3
Ratio	10.7	1.0	1.2	1.8

Notes: The first (second) row in each block refers to the standard deviation of the structural disturbance in the fixed (flexible) exchange rate model. The third row is the ratio of the standard deviation of the structural disturbance in the flexible to fixed period (values exceeding 1 indicate an increase in the variance of the structural disturbance).

Source: Calculations from author's statistical model, using the following monthly data series: International Monetary Fund, world crude oil prices and G7 industrial production; and Federal Reserve Board of Governors, nonborrowed reserves and total reserves.

me to compare the shape and size of the response under fixed or flexible exchange rates.

Oil price disturbances

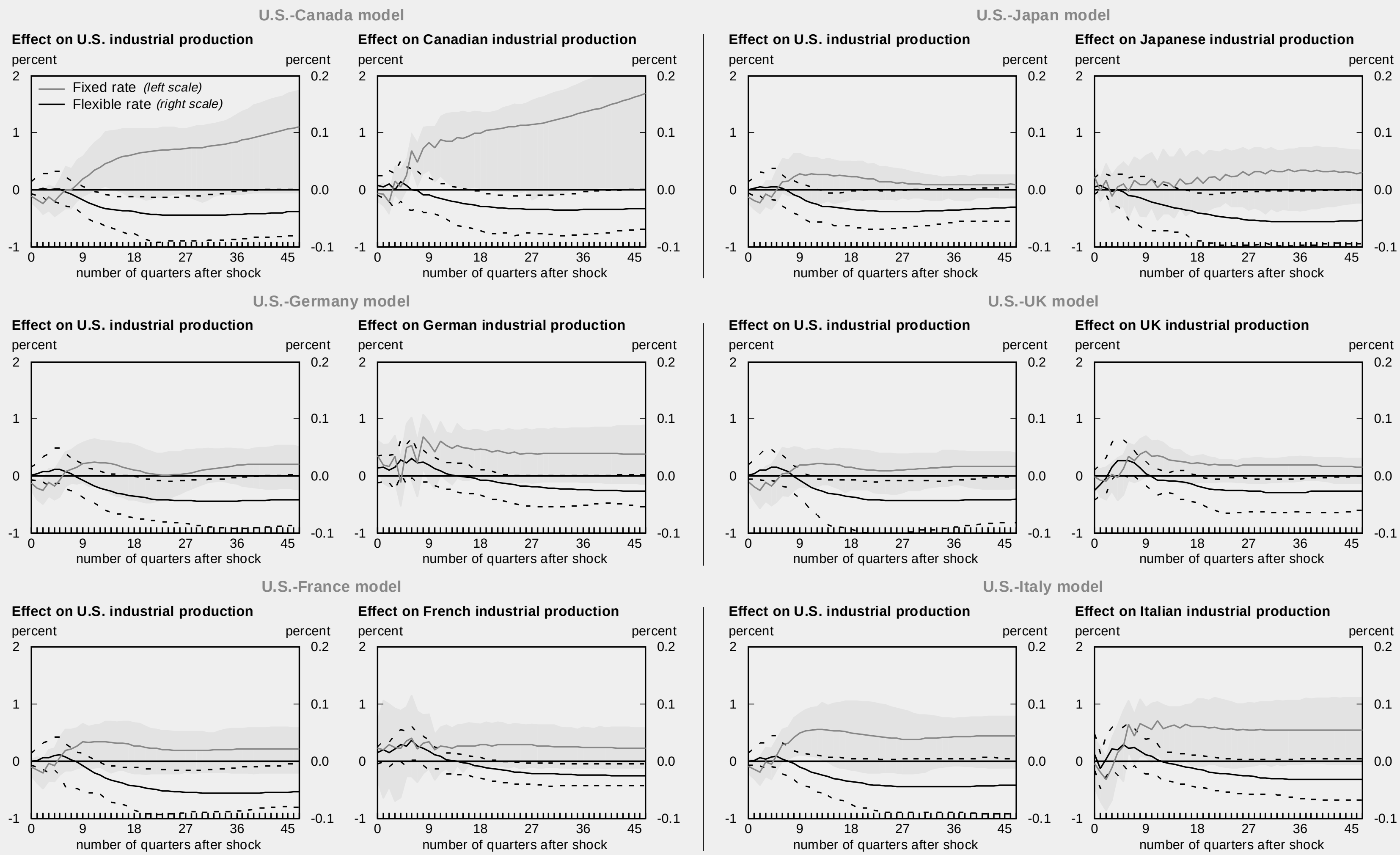
Figure 4 plots responses to oil price changes in the fixed and flexible periods. Note the scale for the response function for the flexible period is one-tenth that of the fixed period response. It is obvious that a 1 percent shock to oil prices had a smaller impact on U.S. and G7 industrial production in the flexible period in both the short and long run. The response functions for oil price changes also have quite different shapes over the two periods. The impact effect of oil prices varies across G7 countries for the fixed exchange rate period, while the long-run effect is consistently positive. In contrast, during the flexible exchange rate period, the impact effect of oil prices is positive, while the long-run effect is negative for all G7 countries. The previous section suggests that oil price movements were generally no more significant a source of variation in the flexible period. Figure 4 suggests that oil price changes were a source of the increased comovement, because G7 countries started responding in a similar way to these common shocks in the flexible period.

U.S. industrial production

A similar result emerges for shocks to U.S. industrial production (see figure 5). In the fixed exchange rate period, shocks to U.S. production generally had a negative immediate impact on other G7 countries, which changed to a positive long-run effect. In the flexible period, the other G7 countries' response to U.S. industrial production shocks changed to a hump-shaped pattern. This pattern is similar to the response function of U.S. industrial production in both the fixed and flexible periods. This suggests that the

FIGURE 4

Impulse response functions: Shock to world oil prices

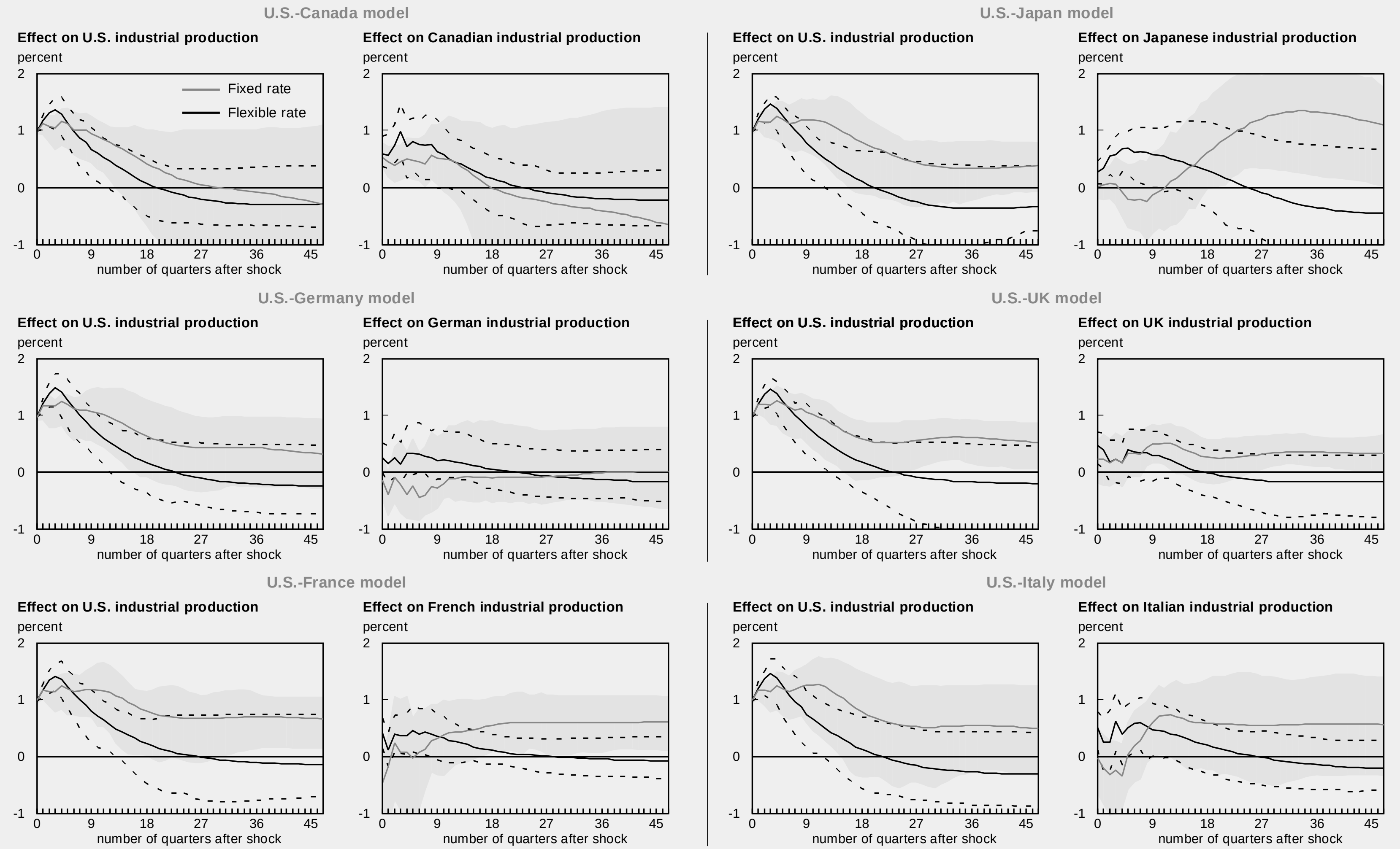


Notes: All figures report percentage changes in U.S. and other G7 industrial production following a 1 percent shock to the world price of oil in the fixed or flexible exchange rate period. The solid color (black) lines represent the point estimate for the fixed (flexible) exchange rate period. The color shaded areas (dashed lines) are the 95 percent confidence bands, computed by Monte Carlo simulation using 1,000 independent draws for the fixed (flexible) exchange rate model.

Source: Calculations from author's statistical model, using the following monthly data series: International Monetary Fund, world crude oil prices and G7 industrial production; and Federal Reserve Board of Governors, nonborrowed reserves and total reserves and U.S. industrial production.

FIGURE 5

Impulse response functions: Shock to U.S. industrial production

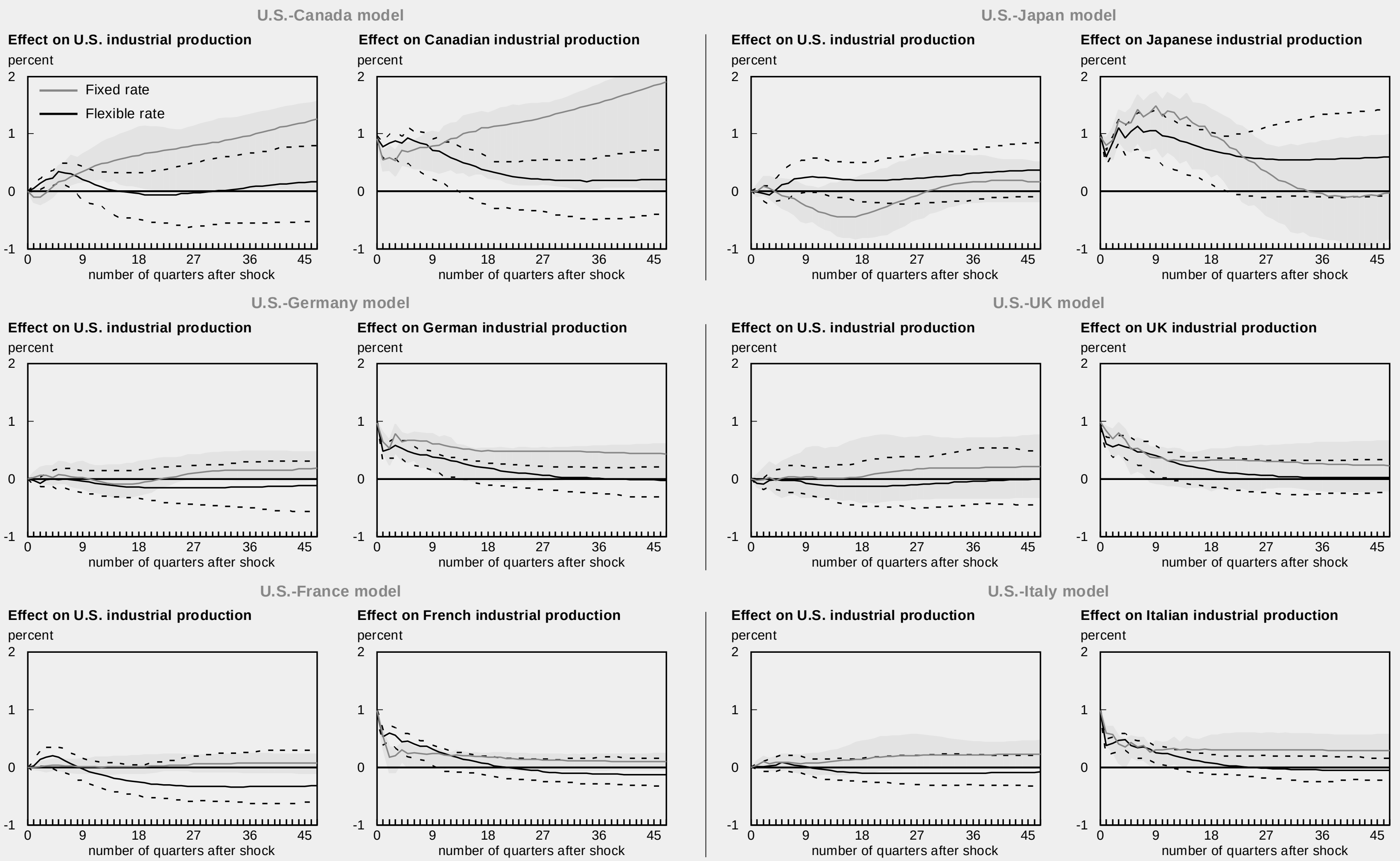


Notes: All figures report percentage changes in U.S. and other G7 industrial production following a 1 percent shock to U.S. industrial production in the fixed or flexible exchange rate period. The solid color (black) lines represent the point estimate for the fixed (flexible) exchange rate period. The color shaded areas (dashed lines) are the 95 percent confidence bands, computed by Monte Carlo simulation using 1,000 independent draws for the fixed (flexible) exchange rate model.

Source: See figure 4.

FIGURE 6

Impulse response functions: Shock to G7 industrial production

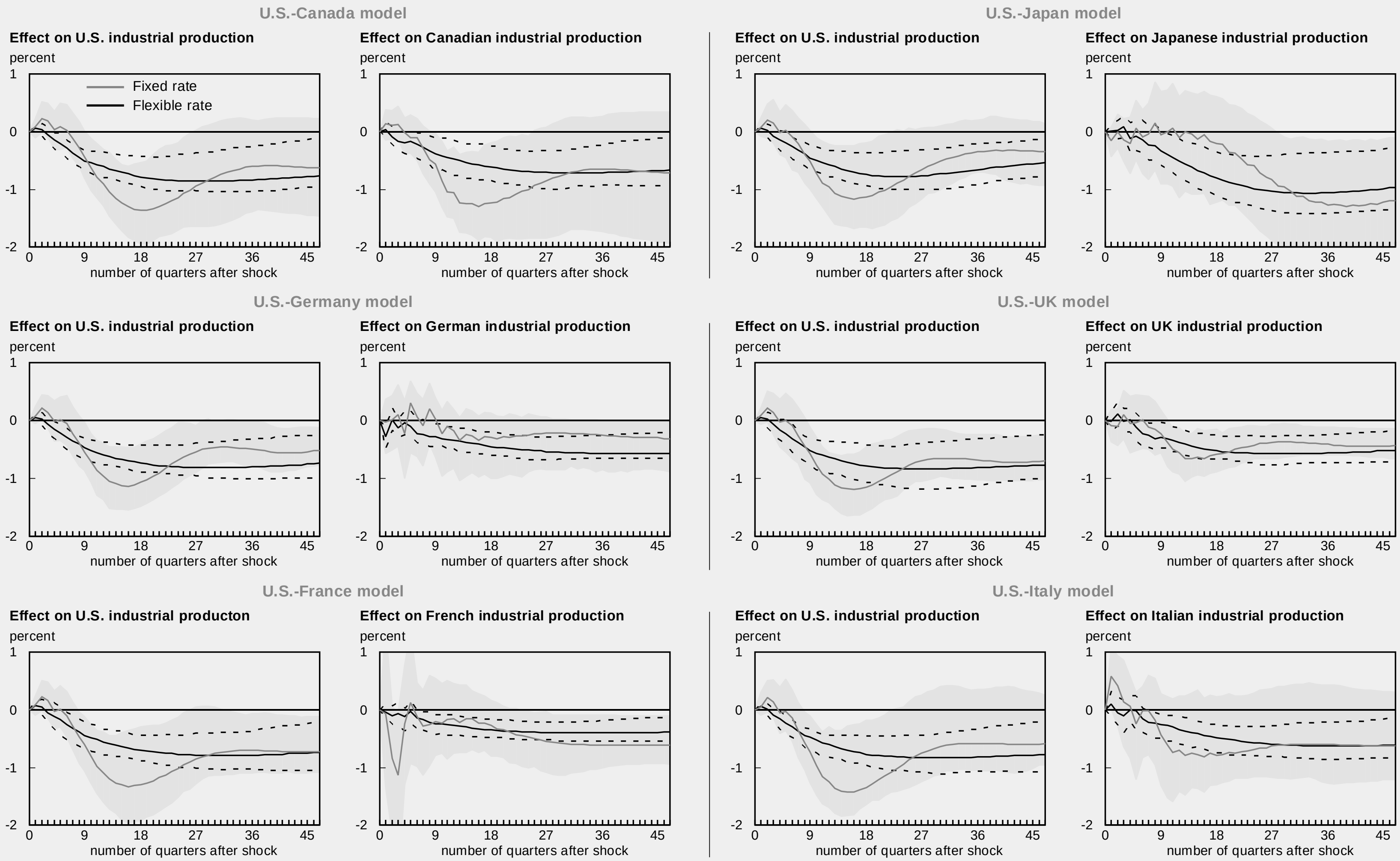


Notes: All figures report percentage changes in U.S. and other G7 industrial production following a 1 percent shock to foreign industrial production in the fixed or flexible exchange rate period. The solid color (black) lines represent the point estimate for the fixed (flexible) exchange rate period. The color shaded areas (dashed lines) are the 95 percent confidence bands, computed by Monte Carlo simulation using 1,000 independent draws for the fixed (flexible) exchange rate model.

Source: See figure 4.

FIGURE 7

Impulse response functions: Shock to U.S. monetary policy



Notes: All figures report percentage changes in U.S. and other G7 industrial production following a 1 percent shock to U.S. monetary policy in the fixed or flexible exchange rate period. The solid color (black) lines represent the point estimate for the fixed (flexible) exchange rate period. The color shaded areas (dashed lines) are the 95 percent confidence bands, computed by Monte Carlo simulation using 1,000 independent draws for the fixed (flexible) exchange rate model.

Source: See figure 4.

transmission of U.S. production shocks changed significantly in the latter period. One clear exception to this is Canada, which had roughly the same hump-shaped response to U.S. industrial production shocks in the two estimation periods. Just as in the case of oil prices, the common responses to U.S. industrial production shocks in the flexible exchange rate period are also a source of the increased comovement of U.S.–G7 industrial production.

Foreign industrial production

In contrast to the earlier results, figure 6 suggests that U.S. industrial production's response to foreign industrial production shocks is largely unchanged over the two periods. Except for Canada, foreign industrial production innovations have an insignificant impact on U.S. industrial production in the short and long run in both the fixed and flexible periods. In the case of shocks to Canada's industrial production, the U.S. and Canada share similar shaped response functions under the two regimes, so this is a possible source of comovement for the U.S. and Canada.

U.S. monetary policy

Finally, I look at unexpected changes in U.S. monetary policy. The monetary indicator used here is the ratio of nonborrowed reserves to total reserves. An exogenous increase in the ratio would indicate a tightening of monetary policy. Figure 7 shows that, historically, shocks to U.S. monetary policy (higher ratios of nonborrowed to total reserves) are associated with a contraction in U.S. and G7 industrial production. Textbook open economy macroeconomic models suggest that a standardized foreign monetary policy shock will have a smaller impact on countries that maintain flexible exchange rates. That also appears to be the consensus view from anecdotal evidence on the abandonment of the gold exchange standard and the UK's recent exit from the ERM. Figure 7 reveals that G7 countries responded to U.S. monetary disturbances is a similar way in the BW and PBW periods. In particular, the impulse response functions of these countries to U.S. monetary disturbances display the same shape, with a significant negative long-run effect. These results suggest that for other G7 countries, flexible exchange rates offer no greater insulation against foreign monetary disturbances. This result is clearly at odds with the consensus viewpoint.

Recall the finding from the previous section that U.S. monetary disturbances became more volatile in the flexible period. Combining this with the fact that the response to these shocks is common, we can see why U.S. monetary policy disturbances became a greater source of variation in G7 industrial production.

Summary

These experiments suggest that the correlation of U.S. and G7 output fluctuations rose in the flexible exchange rate period because of two factors. First, the G7's response to various structural disturbances became more alike in the flexible exchange rate period. Second, global or foreign shocks, such as U.S. monetary policy, became more volatile in the flexible exchange rate period.

Conclusion

This article sheds light on the link between exchange rate regimes and international business cycles. The key stylized fact is that the correlation of cyclical fluctuations in industrial output of the U.S. and other G7 countries rose quite dramatically in the flexible exchange rate period. This calls into question conventional wisdom, which argues that flexible exchange rates increase the degree to which national economies are insulated from the effects of foreign / global disturbances. By estimating a series of bilateral models of the U.S. and its G7 counterparts over the postwar fixed and flexible exchange rate periods, I was able to determine that higher comovement emerged in the PBW period due to a combination of two factors. First, the sensitivity to U.S. monetary policy shocks among the rest of the G7 countries remained unchanged over the fixed and flexible exchange rate regimes, but the volatility of shocks to U.S. monetary policy increased significantly in the flexible exchange rate period. This made U.S. monetary policy disturbances a more important source of variation for G7 industrial production and, in the process, raised the correlation of U.S. and G7 output fluctuations. Second, the responses of the G7 to all shocks, global and domestic, changed in the flexible regime so that they were more alike than in the fixed exchange rate period. One of the important findings of this study is that G7 sensitivity to foreign and domestic monetary policy shocks remained unchanged in the flexible exchange rate period.

There is much debate in the popular press and academic circles about the desirability of pursuing a common currency area in Europe.

The debate is an old one. Early examples include work by Mundell (1961), who argued that the desirability of a common currency area depends on the nature of disturbances and the economies' response to these shocks. Highly correlated disturbances and similar responses to disturbances were argued by Mundell to be essential elements in the desirability of a common currency area. Here, I use empirical techniques that uncover the nature of disturbances and the responses to these shocks with a view to understanding why fluctuations in national outputs of countries are highly correlated. My results suggest that G7 countries respond to shocks in a similar way and that common global shocks explain a large share of the variance of national output fluctuations. In the light of these empirical findings and Mundell's theoretical results, it would seem that the G7 would gain from the move to a common currency.

TECHNICAL APPENDIX

This appendix describes my methodology in greater technical detail. To isolate the various exogenous shocks, including U.S. monetary policy shocks, I use the vector autoregression (VAR) procedure developed by Christiano, Eichenbaum, and Evans (1994a, 1994b). Let Z_t denote the 4×1 vector of all variables in the model at date t. This vector includes changes in the log of world oil prices (*POIL*), log levels of U.S. industrial production (*USIP*), log levels of industrial production for another G7 country (*FORIP*), and the ratio of U.S. nonborrowed to total reserves (*NBR*), which I assume is the U.S. monetary policy indicator. The order of the variables is:

1) $Z_t = (POIL_t, USIP_t, FORIP_t, NBR_t)$.

I assume that Z_t follows a sixth-order VAR:

2) $$Z_t = A_0 + A_1 Z_{t-1} + A_2 Z_{t-2} + \ldots + A_q Z_{t-6} + u_t,$$

where A_i, $i = 0,1, \ldots , 6$ are 4×4 coefficient matrices, and the 4×1 disturbance vector u_t is serially uncorrelated. I assume that the fundamental exogenous process that drives the economy is a 4×1 vector process $\{\varepsilon_t\}$ of serially uncorrelated shocks, with a covariance matrix equal to the identity matrix. The VAR disturbance vector u_t is a linear function of a vector ε_t of underlying economic shocks, as follows:

$$u_t = C\varepsilon_t,$$

where the 4×4 matrix C is the unique lower-triangular decomposition of the covariance matrix of u_t:

$$CC' = E[u_t u_t'] .$$

This structure implies that the jth element of u_t is correlated with the first j elements of ε_t, but is orthogonal to the remaining elements of ε_t.

Following Christiano et al., I assume that in setting policy, the U.S. Federal Reserve both reacts to the economy and affects the economy; I use the VAR structure to capture these cross-directional relationships. In particular, I assume the feedback rule can be written as a linear function Ψ defined over a vector Ω_t of variables observed at or before date t. That is, if I let NBR_t denote the ratio of U.S. nonborrowed to total reserves, then U.S. monetary policy is completely described by:

3) $$NBR_t = \Psi(\Omega_t) + c_{4,4}\varepsilon_{4t},$$

where ε_{4t} is the fourth element of the fundamental shock vector ε_t, and $c_{4,4}$ is the (4,4)th element of the matrix C. (Recall that NBR_t is the fourth element of Z_t.) In equation 3, $\Psi(\Omega_t)$ is the feedback-rule component of U.S. monetary policy, and $c_{4,4}\varepsilon_{4t}$ is the exogenous U.S. monetary policy shock. Since ε_{4t} has unit variance, $c_{4,4}$ is the standard deviation of this policy shock. Following Christiano et al., I model Ω_t as containing lagged values (dated $t-1$ and earlier) of *all* variables in the model, as well as time t values of those variables the monetary authority looks at contemporaneously in setting policy.

In accordance with the assumptions of the feedback rule, an exogenous shock ε_{4t} to monetary policy cannot contemporaneously affect time t values of the elements of Ω_t. However, lagged values of ε_{4t} can affect the variables in Ω_t.

I incorporate equation 3 into the VAR structure of equations 1 and 2. Variables *POIL*, *USIP*, and *FORIP* are the contemporaneous inputs to the monetary feedback rule. These are the only components of Ω_t that are not determined prior to date t. With this structure, we can identify the right-hand side of equation 3 with the fourth equation in VAR equation 1: $\Psi(\Omega_t)$ equals the fourth row of $A_0 + A_1 Z_{t-1} + A_2 Z_{t-2} + ... + A_6 Z_{t-6}$, plus $\sum_{i=1}^{3} c_{4i}\varepsilon_{it}$ (where c_{4i} denotes the $(4,i)$th element of matrix C, and ε_{it} denotes the ith element of ε_t). Note that NBR_t is correlated with the first four elements of ε_t. By construction, the shock $c_{4,4}\,\varepsilon_{4t}$ to U.S. monetary policy is uncorrelated with the monetary policy feedback rule Ω_t.

I estimate matrices A_i, $i = 0,1, ... , 6$ and C by ordinary least squares. The response of any variable in Z_t to an impulse in any element of the fundamental shock vector ε_t can then be computed by using equations 1 and 2.

The standard error bounds in figures 4 through 7 are computed by taking 1,000 random draws from the asymptotic distribution of A_0, A_1, ... , A_6, C, and, for each draw, computing the statistic whose standard error is desired. The reported standard error bounds give the 95 percent confidence bands from 1,000 random draws.

NOTES

[1]This section draws heavily on material in Krugman and Obstfeld (1994), chapter 19.

[2]Researchers such as Grilli and Kaminsky (1991) argue that during this period the U.S. was involved in four fixed exchange rate regimes, the gold standard from January 1879 to June 1914, the gold exchange standard from May 1925 to August 1931, the wartime control period from September 1939 to September 1949, and finally the Bretton Woods system from October 1949 to August 1971. With the exception of the wartime control period, these regimes involved a fixed rate of exchange between the U.S. and other currencies in addition to a fixed dollar price of gold. The intervening years and the period following abandonment of the Bretton Woods system have been characterized by various floating exchange rate regimes.

[3]In general time series, data are nonstationary. Nonstationary data do not have well-defined standard deviations or correlations. One way of overcoming this problem is to filter the data using a filter that removes nonstationary components and renders the data stationary. Baxter and Stockman report statistics for two different filters, a linear time trend and first difference filter. In subsequent work, Baxter (1991) argued that these filtered data highlight frequencies of the data that are uninteresting for policy analysis. Baxter and King (1995) responded to this by developing a filter that is designed to isolate components of the data corresponding to frequencies policy analysts are interested in, the so-called business cycle frequencies of one and a half to eight years. I use a Baxter–King business cycle filter to isolate cyclical movements in industrial production. However, filtering industrial production with a linear time trend or first difference filter yields the same conclusion. This suggests that Baxter and Stockman's (1989) figure 4 is mislabeled.

[4]Backus, Kehoe, and Kydland (1995) study the cyclical properties of a broader set of national output data, for a smaller set of countries (Canada, Japan, the UK, and the U.S.), over the fixed and flexible periods. Using a similar business cycle filter, developed by Hodrick and Prescott (1997), they also find that the volatility of gross domestic product (GDP) and the correlation between foreign and U.S. GDP rose in the flexible period.

[5]Other empirical attempts have relied on cross-sectional econometric methods. For example, Canova and Dellas (1993) study the relationship between trade interdependence and business cycle comovement. They argue that comovement in the PBW period seems to be due to common shocks rather than changes in the international transmission of business cycles.

[6]Adding an indicator of foreign monetary policy had no impact on the analysis.

[7]Before I can shed light on the issue of whether increased comovement in national output occurred because of changes in the relative volatility of global versus national disturbances and/or changes in the response to national and global disturbances, I need to impose some structure on the system of equations described by the VAR. There are numerous forms of indentifying restrictions in the literature. In their work on Japan, Hutchinson and Walsh (1992) impose long-run restrictions on the data. Identification in Ahmed et al. (1993) and Bayoumi and Eichengreen (1994) comes from different theoretical models. I use a recursive structure popularized by Sims (1972). This approach imposes restrictions on the covariance function of the disturbances of the model. In particular, structural disturbances are identified by imposing a recursive information ordering. Throughout the analysis, I impose the following information ordering: world oil prices; U.S. industrial production; foreign industrial production; and indicator of U.S. monetary policy. This approach assumes, as in Eichenbaum and Evans (1995), that the U.S. monetary authority chooses the value of the mone-

tary instrument after observing contemporaneous movements in oil prices and U.S. and foreign industrial production. In this setting I can conveniently refer to the structural disturbances as an oil price or global shock, U.S. output shock, foreign output shocks, and U.S. monetary policy shock.

[8] Ahmed et al. (1993), Bayoumi and Eichengreen (1994), and Hutchinson and Walsh (1992) also find that foreign or global shocks became relatively more volatile in the flexible exchange rate regime. This is a noteworthy result because each study uses a different structural identification, but essentially ends up with the same general conclusion about the changing source of disturbances in the international economy.

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