International Business Cycles: G7 and OECD Countries

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Monitoring economic activity through the use of composite leading and coincident indicators has been a tradition in the United States for over sixty years, since the seminal book by Arthur Burns and Wesley Mitchell (1946). These indicators are some of the most watched series by the press, businesses, policymakers, and stock market participants. Progressive globalization has sparked a worldwide interest in using economic indicators to analyze cyclical fluctuations. The development of the European Monetary Union and advances in econometric models that explore potential dynamic differences across business cycle phases have given rise to a large recent literature focused on economic indicators and inferences on turning points for European countries.

As markets become more integrated, governments and the private sector seek to conduct their activities in light of both national and international economic conditions. Changes in exchange rates, output, consumption, inflation, and interest rates in different parts of the world can influence the effectiveness of government policies and the competitive position of businesses, even those not directly related to international operations. The benefits of a warning system to detect recessions in major economic partners and in industrialized countries as a whole are considerable. The more reliable the warning system is, the more efficiently economic policy can be implemented as a pre-emptive action against the negative effects of widespread economic weakness and unemployment. Private businesses also benefit from making decisions based on more complete information regarding demand and supply for their services.

This article constructs an international business cycle indicator using a broad production measure of the G7 countries and the Organisation for Economic Co-operation and Development (OECD) member countries.[1] It also builds national business cycle indicators for each of the G7 countries individually using series that comove with their aggregate economic activity. A dynamic factor model with Markov switching (DFMS) is used to combine these macroeconomic series and to estimate probabilities of current

business cycle phases for each of the G7 countries and for the aggregate G7 and OECD measures, which can be used as a warning system to monitor country-specific and international business cycles.[2]

The novelty of this approach is that we extend the DFMS model to include a filter that minimizes the occurrence of false turning points as it sorts out minor contractions and estimates only major economic recessions and expansions. This feature is espe-

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cially important in situations in which an economy often slows down but does not enter a recession, occurrences that lead to a high rate of false alarms.

The phases of business cycles are well characterized by the model probabilities, which show a clear dichotomy between expansions and recessions for each of the

G7 countries and for the aggregate OECD and G7 measures. The proposed model detects only probabilities of major recessions compared with the probabilities obtained without the filter, which capture several minor contractions for some of the G7 countries. Discerning between major downturns and minor contractions helps to avoid identifying false turning points. This quality is especially important for monetary policy purposes because central banks may want to act only in the event of major recessions affecting several sectors of the economy at the same time, such as employment, sales, output, and income.

OECD countries differ in their institutions, monetary and fiscal policies, industrial compositions and structures, and average aggregate growth rates. The results of this study indicate, however, that OECD countries share some common business cycle phases despite their idiosyncrasies. Some economic recessions and expansions were common to the majority of countries studied, characterizing an international business cycle. The results from the probabilities also suggest that the business cycle derived from the OECD and G7 output data coincides with the swings in the euro area. The OECD countries altogether have experienced three major recessions in the period analyzed: during the oil crisis in the mid-1970s, in the early 1980s, and in the early 1990s.

Comparing the U.S. business cycle with the international business cycle shows that recessions in the United States are more frequent and of shorter duration than in the aggregate OECD in the sample analyzed. The U.S. economy led the beginning and end of the contractions occurring in the rest of the world in the early 1970s and early 1990s, whereas the 1980s recession started and ended at about the same time in the United States and the OECD countries. Some patterns of lead-lag relationship are also revealed in the business cycle phases among the G7 countries.

The article begins with an intuitive explanation of the model and then presents the empirical results for the aggregate OECD countries and for each of the G7 countries.

Constructing the Model

This analysis uses a multivariate system to model business cycle fluctuations in G7 and OECD countries. The model is an extension of the DFMS model, which has been successfully applied to represent business cycles worldwide. As in the DFMS model, an unobservable variable is computed as a nonlinear weighted average of the observed coincident macroeconomic series, and it represents the common information related to business cycles contained in these series. This latent variable switches regimes following a two-state Markov process, which represents expansion and contraction phases of the business cycle.

We extend the model by including a self-adjusting variable-bandwidth filter, which enhances signal-to-noise ratio cycles. The advantage of this filter is that it minimizes the occurrence of false turning points because it removes minor economic contractions and estimates only major recessions and expansions (Chauvet 2005). This filtering is especially important in situations with low signal-to-noise ratios, where the detection threshold in Markov-switching models can be low to capture recessions and can thus lead to a high rate of false alarms when the economy slows down but does not enter a recession.

We apply the model for each of the G7 countries' macroeconomic variables that display simultaneous movements with national gross domestic product (GDP), such as consumption, production, sales, employment, and income, among others. The resulting dynamic factor model characterizes country-specific business cycles. We also apply the model to an aggregate measure of output of twenty-nine OECD countries and to the GDP of each of the G7 countries to obtain a broad measure of the international business cycle shared by most industrialized and semi-industrialized countries. The proposed method tracks business cycle fluctuations and generates coincident probabilities of business cycle phases, which can be used to predict business cycle turning points.

The Data

We use quarterly data to build the coincident indicators for each of the G7 countries individually. These data were obtained from the International Financial Statistics database, Datastream Systems Inc., and the OECD database, with different sample ranges. For the United States, we use the same four coincident variables used by the National Bureau of Economic Research (NBER): measures of sales, personal income, industrial production, and employment.[3] For the other six countries, we select four series that correspond closely to the same measurement variables used to build the coincident indicators of the U.S. economy (see Table 1). In particular, industrial production and employment are common variables used for all countries. Different measures of income (such as personal income or wages and salaries) are used for all countries except Japan. Other variables used are sales (retail or manufacturing), electricity consumption, GDP, consumption, and manufacturing orders.

In order to represent a broad measure of international business cycles, we use the aggregate OECD quarterly industrial production series for its country members combined with the GDP of each G7 country. Table 1 summarizes the information about all the series used.

Empirical Results[4]

Business cycle phases are well characterized by the estimated probabilities, which display a clear dichotomy between expansions and recessions for each G7 country

1. G7 members are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. OECD members are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Since the Slovak Republic became a member only in December 2000, the aggregate industrial production series we use does not include this country.
2. See Chauvet and Hamilton (2006) for a detailed explanation of the multivariate DFMS model and the univariate Markov switching model.
3. The NBER's decisions regarding business cycle dates are considered the official U.S. turning points and are used as the benchmark for model comparison.
4. The model selected by diagnostic and predictive performance tests in identifying turning points is an autoregressive specification of order two for each country and for the aggregate OECD and G7 series.

Table 1
Coincident Variables of G7 and OECD Countries

	Series	Sample
OECD countries	Aggregate industrial production for 29 countries	1960Q1–2000Q1
United States	Industrial production Total civilian employment Personal income less transfer payments Manufacturing and trade sales	1959Q1–2000Q2
Canada	Industrial production Employment, business and personal services Personal income Personal consumption expenditures	1967Q2–2000Q1
United Kingdom	Industrial production Employee jobs Disposable income Retail sales	1980Q1–2000Q2
Japan	Industrial production Employees nonagricultural ind. Department stores sales Electric power consumption	1973Q1–2000Q2
Germany	Industrial production Employed persons Gross wages and salaries Manufacturing orders	1962Q2–2000Q2
France	Industrial production Employment except agriculture Gross disposable income Gross domestic product	1978Q1–2000Q1
Italy	Industrial production Employment Wages and salary earnings Private consumption	1982Q1–1999Q4

Source: International Financial Statistics database, International Monetary Fund, Datastream Systems Inc., and OECD database

and for the aggregate G7 and OECD measures, as shown in Figure 1. The coincident probabilities of recessions increase substantially during recessions and display low values during expansions. Figure 1 also compares the probabilities of recession from the DFMS model with and without the self-adjusting variable-bandwidth filter. For the model with the filter, the probabilities of recessions detect only major recessions, but in the model without the filter the probabilities also capture several other minor contractions in addition to the major recessions for some G7 countries. The fact that the probabilities estimated without the filter capture minor contractions is not a disadvantage per se if the goal is in fact to capture them. However,

Figure 1
Coincident Probabilities of Recessions for G7 and Aggregate OECD Countries
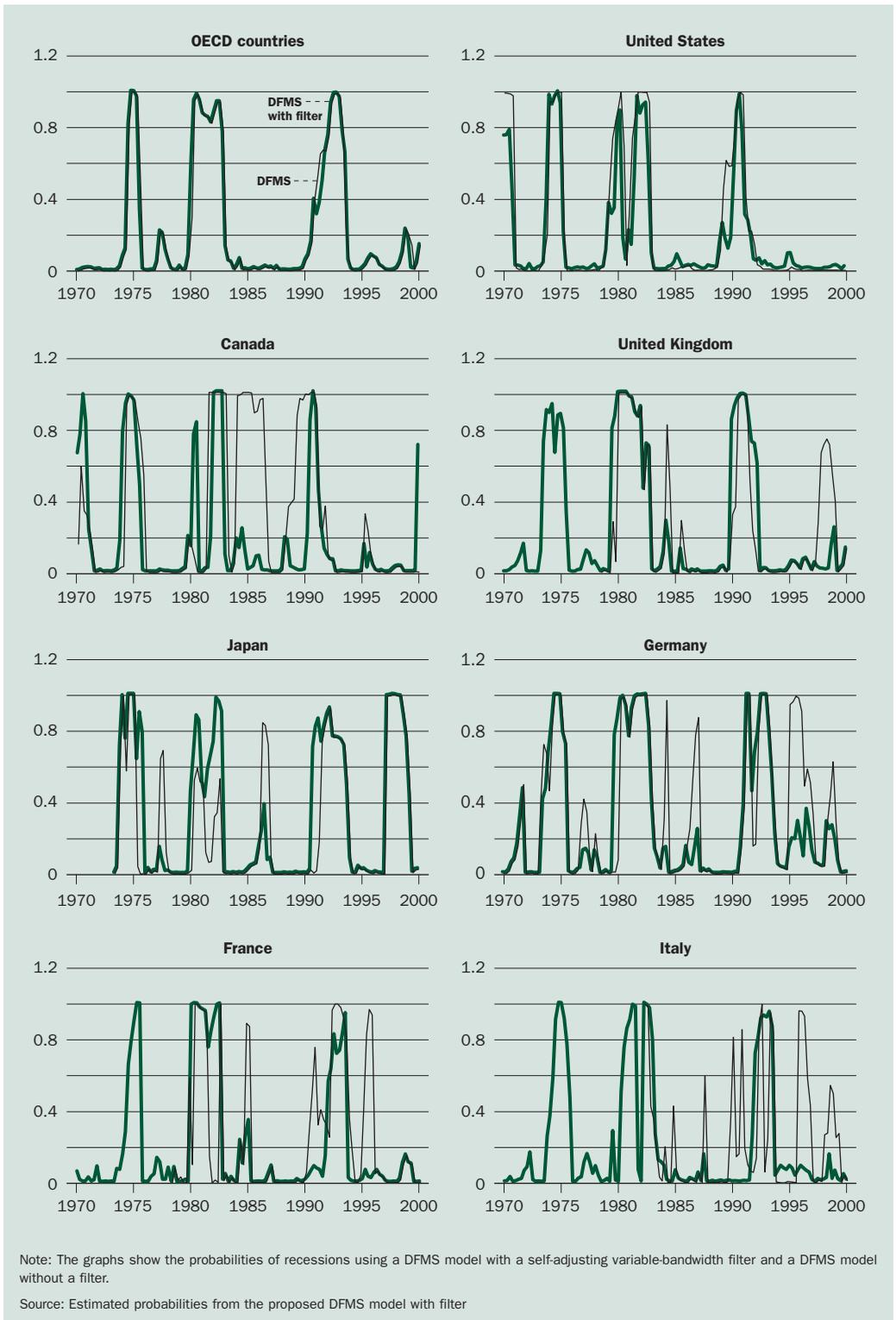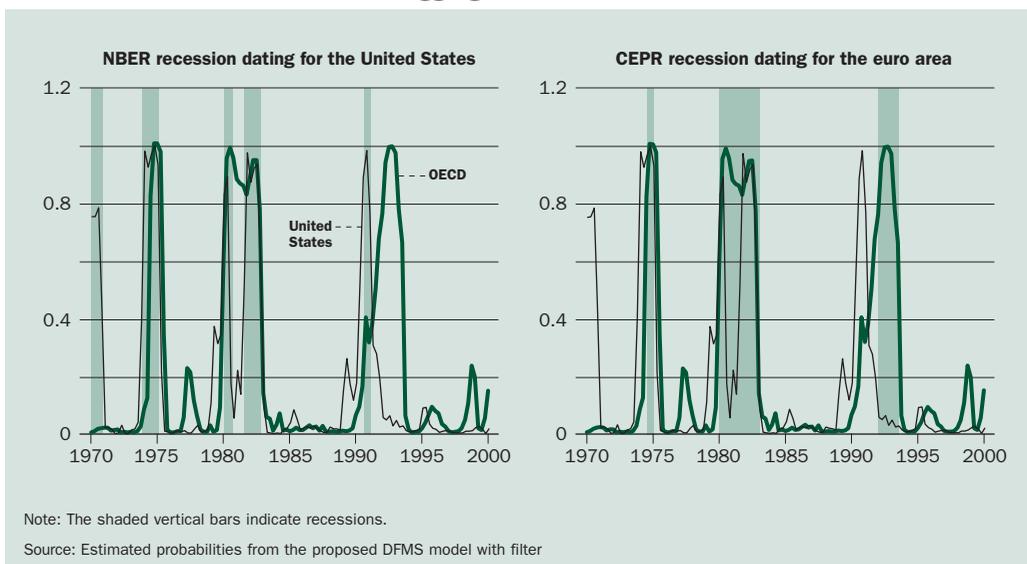

Note: The graphs show the probabilities of recessions using a DFMS model with a self-adjusting variable-bandwidth filter and a DFMS model without a filter.

Source: Estimated probabilities from the proposed DFMS model with filter

Figure 2
Probabilities of Recessions for the Aggregate OECD Countries and the United States

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

if the aim is to discern between major downturns and minor contractions, then the filter reduces the risk of calling false turning points. This feature is especially important for monetary policy purposes because central banks may want to change the size and direction of changes in interest rates depending on the severity of the economic downturn.

In order to analyze business cycle phases, we define turning points based on whether the probabilities of recessions and expansions are smaller or greater than 50 percent. For example, the beginning of a recession occurs when the probability of a recession moves from below 50 percent to above 50 percent. This rule provides a good definition of turning points because the estimated probabilities clearly distinguish times when an expansion is more likely from those when a recession is more likely.

OECD countries.[5] Figure 2 shows the full-sample probabilities of recession for the aggregate output of the OECD and GDP of each G7 country. The probabilities of recessions and expansions can be interpreted as a representation of business cycle phases for industrialized and semi-industrialized countries given that the analysis includes twenty-nine member countries.

Table 2 summarizes some features of the probabilities of recession measure. The average duration of a recession shared by OECD countries is eight quarters, and the average probability that the economy will enter a recession is 87 percent. Expansions last twenty quarters on average, and the average probability of entering an expansion is 95 percent. According to the recession probabilities, OECD countries altogether have experienced three major recessions in the period analyzed: during the oil crisis in the mid-seventies, in the early eighties, and in the early nineties. The results from the probabilities suggest that the business cycle obtained from the broad OECD output measure coincides with the euro area's business cycle. The timing of recessions is very close to the euro area's recessions as dated by the Centre for Economic Policy Research (CEPR) Business Cycle Dating Committee (see the shaded area in the second panel of Figure 2), which is a European counterpart to the NBER Business Cycle

Table 2
Estimated Business Cycles of OECD and G7 Countries

	Number of full recessions	Average expansion probability	Average expansion duration (quarters)	Average recession probability	Average recession duration (quarters)
OECD	3	0.95	20	0.87	8
United States	4	0.94	17	0.84	6
Canada	4	0.95	20	0.88	8
United Kingdom	3	0.96	25	0.86	7
Japan	4	0.95	20	0.83	6
Germany	3	0.90	10	0.89	9
France	3	0.96	25	0.87	8
Italy	3	0.95	20	0.87	8

Source: Authors' calculations based on estimated probabilities from the proposed DFMS model with filter

Table 3
Business Cycle Dating for OECD Countries and the Euro Area

CEPR dating for the euro area		Model dating for OECD countries	
Peak	Trough	Peak	Trough
1974Q3	1975Q1	1974Q3	1975Q2
1980Q1	1982Q3	1980Q1	1982Q4
1992Q1	1993Q3	1991Q3	1993Q3

Source: CEPR (2003); authors' calculations based on estimated model probabilities

Dating Committee.[6] During periods that the CEPR classifies as expansions, the probabilities of recessions are generally close to zero. At CEPR peak dates (the onset of recessions), the probabilities of recession increase substantially above 50 percent and stay high until the trough dates (the end of recessions).

Table 3 compares the CEPR recession dating for Europe and the recession dating obtained from our model of OECD countries. From the six estimated turning points in the period studied (three peaks and three troughs), three match exactly, and the other three are off by only one or two quarters. This dating also coincides with the the euro

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5. Since G7 members are also OECD members, the results of the combination of aggregate G7 outputs are subsumed in the OECD results.
6. Although the techniques used differ between the NBER and the CEPR, the dating generated by these institutions is similar in the sense that it is often used as a benchmark. The euro area considered by the CEPR includes Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain.

Figure 3
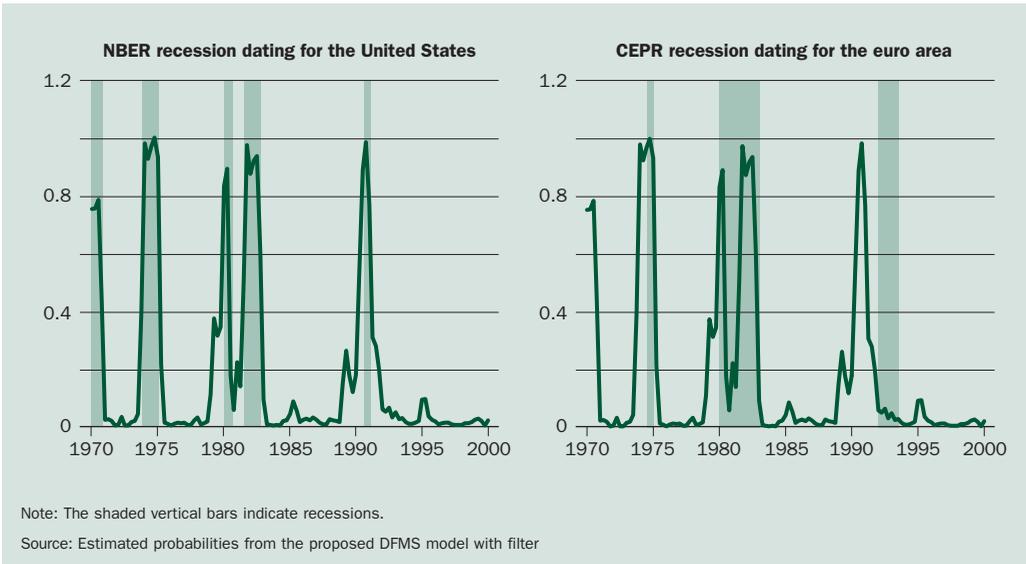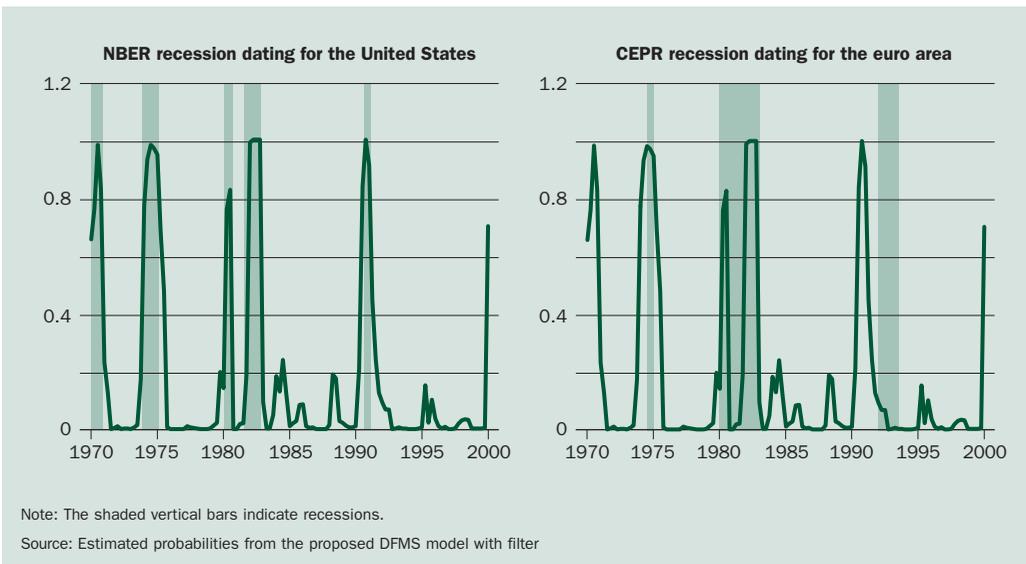**Probabilities of Recessions for the United States**

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

Figure 4
Probabilities of Recessions for Canada

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

area dating by Artis, Marcellino, and Proietti (2003), Dopke (1999), Artis, Krolzig, and Toro (2004), Anas and Ferrara (2004), and Krolzig (2001), among others.

Figure 2 also compares the probabilities of recession for OECD countries and the U.S. economy, the NBER dating for U.S. recessions, and the CEPR dating of recessions for the euro area. Recessions in the United States are more frequent and of shorter duration than in the aggregate OECD countries during the period studied. The U.S. economy led the beginning and end of contractions occurring in the OECD countries in the early 1970s and early 1990s recessions whereas the 1980s recession

Figure 5
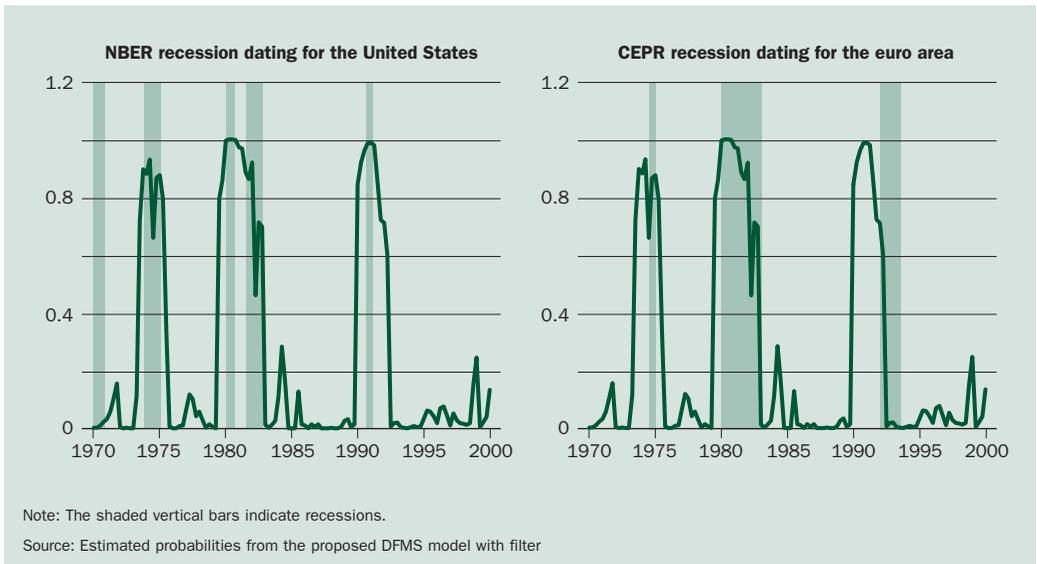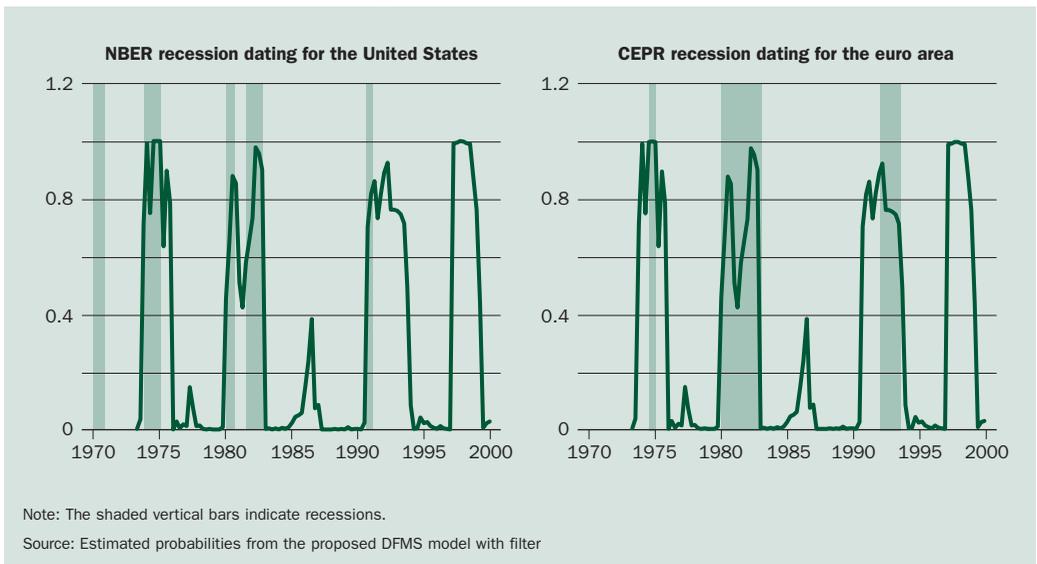**Probabilities of Recessions for the United Kingdom**

NBER recession dating for the United States   CEPR recession dating for the euro area

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

Figure 6
Probabilities of Recessions for Japan

NBER recession dating for the United States   CEPR recession dating for the euro area

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

started and ended at about the same time in the United States and the OECD. However, the U.S. economy experienced two recessions between 1980 and 1982 while only one long recession occurred in the OECD countries altogether.

G7 countries. Figures 3–9 plot the probabilities of recession for all G7 countries and contrast these probabilities with the NBER dating for the United States (the first panels of Figures 3–9) and the CEPR dating for the euro area (the second panels of Figures 3–9) for each country. The probabilities of recession show some similarities and differences in the business cycles of the G7 countries. The G7 countries also

Figure 7
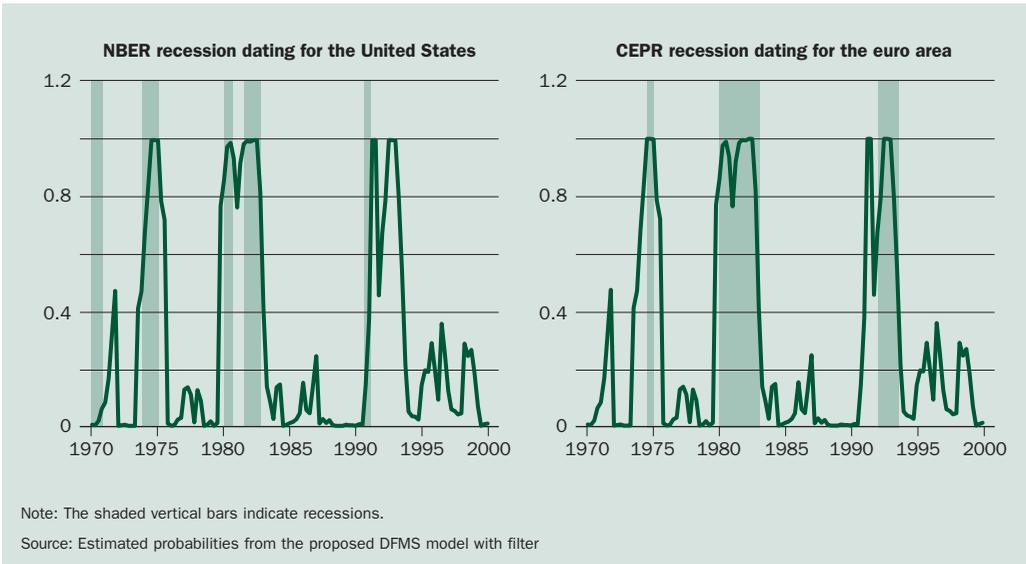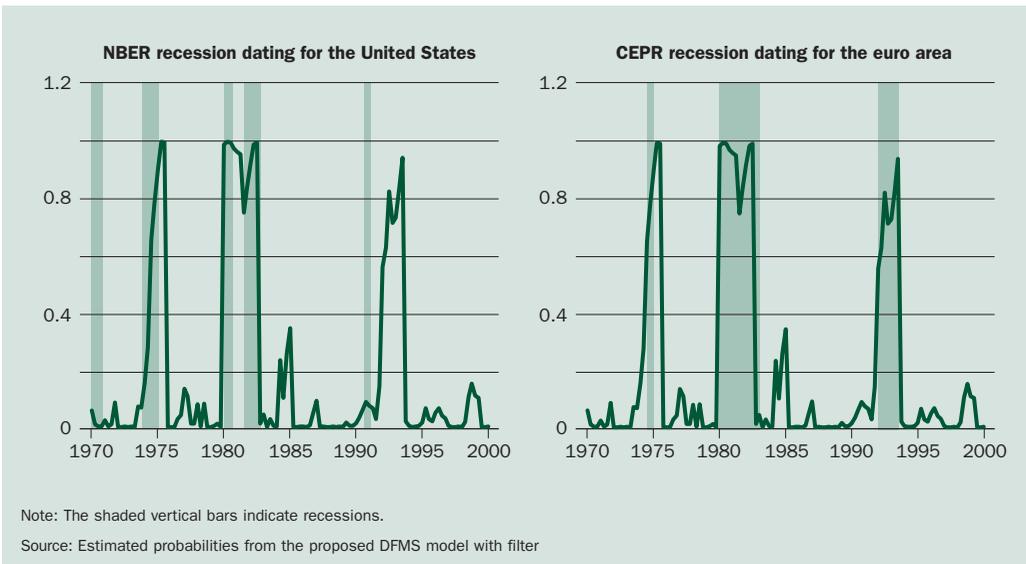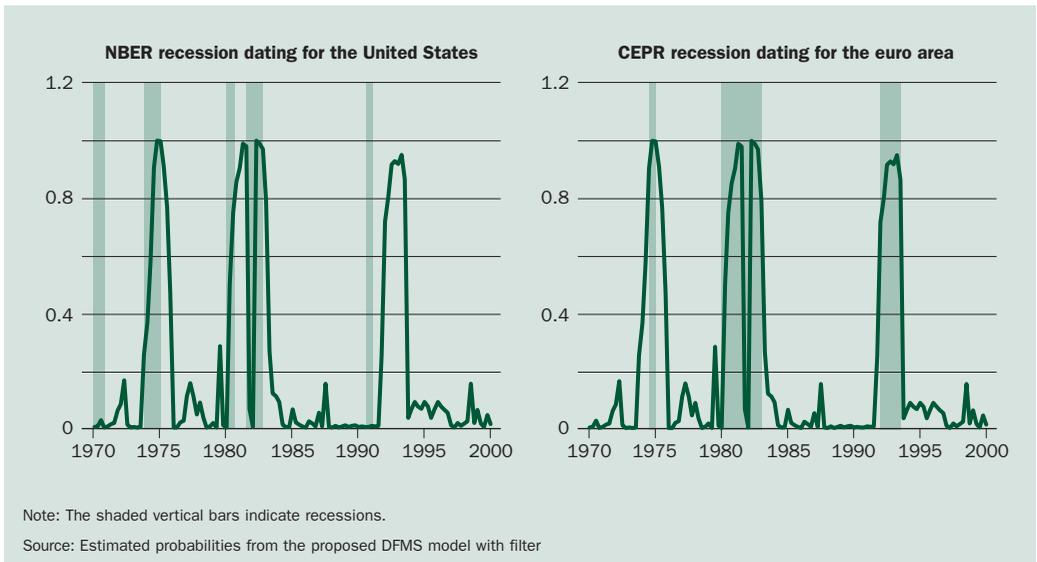**Probabilities of Recessions for Germany**

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

Figure 8
Probabilities of Recessions for France

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

experienced three or four full recessions in the period studied;[7] Japan experienced
an additional recession in 1997–99.

The most similar recession across the G7 countries is the one that took place in the
mid-1970s, which hit all economies at about the same time. The recession in the early
1980s was a long one, lasting three or four years for some countries (France, Germany,
the United Kingdom, and Japan) and for the aggregate OECD and G7 measures,
whereas for a few countries (Italy, the United States, and Canada), two shorter reces-
sions instead occurred close to each other during the same period.

Figure 9
Probabilities of Recessions for Italy

NBER recession dating for the United States

CEPR recession dating for the euro area

Note: The shaded vertical bars indicate recessions.

Source: Estimated probabilities from the proposed DFMS model with filter

The main difference in business cycles among these countries concerns the early 1990s recession. This recession started earlier in the United Kingdom, the United States, Canada, and Japan while in Germany and the other G7 countries this recession did not begin until one or two years later. For the aggregate OECD and G7 countries, this recession started and ended at about the same time as the CEPR date for the euro area (Figure 2). The NBER dates the beginning of this recession in the United States in July 1990 while the CEPR dates the start of the recession in the first quarter of 1992.

The closest estimated probabilities of recessions are for the United States and Canada. Recessions began and ended at about the same time in these two countries. Italy and France also have very close recession timing. The one difference between these two countries is in the early 1980s: France experienced a single long recession while Italy had two recessions during this period.

The probabilities of recession for Germany, the United Kingdom, and Japan are also very similar for the first two recessions in the sample. The probabilities suggest that recessions in the United Kingdom occurred slightly ahead of those in Germany and Japan and occurred more closely to recessions in the United States and Canada. In the 1990s recession, the U.K. economy contracted even before the U.S. and Canadian economies. Overall, recessions in the United Kingdom occurred earlier than in other European countries, followed by Germany. Recessions in the United Kingdom also lasted longer than those in the United States, Canada, and Germany.

The Japanese economy displays dynamics similar to the other G7 and OECD countries in the 1970s and 1980s. However, Japan experienced two severe and long recessions in the 1990s: one in 1991–94 and another in 1997–99 (Figure 6). The earlier recession hit Japan at about the same time that it hit the United States but did not end until much later, coinciding with the trough of the recession in the OECD countries.

7. The sample begins in 1970 and therefore does not include the recessions that occurred in the United States and Canada around 1969–70.

The Asian financial crisis that started in 1997 marked the beginning of a second 1990s recession in Japan that was not experienced by any of the other G7 countries studied.

Conclusions

This article constructs business cycle indicators for the G7 countries and for an aggregate measure of output by twenty-nine industrialized and semi-industrialized OECD member countries. We extend the Markov-switching dynamic factor model by adding a self-adjusting variable-bandwidth filter. The model yields output probabilities of the current business cycle phase for each G7 country and for the aggregate OECD and G7 output measures, which can be used as a warning system to monitor country-specific and international business cycles.

As a result of the filter, the probabilities of recession display a clearer distinction between recessions and expansions, reducing the risk of calling false turning points. We find a common business cycle underlying the twenty-nine OECD countries, characterizing an international business cycle. The probabilities of recessions for the aggregate OECD countries indicate that they shared three major recessions in the period analyzed: during the oil crisis in the mid-1970s, in the early 1980s, and in the early 1990s. The most similar recession in terms of timing and duration across countries is the one that took place in mid-1970s, and the most divergent is the one that occurred in the early 1990s.

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