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ABSTRACT
This paper proposes classical business cycle turning points for a number of countries based on industrial production. The countries selected are the G7 together with most major European countries. This information enables us to examine the international nature of cyclical movements. In particular, we examine whether cyclical movements are similar across different countries and consider the lead/lag relationships between countries at peaks and troughs.

Keywords: Classical Business Cycles, Turning Points, International Business Cycles

JEL classification: E32

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1 Introduction

Over the last two decades it has become evident that recessions, exhibiting substantial declines in the absolute level of economic activity, are a reality in many countries. This has prompted a revival of interest in business cycle research. The most recent recession has played an important role in this revival because it was largely unpredicted by conventional macroeconomic forecasting models and because many observers have linked it to a perception that financial liberalization and deregulation may have rendered the global economy inherently unstable.

Despite the recent appreciation of the importance of business cycles, relatively little is known about the characteristics of such cycles outside the United States. Therefore, it is unclear whether the wealth of results obtained from contemporary business cycle research will be applicable to other countries. Similarly, there has been relatively little attempt to understand cross-country influences in business cycles, but it is clearly important for policymakers to know whether the occurrence and timing of expansions and contractions across countries can be primarily attributed to common shocks or to the transmission of shocks across countries. In this respect, the most recent recession is worthy of particular study, since its economic origins are not well understood. Further, although the recessions of the 1970s and early 1980s may be attributed to oil price shocks, differences in the timing of the absorption of these shocks across different economies are also of interest. Perhaps more interesting here, however, is whether recoveries from these recessions began simultaneously in various countries, or whether they were transmitted from one or more lead countries.

There have been a number of recent studies of international business cycles, including those by Canova (1993a), Engle and Kozicki (1993), Backus, Kehoe and Kydland (1992), Backus and Kehoe (1992), Canova and Dellas (1992), for example. However, none of these studies explicitly considers turning points, so that they cannot directly examine the transmission of expansions and contractions of interest here. This is especially important in that an accumulation of evidence indicates asymmetry of economic relationships in expansions and contractions; see Neftci (1984) and Hamilton (1989) for classic references in the US context, while Acemoglu and Scott (1994) present some evidence for the UK. It appears entirely plausible that different international mechanisms could apply at peaks and troughs.

None of the work on international mechanisms hinted at above can be undertaken at the present time for the simple reason that no accepted business cycle turning points appear to be available for countries other than the United States. For the US, the National Bureau of Economic Research (NBER) dates peaks and troughs; the corresponding cycles, representing periods of expansion and contraction in the level of activity, have become known as "classical" business cycles. There is a related concept of "growth" cycles, which refers to cyclical movements around an underlying trend[1]. Dates are regularly published for growth cycle turning points in a number of countries, but corresponding classical dates are not.

[1] There was a change in emphasis from classical to growth cycles, particularly in Europe, after the debate in the 1960s over the possible obsolescence of the business cycle; see Bronfenbrenner (1969) for a conference on this theme.

It seems self-evident that recessions, in the sense of absolute declines in activity, are more important that declines relative to trend. There are also technical reasons why one may choose to analyze classical business cycles instead of growth cycles. In particular, different detrending methods may yield different growth cycle chronologies (Canova, 1993b), which is a problem when the trend is a fuzzy concept. Further, commonly used detrending methods may induce spurious cycles (see King and Rebelo, 1993, and Osborn, 1993, for two examples).

This paper goes some way towards rectifying the lack of classical business cycle information by proposing dates for a number of countries based on industrial production. The countries selected are the G7 together with most major European countries. This information then enables us to examine the international nature of cyclical movements. In particular, we are interested in whether cyclical movements are similar across different countries and in the lead/lag relationships between countries at peaks and troughs.

The paper is organized as follows. Section 2 discusses our methodology for identifying classical turning points, with the details of our procedure included as Appendix 1. Results are discussed in the following two sections, with Section 3 considering cycles country by country and Section 4 looking at international aspects. Conclusions complete the paper.

2 Establishing Business Cycle Chronologies

Our methodology for turning point dating is based on that employed by the NBER and, in particular, the work of Burns and Mitchell (1946) and Bry and Boschan (1971). The latter are henceforth denoted as BB. BB (p.17) point out that "*...turning point determination ... cannot be regarded as objective in the sense that all reasonable and conscientious investigators would agree on the answers. Only agreement on the application of a specific set of detailed, and sometimes arbitrary, procedural conventions could bring about agreement on the choice of turns.*" Our classical business cycle turning point dates are based on such a set of rules. We hope that other researchers will agree that these rules are at least reasonable. BB themselves provide a set of rules, which have been widely used (see Watson, 1994, for a recent example) and these provide our starting point.

The procedure we adopt is detailed in the Appendix. It consists essentially of four steps. In step I extreme values are identified and replaced, since we do not want these to unduly influence a procedure which is designed to look for broad upward and downward movements. Then step II smooths (or averages) values to reduce the importance of short-run erratic fluctuations. Turning points are tentatively identified in this smoothed series as occurring at observations the values of which are greater (less) than those for twelve months on either side whilst peaks and troughs are required to alternate. In step III we return to the unsmoothed data and use similar rules to identify tentative turning points with the additional requirements that the amplitude of a phase be at least as large as one standard error of the monthly log changes and the duration of a cycle (peak to peak and trough to

trough) be at least 15 months. The final stage, step IV, compares the two sets of tentative turning points. When there is a close correspondence between the indications given by the two alternative sets of tentative turning points (and only in this case), we confirm the existence of a turning point, with the final date being that identified in the unsmoothed (original) series.

Table 1 shows the turning points identified for industrial production data for nine European countries (Germany, France, UK, Italy, Spain, Belgium, Netherlands, Ireland and Luxembourg) together with the USA, Canada and Japan. The data used are monthly and seasonally adjusted, covering the period 1961:1-1993:12. For ease of later international comparison, turning point dates are aligned in the table in accordance with apparent "common" cycles. Our (arbitrary) rule was that cycles were aligned if the recessions either overlapped or the beginning of recession in one country was within three months of the end of recession in another. Mild recessions (defined as involving a total decrease of less than 5 percent) are indicated by the use of underlining.

Attention here is confined to industrial production for reasons of tractability and data availability. Nevertheless, we recognise that the identification of business cycle turning points ideally requires the analysis of a number of different series. However, we believe that the important characteristics which we uncover will apply more generally than just to industrial production. Figures 1-12 show the series together with the identified turning points; the top panel of each diagram shows the series smoothed using a seven-month centred moving average, while the original

data are graphed in the bottom panel. Note that the symbol "x" in the lower part of a figure indicates cases where a turning point was identified in stage III of the procedure but subsequently deleted in the final stage IV since no corresponding turning point was identified close to that region in the smoothed series.

There is no objective standard with which we can compare the dates we show in Table 1. We have, however, compared our results with those obtained by applying the comparatively more complicated set of rules embodied in the BB procedure[2]. As shown by the comparison in Appendix Table A3, the BB procedure is relatively more sensitive; with the single exception of a cycle for Belgium detected by BB in 1990-91, all of our identified cycles correspond to the ones detected by the BB procedure but that procedure also identifies some additional cycles. As an examination of the graphs in Figures 1 to 12 indicates, the recessions in these additional cycles are not very marked; whether they represent "true" recessions must be a matter of judgement. We note, however, that the additional cycle identified by BB for the US is not a business cycle according to the widely-accepted NBER reference chronology (see Table 2 below). On balance, we prefer the stricter criteria embodied in our procedure, since they serve to guard against small idiosyncratic movements in industrial production being confused with business cycles.

[2]The GAUSS procedure was written by Mark Watson and replicates that of the BB procedure. The BB programs are also described and used by King and Plosser, 1994, and Watson, 1994.

Table 1: Classical Business Cycle Chronologies for Industrial Production

	USA	Canada	Japan	Germany	France	UK	Italy	Spain	Belgium	Netherl.	Ireland	Luxemb.
Peak							64M1					
Trough							64M8					
Peak				66M3		66M7						65M2
Trough				67M5		66M11						67M8
Peak	69M10	69M7				71M1						70M3
Trough	70M11	70M10				72M2						70M10
Peak	73M11	74M3	74M1	73M8	74M8	74M6	74M6	74M8	74M4	74M8	74M2	74M8
Trough	75M3	75M5	75M3	75M7	75M5	75M8	75M4	75M8	75M7	75M8	75M4	75M8
Peak					77M1		77M1		76M10	76M9		76M5
Trough					77M12		77M6		77M9	78M5		76M12
Peak	80M3	79M8		79M12	79M8	79M6	80M3		79M12	80M3	79M9	79M12
Trough	80M7	80M6			80M11	81M5			80M12		80M12	81M4
Peak	81M7	81M4	81M11		81M12							
Trough	82M12	82M10	82M10	82M11	82M8		83M6			82M11		
Peak						84M1						
Trough						84M8						
Peak		86M1	85M5							87M1		85M10
Trough		86M8	86M8							88M4		87M8
Peak	89M4	89M4	91M5	91M6	92M4	90M6	89M12	90M1	90M3	91M2		92M5
Trough	91M3	91M2				92M5		91M3	91M8			
Peak								91M10	91M12			

Note: Underlined dates denote minor recessions with total decline of less than 5 percent.

3 Results for Individual Countries

The dates identified in Table 1 provide a starting point for a closer analysis of the cycles. In what follows we briefly discuss the cycles in each country, highlighting any difficulties encountered in the analysis.

Figure 1 relates to the USA, where our procedure identifies five peaks and troughs over the relevant period. In this case we can refer to the alternative chronology provided by the NBER reference dates and Table 2 compares these with our dates for turning points in industrial production. Although the NBER dates refer to general economic conditions and not simply to industrial production, there is a striking correspondence between the two chronologies[3]. In six out of the ten cases the dates coincide exactly, with generally small differences otherwise. The only disagreement of note is in the dating of the 1989/90 peak, where our procedure selects a date more than a year in advance of the NBER one. In the context of industrial production, however, the earlier date is more plausible in that its value exceeds the maximum reached in 1990.

Figure 1 shows three cases of an apparent turning point in the original series being deleted by our procedure as it is not also identified in the smoothed series of the upper panel. One of these occurs in 1967 and the other two more recently in

[3] An NBER reference trough in 1961 is ignored in Table 2, because this occurs too early in the sample period for our procedure to be able to identify it.

1989-90. The exclusion of these dates suggests that the mapping process, in the last stage of the procedure, is useful in eliminating possibly spurious cycles[4].

Table 2: NBER Dates and Own Industrial Production Chronology for the US

Peaks:	NBER	69M12	73M11	80M1	81M7	90M7
	Industrial Production	69M10	73M11	80M3	81M7	89M4
Troughs:	NBER	70M11	75M3	80M7	82M11	91M3
	Industrial Production	70M11	75M3	80M7	82M12	91M3

Source for NBER dates: Survey of Current Business, April 1994.

Canada has relatively clear cycles. The only difficulty encountered is that the last trough in the original series is located 11 months away from the corresponding trough in the moving average. For inclusion as a reference turning point, our program sets a limit of 5 months between the tentative turning points identified in the original and smoothed series. In this case, however, we override the automatic program and include it as a reference trough. A similar situation occurs in Italy (see Figure 7) during 1977, where we set 1977:6 as a trough despite its exclusion by the automatic procedure. Otherwise, despite erratic month-to-month movements, the turning points identified for Italy appear to be clear.

[4]It is worth pointing out that, in contrast to the procedure adopted here, the original Bry-Boschan procedure comes up with two cycles during 1989-91; see the Appendix.

The case of Japan is an interesting one and requires some discussion. As shown in Figure 3, the dominant property of Japanese industrial production is of sustained growth with little cyclical fluctuation. Our procedure does, however, identify some cycles with the two largest recessions being in 1974-75 and the most recent one, 1991-onwards. These two cycles show obvious (absolute) declines in industrial production. For the recessions identified in 1981-82 and 1985-86, on the other hand, industrial production is relatively flat, with declines in total of only 4.2 and 3.4 per cent respectively.

In contrast, Germany is straightforward and cycles are generally clear after smoothing is undertaken. Notice that the value marked with "E" on the lower part of the diagram is classified as 'extreme' according our rules and is not regarded as a turning point. Figure 4 also reveals that although two turning points were identified in 1986 in the smoothed series, these were not included in the final selection since no corresponding turning points were detected in the original series. In contrast, the BB procedure would retain these.

The case of France (Figure 5) is more problematic, with cyclical movements during the 1980s being far from clear. Our procedure selects 1980:11 and 1981:12 as a trough and peak respectively, but this is a minor fluctuation and the question is whether one should classify this as a cycle at all. Certainly in terms of the amplitude this is not typical and output only rises by 3.1 per cent to reach the peak in December 1981. The recession detected in 1982 is also relatively minor and further doubts must exist about the recession identified in 1984-85. For this latter

case, the points marked "a" in the lower panel imply that these potential turning points are excluded in accordance with the minimum amplitude rule; that is, the change from trough to peak is less than one standard error of (log) changes in the series. It may also be noted that the two extreme values in 1963 and 1968 are effectively ignored.

The UK cycles are identified relatively easily in Figure 6, but two features are worth noting. The first is the selection of 1972:2 as a trough; this was classified as an extreme observation (it is thus adjusted for in the top panel of the diagram) but since the procedure identified a trough for the smoothed series in 1972:12, this extreme observation (being the local minimum in the original series) was selected as a trough for industrial production. The second point refers to 1973-74. A peak is required to be larger than values 12 months on either side: this rules out a short cycle with a peak in 1973 and the abrupt fall in industrial production early in 1974 as a recession[5].

For the case of Belgium, shown in Figure 9, the decade of the 1980s is again problematic. This is especially so with the original data, where erratic movements are in evidence. Since, however, our procedure requires turning points to be detected in both the original and smoothed series before they are accepted, the period from 1981 to 1990 is classed as an expansion for Belgium. The trough dated in 1991 may also be controversial due to the erratic nature of the

[5] This fall relates to the "three day" working week enforced to economise on stocks of fuel during a coal mining strike, and hence may be attributed to special factors.

fluctuations. Industrial production for the Netherlands (Figure 10) raises similar problems due to its noisy movements. Two particular cases to note are the recessions identified from 1976 to 1978 and from 1987 to 1988, during which industrial production declined by 5.4 and 8.8 per cent respectively. The latter one, at least, appears to be reasonably clear in the graph after the values are smoothed.

The data for Luxembourg, shown in Figure 12, are noisy but exhibit quite marked cyclical fluctuations. Indeed, with seven peaks and six troughs, Luxembourg has experienced more business cycles than any other country considered. As the smallest country in the sample, it may be more susceptible to such fluctuations. The principal difficulty in dating relates to the 1976 recession which our procedure detects, although this does not seem to be an important cyclical fluctuation in the graph of the original series.

Spain and Ireland (Figures 8 and 11) are fascinating since they exhibit very few classical cycles. Although industrial production in Spain fell substantially in 1974-75 and during the latest recession, Ireland displays no cycles except for those resulting from two mild recessions (1974-75 and 1979-80).

Tables A4-A15 in the Appendix record the statistical characteristics, country by country, of each identified business cycle. Rather than explicitly discussing these here, we move on to our principal interest, which is relationships across countries.

4 International Business Cycles

The first question that needs to be investigated is whether cycles differ in terms of their timing, that is whether they are synchronised with each other. In addition, it is also of interest whether cycles differ in terms of their intensity and duration.

Table 3 provides comparative summary information on regime-specific characteristics. The figures in the table are derived by calculating the averages across all completed expansions and contractions in the sample; the average monthly decline (rise) in Industrial Production multiplied by the average duration of contractions (expansions) gives the total change, also shown in the table.

Table 3: Classical Business Cycle Characteristics

	Recessions			Expansions		
	Monthly change	Total change	Duration	Monthly change	Total change	Duration
USA	-0.763	-8.672	15	0.493	22.512	46
CAN	-0.650	-9.195	14	0.625	20.330	35
JAP	-0.743	-10.095	13	0.535	28.878	56
GER	-0.519	-11.373	24	0.456	33.708	77
FRA	-0.795	-7.862	11	0.451	12.350	42
UK	-0.778	-9.810	14	0.448	18.445	45
ITA	-1.462	-13.742	15	0.673	35.491	63
SPA	-1.308	-16.529	13	1.146	26.535	90
BEL	-0.842	-11.417	14	0.877	17.323	39
NET	-0.515	-9.247	20	0.600	15.408	30
IRE	-0.739	-10.641	15	0.740	39.219	53
LUX	-1.879	-21.821	16	1.171	30.362	39
Avg	-0.916	-11.7003	15	0.684	25.046	51

Notes: (a) Changes are expressed in terms of logarithms, while durations refer to months.
(b) All figures are averages over completed recessions or contractions.

The first thing to note is the asymmetry of the cycles across all countries; output falls much more abruptly than it rises. Simply averaged across countries, industrial production falls by 0.916 per cent a month in recession, compared to a 0.684 per cent rise during expansions. Indeed, only in the individual cases of Belgium and the Netherlands is the average monthly change in recessions smaller in magnitude than the average growth in expansions. Since industrial production has grown over the post-war period, it is not surprising to find that economies stay, on average, approximately three times as long in the expansion phase as they do in recession. When they occur, recessions in Germany appear to be severe: they last longer than in other countries, with the three recessions detected here having an average duration of two years and they result in a total decline of industrial production of over 10 percent. At the other extreme, France has experienced four recessions at an average duration of less than a year and with the smallest average decline of under 8 percent. In expansions, Spain and Ireland show, respectively, the longest average duration and the largest total change. Whilst Germany stays in recessions for longer periods she also grows for longer in the recovery phase; the ratio of the duration of the upturn to that of the downturn is close to the overall average.

Table 4 shows the durations of complete cycles, that is from peak-to-peak and trough-to-trough. Germany experiences long cycles compared to other countries with the average duration from peak-to-peak being 101 months in contrast to 58.5 months for the USA and 69.3 months for Japan. In this respect, the group of European countries of France, Belgium, the Netherlands and Luxembourg appear to exhibit shorter cycles than Germany, Japan or, less markedly, the USA. However,

it must be borne in mind, both here and elsewhere, that these results should be interpreted with care since few cycles occur within our sample period[6].

Table 4: Average Durations of Cycles

Country	Peak-to-Peak	Trough-to-Trough
USA	58.5	63.5
CANADA	47.4	48.8
JAPAN	69.3	68.5
GERMANY	101.0	93.0
FRANCE	53.0	29.0
UK	57.4	61.2
ITALY	77.75	75.0
SPAIN	185.0	187.0
BELGIUM	53.0	64.3
NETHERLANDS	49.5	50.6
IRELAND	67.0	68.0
LUXEMBOURG	54.16	48.0
Average	72.75	71.4

From the results in the appendix it can be seen that the most severe recession (during the period under investigation) was the one associated with the first oil shock in 1973-75. In the USA, for example, industrial production declined by approximately 16 per cent from peak to trough. The shortest recession occurred during 1980 in the USA (see also Zarnowitz and Moore, 1981), lasting only 4 months and implying an average fall in the index of industrial production of nearly 1.5 per cent an month.

[6]The big difference between the peak-to-peak and trough-to-trough durations for France is the result of the exclusion of the last trough-to-trough cycle which has not yet been completed.

An interesting observation can be made by comparing the figures for USA and Canada. Contrary to the conventional wisdom, our dates suggest that the average duration of US expansions is large compared to Canada[7]. Furthermore Canada experienced an additional recession in the mid-1980s which, although lasting only 7 months, involved a substantial fall in industrial production. Moreover, whilst the first two contractions are milder for the case of Canada, the three cycles occuring after 1979 are deeper and longer lasting. For example, during the last recession, industrial production in Canada declined by nearly 10 per cent from peak to trough compared with only 4.6 per cent for the USA.

In aligning cycles across countries in Table 1, we attempt to present further information on the synchronisation of cycles. It is, indeed, striking how few recessions in this period are confined to one country alone. Only those experienced by Italy in 1964 and the UK twenty years later are, by our alignment convention, unique.

Compared to the subsequent two decades, the 1960s shows few classical business cycle recessions. The first truly international recession here is that of 1973-74. Although the severity of this was undoubtedly associated with the oil price rises,

[7]One reason for the big difference between the average duration rates between the two countries is the additional cycle experienced by Canada in the mid-1980s. Also the BB dates, reported in Appendix 1, suggest that a second cycle exists in the 1989-92 period, that is a 'double dip' recession did occur (this is not consistent with the NBER dates). This small difference in the turning points reduces the average duration for the USA cycle (peak-to-peak) to 50.6 months compared to 48.2 for Canada, thus eliminating the apparent gap between the two countries.

the peaks in Germany and the US pre-date the oil price increase of 1974[8]. Although avoided by some countries, industrial production in a number of countries also declined in 1976-77. Indeed, the evidence of Table 1 is that this recession was a European phenomenon. Then, between 1979 and 1981 all countries with the single exception of Spain experienced one, or sometimes two, recessions. Of course, oil price rises again played a role here. Apart from the UK's idiosyncratic decline in industrial production in 1984, four other countries showed declines in output in the mid-1980s. Of these, however, those of Canada and Japan were relatively slight. Finally, another international business cycle recession was in evidence around the turn of the decade.

In summary, three recessions are common across almost all countries, those being the ones commencing in 1973-75, 1979-80 and 1989-91. These are associated with large falls in output and are examined in further detail below.

Table 5 compares the contractions which occurred in 1973-74 and which are associated with the first oil price shock. It shows the dates of the turning points for the twelve countries analyzed together with the cumulative (percentage) decline in industrial production, the duration (in months) and information concerning the timing of the turning points relative to those in the US and Germany.

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[8]Oil prices rose gradually from October 1973, when the oil embargo was imposed, to January 1974. The biggest rise occurred between December and January when the price of oil rose from approximately $5 a barrel to $12 in January.

Industrial production declined significantly during that period with the smallest country, Luxembourg, experiencing the largest fall. Among the remaining countries Japan and Spain experienced the biggest declines, the Netherlands the smallest. In terms of duration Germany had the longest (23 months) and France the shortest (9 months) recession while the rest varied from 10 to 16 months.

Table 5: The 1973-75 Recession

Country	Peak/Trough	Depth(%)	Duration	Lead(-)/Lag(+) Relative to USA	Lead(-)/Lag(+) Relative to GER
USA	73M11/75M3	16.023	16		+3/-4
CANADA	74M3/75M5	12.128	14	+4/+2	+7/-2
JAPAN	74M1/75M3	22.653	14	+2/0	+5/-4
GERMANY	73M8/75M7	12.921	23	-3/+4	
FRANCE	74M8/75M5	15.989	9	+9/+2	+12/-2
UK	74M6/75M8	12.623	14	+7/+5	+10/+1
ITALY	74M6/75M4	17.415	10	+7/+1	+10/-3
SPAIN	74M8/75M8	21.395	12	+9/+5	+12/+1
BELGIUM	74M4/75M7	13.141	15	+5/+4	+8/0
NETHER.	74M8/75M8	9.333	12	+9/+5	+12/+1
IRELAND	74M2/75M4	11.056	14	+3/+1	+6/-3
LUXEM.	74M8/75M8	53.564	12	+5/+5	+8/+1
Average		**18.19**	**13.75**	**+5.2/+2.2**	**+8.5/-1.3**

Finally, the table shows that, with the exception of Germany, all the countries went into the recession after the US. On exit, the US preceded all countries except Japan, with which it was contemporaneous. Perhaps the most remarkable thing about the upturn, however, is that despite the widely varying durations of the recession, only five months separated the troughs across these 12 countries. This, with the contemporaneous dating of those US and Japan, indicates that a simultaneous shock may have been responsible.

Table 6: The 1979-80 Recession

Country	Peak/Trough	Depth(%)	Duration	Lead(-)/Lag(+) Relative to USA	Lead()/Lag(+) Relative to GER
USA	80M3/80M7	5.980	4		+3/na
CANADA	79M8/80M6	7.607	10	-7/-1	-4/na
JAPAN	na/na				
GERMANY	79M12/na	12.139*	35*	-3/na	
FRANCE	79M8/80M11	6.286	15	-7/+4	-4/na
UK	79M6/81M5	15.806	23	-9/+10	-6/na
ITALY	80M3/na	16.338*	39*	0/na	+3/na
SPAIN	na/na				
BELGIUM	79M12/80M12	15.209	12	-3/+5	0/na
NETHER.	80M3/na	13.353*	32*	0/na	+3/na
IRELAND	79M9/80M12	10.226	15	-6/+5	-3/na
LUXEM.	79M12/81M4	21.507	16	-3/+9	0/na

*Notes: (a) * indicates one recession experienced over the period 1979 to 1982.*
(b) na indicates that no peak (trough) is dated for this recession

Table 7: The 1981-82 Recession

Country	Peak/Trough	Depth(%)	Duration	Lead(-)/Lag(+) Relative to USA	Lead(-)/Lag(+) Relative to GER
USA	81M7/82M12	9.423	17		na/+1
CANADA	81M4/82M10	17.027	18	-3/-2	na/-1
JAPAN	81M11/82M10	4.216	11	+4/-2	na/-1
GERMANY	na/82M11	12.139*	35*	na/-1	
FRANCE	81M12/82M8	4.386	8	+5/-4	na/-3
UK	na/na				
ITALY	na/83M6	16.338*	39*	na/+6	na/+7
SPAIN	na/na				
BELGIUM	na/na				
NETHER.	na/82M11	13.353*	32*	na/-1	na/0
IRELAND	na/na				
LUXEM.	na/na				

*Notes: (a) * indicates one recession experienced over the period 1979 to 1982.*
(b) na indicates that no peak (trough) is dated for this recession

Notice also that the US lead time for the peak seems to be longer compared to that for the trough (5.2 and 2.2 months respectively). Compared with the US, Germany seems to have gone early into the recession, but came out late.

Tables 6 and 7 compare the contractions of the 1979-82 period. Since a number of countries experienced two cycles at the beginning of the 80s we present the results for the two cycles separately, while indicating where only one cycle occurs. The US and Canada each experienced two recessions in the 1979-82 period. In both countries the second was the more severe and lasted longer. Further, Japan went through one (mild) recession at about the same time as the second US/Canada cycle. France was the only European country to experience both recessions, but here the second was relatively mild[9]. European countries, notably Germany, Italy and the Netherlands, experienced a single prolonged recession spanning both periods. Indeed, Europe led the 1979 downturn, with all the European countries going into recession before the USA, in contrast to the 1973-74 cycle. It may be germane to note that the European countries decided at the same time to prioritize counter-inflationary policies, and began their participation in the ERM.

In recovery from the first recession, North America once again led the way. For the US and Canada the second recession was, however, the more severe. Here the US, German and Japanese economies all emerged within two months of each other,

[9]One can argue that the extra (minor) cycle experienced by France was associated with the famous 'Mitterrand U-turn'(see Sachs and Wyplosz, 1986, for example).

again raising the question of the synchronous nature of the process which might have led to this.

Table 8: The Latest Recession

Country	Peak/Trough	Depth(%)	Duration	Lead(-)/Lag(+) Relative to USA	Lead(-)/Lag(+) Relative to GER
USA	89M4/91M3	4.603	23		-26/
CANADA	89M4/91M2	9.928	22	0/-1	-26/
JAPAN	91M5/			+25/	-1/
GERMANY	91M6/			+26/	
FRANCE	92M4/			+36/	+10/
UK	90M6/92M5	8.091	23	+14/+14	-12/
ITALY	89M12/			+8/	-18/
SPAIN*	90M1/			+9/	-17/
BELGIUM*	90M3/			+11/	-15/
NETHER.	91M2/			+10/	-4/
IRELAND					
LUXEM.	92M5/			+37/	+11/

*Note: * indicates that, according to our dates, two downturns were experienced during this period. The earlier peak is used here.*

Finally table 8 compares the latest contractions. Although we have identified the trough for only three countries (USA, Canada and the UK) the information in the table reveals that, as with the 1973-74 contraction, the US and Canada were the first to go into recession. In addition, the time lag is substantially longer and varies from 8 months for Italy to 36 months for the case of France. Finally, from the table we can also see that Germany went late in to recession; this may reflect the idiosyncratic 'unification shock' suffered by that country.

5. Conclusions

In this paper we have examined the existence and properties of classical cycles in industrial production for a number of countries. The countries selected were the G7 together with most major European countries, enabling us to examine the international nature of cyclical movements. Our dates were derived using mechanical rules which effectively reproduce the NBER reference dates for the US. Therefore, we are confident that our procedure is reasonable. For countries other than the US, we know of no other dating exercise comparable to that undertaken here.

Although attention was confined to industrial production, we believe that we have uncovered features of interest in the international transmission of business cycles. Although our dating exercise looks at each country in isolation, we have established that very few business cycles are confined to a single country. This indicates that macroeconomists should be alert to turning points (both peaks and troughs) resulting from external factors, rather than always being the consequence of domestic events. Further, this indicates the potential value of information from other countries in the construction of leading indicators and the prediction of turning points.

Our study also finds that many countries started their recoveries from the 1973-74 recession almost simultaneously, while the same is true for the recoveries of the US, Japan and Germany from the 1981-82 recession. This raises the question of what gives rise to such an international effect. On the other hand, however, the

most recent recession seems to be different, since by the end of 1993, of these three dominant economies, only the US appeared to be in an expansion phase. With the possible exception once again of this last recession, there appears to be greater correspondence in the dates of troughs across countries than in that of peaks.

APPENDIX 1: PROCEDURES FOR DATING CLASSICAL BUSINESS CYCLES

The Bry-Boschan procedure

The approach employed by BB is related to the process of turning point determination practised by the NBER. It involves, in the first instance, the detection of extreme values and their substitution by interpolated values. Turning points are then detected for a smoothed series and these are subsequently used as a basis for the identification of cycles.

The idea is that smoothing (accomplished by applying a moving average filter) will simplify the identification of expansions and contractions and the selection of the general neighbourhoods of "potential" peaks and troughs. The procedure continues and the neighbourhood of potential turns is redefined by identifying peaks and troughs corresponding to those of a series that is only slightly smoothed by a shorter moving average. As a result of the second filter one comes closer to the eventual location of the turning point. Once the immediate neighbourhood of potential turns is established the analysis shifts back to the original data.

Table A1: Bry-Boschan Procedures

I. Determination of extremes and substitution of values

II. Determination of cycles in 12-month moving average (extremes replaced).
- *A. Identification of points higher (or lower) than 5 months on either side.*
- *B. Enforcement of alternation of turns by selecting highest of multiple peaks (or lowest of multiple troughs)*

III. Determination of corresponding turns in Spencer curve (extremes replaced).
- *A. Identification of highest (or lowest) value within ±5 months.*
- *B. Enforcement of minimum cycle duration of 15 months by eliminating lower peaks and higher troughs of shorter cycles.*

IV. Determination of corresponding turns in short-term moving average of 3 to 6 months, depending on MCD (months of cyclical dominance).
- *A. Identification of highest (or lowest) value within ±5 months of selected turn in Spencer curve.*

V. Determination of turning points in unsmoothed series.
- *A. Identification of highest (or lowest) value within ±4 months, or MCD term, whichever is larger, of selected turn in short-term moving average.*
- *B. Elimination of turns within 6 months of beginning and end of series.*
- *C. Elimination of peaks (or troughs) at both ends of series which are lower (or higher) than values closer to end.*
- *D. Elimination of cycles whose duration is less than 15 months.*
- *E. Elimination of phases whose duration is less than 5 months.*

VI. Statement of final turning points.

Table A1 shows the procedure followed by Bry-Boschan (1971). The procedure initially identifies, potential turning points on the 12-month moving average, then uses the Spencer curve to identify the highest (lowest) value within ±5 months of the selected turns in the 12-month moving average. When the set of tentative turning points for the Spencer curve is established, a minimum cycle duration requirement is imposed. The next step is to map, once more, the potential turning points identified on the Spencer curve on to a shorter moving average (3 to 6

months). Specifically the procedure identifies the highest (lowest) value, for this short moving average, within ±5 months of the selected turns in the Spencer curve. In the final stage the procedure repeats the exploration for turns using the original, unsmoothed series, based on the record of tentative turning points from the previous stage, that is, the short-term moving average. In this stage, however, the program identifies the highest (lowest) value within ±4 months (or MCD term) of the selected turns in the short-term moving average. In addition other rules are enforced, including minimum phase and cycle durations of 5 and 15 months respectively.

The procedure adopted

A simplified version of the BB procedure is followed in this paper; Table A2 provides an overview of this procedure. The results of our procedure and those of BB are compared in Table A3.

As in the BB procedure, the process begins with a search for "extreme" values or outliers. This is necessary for the second stage in the identification process since these extreme values have to be adjusted before the smoothing of the data. In this paper extreme values are defined as those values whose change compared with both adjacent months is greater than 3.5 standard errors of the (log) differenced series. Jumps in the index of industrial production, that is permanent increases or decreases in the series, are therefore not classified as extreme observations. Ideally one would have liked to use the standard error of a corrected series as a

basis for the identification of extreme values but this is not practical. For such extreme values, the series are adjusted prior to stage II[10].

In the second stage the procedure determines cycles in a 7-month (centred) moving average[11]. Values identified as local minima or maxima are chosen as tentative turning points and these are subjected to a simple test for the proper alternation of peaks and troughs.

The location of locally extreme points is determined by the identification of points higher (lower) than 12 months on either side. We experimented with 9 and 15 months but the 12-month criterion proved to give the most satisfactory balance between the elimination of too many fluctuations and the retention of shallow fluctuations[12]. As far as the enforcement of the proper alternation of peaks and troughs in concerned, the procedure chooses, of the two or more adjacent peaks (troughs), the highest (lowest) one. At the end of this process a list of tentative turning points is obtained.

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[10]The value which is identified as "extreme" , say x_t, is substituted using the average of the two adjacent observations, that is $x_t^* = (x_{t-1} + x_{t+1})/2$.

[11]BB use a long (12 month) and a short (3 or 6 months) moving average in their procedure. Since we only adopt a two stage procedure and use only one smoothed series, a 7-month moving average proved to be the best choice between shorter and longer moving averages.

[12]The results of applying the 9, 12 and 15-month local minimum/maximum rule are available upon request.

Table A2: Procedure for programmed identification of turning points

I. Determination of extreme values

II. Determination of Cycles in 7-month moving average

A. Identification of points higher (lower) than 12 months on either side.
B. Enforcement of alternation of turns by selecting the highest of multiple peaks (lowest of multiple troughs).

III. Determination of turning points on unsmoothed series

A. Identification of points higher (lower) than 12 months on either side.
B. Enforcement of alternation of turns by selecting the highest of multiple peaks (lowest of multiple troughs).
C. Identification of flat segments.
D. Identification and exclusion of "outliers" from "possible" turning points.
E. Enforcement of alternation of turns by selecting the highest of multiple peaks (lowest of multiple troughs).
F. Identification of "short cycles" (less than 15 months from peak to peak or trough to trough).
G. Minimum amplitude rule requiring the amplitude of a phase (peak to trough or trough to peak) be at least as big as 1 standard error of log changes.

IV. Comparison of tentative turning points selected for smoothed and original series

A. Exclusion of "possible" turning points of unsmoothed series that do not correspond to similar turns (± 5 months) of the moving average.

From this point onwards the process of turning point selection differs from the BB method. As we pointed out earlier the process now moves back to the original series (without adjustment for extreme values) whereas the BB procedure employs two further intermediate stages, namely the use of the Spencer curve and a short-term moving average. In addition, our procedure identifies tentative turning points for the original series independently of the turning points identified in the smoothed series. That is, the new process of identification beginning in stage III is not based

on any results obtained in the earlier stage II[13]. Those turning points selected in the original series, which do not correspond to turns in the 7-month moving average, are excluded from the final list of turning points.

In the stage III a number of additional rules are also employed, as listed in table A2. Specifically, where turning points are selected within a sequence of two or more adjacent and equal values, the procedure selects the last one of these as the turning point. In addition, since the original series includes extreme observations which are not adjusted, it is possible that these are chosen as turning points.

Furthermore a minimum duration of 15 months for cycles (peak to peak and trough to trough) is imposed. If shorter cycles are identified the peak (trough) with the lowest (greatest) value is excluded. Finally, in contrast to BB, we do set a minimum amplitude rule: our procedure requires the amplitude from peak to trough and trough to peak to be at least as large as one standard error of the (log) differenced series.

[13]This is in contrast to the BB procedure for which search in stages II, III and IV begins from the tentative dates selected in the previous stage of the procedure.

The dates compared

Table A3 compares the dates derived using the Bry-Boschan procedure with the one derived after applying the alternative simpler methodology described here. There are two things to note: firstly, in the case of a sequence of equal values we choose the last one as the cyclical turn in accordance with Bry and Boschan (1971). This is not, however, the case with the BB program we are using, which chooses the first one as the turn[14]. Secondly, as noted in the text of Section 2, the BB method identifies more cycles than our procedure, with the differences relating to relatively mild movements.

[14]BB assert that "*In the case of equal values the rule is to choose the last one as the cyclical turn, i.e., the month before the reversal of the cyclical process begins*", p.12.

Table A3: A Comparison of Classical Business Cycle Chronologies for Industrial Production

	USA		CAN		JAP		GER		FRA		UK		ITA		SPA		BEL		NET		IRE		LUX	
	New	BB	New	BB	New	BB	New	BB	New	BB	New	BB	New	BB	New	BB	New	BB	New	BB	New	BB	New	BB
Peak												7/61												8/61
Trough												1/62												5/62
Peak										4/64			1/64	1/64									2/65	2/65
Trough										12/64			8/64	8/64									8/67	8/67
Peak							3/66	3/66			7/66	3/66												
Trough							5/67	5/67			11/66	11/66												
Peak	10/69	8/69	7/69	3/69							1/71	10/70											3/70	1/70
Trough	11/70	11/70	10/70	10/70							2/72	1/72											10/70	10/70
Peak	11/73	10/73	3/74	3/74	1/74	1/74	8/73	8/73	8/74	7/74	6/74	6/74	6/74	6/74	8/74	8/74	4/74	4/74	8/74	8/74	2/74	2/74	8/74	8/74
Trough	3/75	3/75	5/75	5/75	3/75	3/75	7/75	7/75	5/75	5/75	8/75	8/75	4/75	4/75	8/75	8/75	7/75	7/75	8/75	8/75	4/75	4/75	8/75	8/75
Peak									1/77	1/77			1/77	1/77			10/76	10/76	9/76	9/76			5/76	10/76
Trough									12/77	12/77			6/77	11/77			9/77	9/77	5/78	11/77			12/76	8/77
Peak	3/80	2/80	8/79	7/79		2/80	12/79	12/79	8/79	7/79	6/79	6/79	3/80	3/80		2/80	12/79	12/79	3/80	11/79	9/79	9/79	12/79	12/79
Trough	7/80	7/80	6/80	6/80		8/80			11/80	4/81	5/81	5/81					12/80	12/80			12/80	12/80	4/81	4/81
Peak	7/81	7/81	4/81	4/81	11/81	10/81			12/81	12/81								1/82						2/82
Trough	12/82	12/82	10/82	10/82	10/82	10/82	11/82	11/82	8/82	8/82			6/83	6/83		1/82		8/82	11/82	11/82				12/82
Peak																				1/85		3/85	10/85	10/85
Trough																				12/85		8/85	8/87	12/86
Peak			1/86	1/86	5/85	5/85		7/86			1/84	1/84						11/85	1/87	1/87				
Trough			8/86	8/86	8/86	8/86		1/87			8/84	8/84						9/86	4/88	4/88				
Peak	4/89	3/89	4/89	4/89	5/91	5/91	6/91	6/91	4/92	7/90	6/90	6/90	12/89	12/89	1/90	6/89	3/90	9/90	2/91	7/92			5/92	5/92
Trough		10/89								3/91				8/91	3/91	6/91	8/91	8/91						
Peak		9/90								4/92				2/92	10/91	10/91	12/91							
Trough	3/91	3/91	2/91	2/91						1/93	5/92	5/92		4/93		1/93				12/92				

APPENDIX 2 DETAILS OF BUSINESS CYCLE CHARACTERISTICS

Tables A4-A16 show the characteristics of classical business cycles experienced by the USA, Canada, Japan, Germany, France, UK, Italy, Spain, Belgium, Netherlands, Ireland and Luxembourg within our sample period. Here information is tabulated for each recession and expansion identified in Table 1 of the text. In each table, the first four columns include the dates of the recessions and the average and cumulative (percentage) changes of industrial production over the this period and finally the duration of that phase (in months). The next four columns display similar characteristics for the expansions.

Dates for each expansion (contraction) refer to the period beginning the month after the turning point. That is an expansion (contraction) phase begins the first month after the trough (peak). The dates in the tables therefore refer to the first month of each phase rather than to the turning point itself.

Table A4: USA - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
69M11/70M11	-0.564	7.332	13	70M12/73M11	0.649	23.355	36
73M12/75M3	-1.001	16.023	16	75M4/80M3	0.494	29.611	60
80M4-80M7	-1.495	5.980	4	80M8/81M782	0.589	7.070	12
81M8/82M12	-0.554	9.423	17	83M1/89M4	0.395	30.010	76
89M5/91M3	-0.200	4.602	23				
Average	-0.763	8.672	15		0.493	22.512	46

Table A5: Canada - Percentage change in Industrial Production

Recession	Mean Change	Absolute Change Peak-to-Trough	Duration	Expansion	Mean Change	Absolute Change Trough-to-Peak	Duration
69M8/70M10	-0.291	4.366	15	70M11/74M3	0.75056	30.773	41
74M4/75M5	-0.866	12.128	14	75M6/79M8	0.415	21.183	51
79M9/80M6	-0.761	7.607	10	80M7/81M4	0.827	8.271	10
81M5/82M10	-0.946	17.027	18	82M11/86M1	0.733	28.572	39
86M2/86M8	-0.587	4.111	7	86M9/89M4	0.402	12.853	32
89M5/91M2	-0.451	9.928	22				
Average	-0.650	9.195	14		0.625	20.330	35

Table A6: Japan - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
74M2/75M3 -	-1.618	22.653	14	75M4/81M11	0.488	39.067	80
81M12/82M10	-0.383	4.216	11	82M11/85M5	0.616	19.106	31
85M6/86M8	-0.228	3.417	15	86M9/91M5	0.499	28.461	57
Average	-0.743	10.095	13		0.535	28.878	56

Table A7: Germany - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
66M4/67M5	-0.647	9.060	14	67M6/73M8	0.572	42.932	75
73M9/75M7	-0.562	12.921	23	75M8/79M12	0.473	25.060	53
80M1/82M11	-0.347	12.139	35	82M12/91M6	0.322	33.133	103
Average	-0.519	11.373	24		0.456	33.708	77

Table A8: France - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
74M9/75M5	-1.777	15.989	9	75M6/77M1	0.810	16.197	20
77M2/77M12	-0.435	4.786	11	78M1/79M8	0.595	11.899	20
79M9/80M11	-0.419	6.286	15	80M12/81M12	0.242	3.143	13
82M1/82M8	-0.548	4.386	8	82M9/92M4	0.157	18.163	116
Average	-0.795	7.862	11		0.451	12.350	42

Table A9: UK - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
66M8/66M11	-0.898	3.593	4	66M12/71M1	0.271	13.539	50
71M2/72M2	-0.989	12.864	13	72M3/74M6	0.824	23.091	28
74M7/75M8	-0.902	12.623	14	75M9/79M6	0.474	21.804	46
79M7/81M5	-0.687	15.806	23	81M6/84M1	0.351	11.219	32
84M2/84M8	-0.841	5.884	7	84M9/90M6	0.322	22.574	70
90M7/92M5	-0.352	8.091	23				
Average	-0.778	9.810	14		0.448	18.445	45

Table A10: Italy - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
64M2/64M8	-1.392	9.744	7	64M9/74M6	0.577	68.027	118
74M7/75M4	-1.741	17.415	10	75M5/77M1	1.045	21.954	21
77M2/77M6	-2.294	11.469	5	77M7/80M3	0.699	23.052	33
80M4/83M6	-0.419	16.338	39	83M7/89M12	0.371	28.930	78
Average	-1.462	13.742	15		0.673	35.491	63

Table A11: Spain - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
74M9/75M8	-1.783	21.395	12	75M9/90M1	0.223	38.591	173
90M2/91M3	-0.833	11.663	14	91M4/91M10	2.069	14.480	7
Average	-1.308	16.529	13		1.146	26.535	90

Table A12: Belgium - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
74M5/75M7	-0.876	13.141	15	75M8/76M10	0.869	13.035	15
76M11/77M9	-0.578	6.362	11	77M10/79M12	0.638	17.227	27
80M1/80M12	-1.267	15.209	12	81M1/90M3	0.290	32.178	111
90M4/91M8	-0.645	10.957	17	91M9/92M12	1.713	6.851	4
Average	-0.842	11.417	14		0.877	17.323	39

Table A13: Netherlands - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
74M9/75M8	-0.778	9.333	12	75M9/76M9	1.025	13.323	13
76M10/78M5	-0.272	5.430	20	78M6/80M3	0.426	9.369	22
80M4/82M11	-0.417	13.353	32	82M12/87M1	0.416	20.793	50
87M2/88M4	-0.592	8.873	15	88M5/91M2	0.534	18.146	34
Average	-0.515	9.247	20		0.600	15.408	30

Table A14: Ireland - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
74M3/75M4	-0.790	11.056	14	75M5/79M9	0.740	39.219	53
79M10/80M12	-0.682	10.226	15				
Average	-0.736	10.641	15				

Table A15: Luxembourg - Percentage change in Industrial Production

Recession	Mean Change	Total Change Peak-to-Trough	Duration	Expansion	Mean Change	Total Change Trough-to-Peak	Duration
65M3/67M8	-0.357	10.717	30	67M9/70M3	0.835	25.899	31
70M4/70M10	-1.806	12.641	7	70M11/74M8	0.734	33.760	46
74M9/75M8	-4.464	53.564	12	75M9/76M5	3.605	32.444	9
76M6/76M12	-2.681	18.769	7	77M1/79M12	0.632	22.763	36
80M1/81M4	-1.344	21.507	16	81M5/85M10	0.728	39.290	54
85M11/87M8	-0.624	13.728	22	87M9/92M5	0.491	28.013	57
Average	-1.879	21.821	16		1.171	30.362	39

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