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Seasonal Adjustment Methods and the Determination of Turning Points of the EMU Business Cycle

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Summary

In this paper, we investigate the impact of the adjustment for seasonal effects with different seasonal adjustment methods, the possible pre-treatment for calendar effects and the different order of aggregation and adjustment for the determination of the turning points of the European business cycle. The European business cycle is represented first by the GDP series (referring to the classical definition of a business cycle as fluctuations in the level of economic activity), and then by deviations from trend (which corresponds to the definition of the cycle as changing capacity utilisation). The turning points are determined using a mechanical procedure (Bry/Boschan methodology), which ensure that all series are treated alike.

The comparison of turning points in the classical and growth cycles has brought the following results:

1. *The order of seasonal adjustment and aggregation has only minor effects on the determined turning points of the European business cycle.*
2. *If the series are pre-treated for calendar effects, turning points in the aggregated series can differ significantly.*
3. *It is not relevant whether the series were adjusted with a single method or with different methods (mixed aggregates).*

1. Introduction

The introduction of the common European currency has increased the interest in and the need for business cycle analysis on the European level. However, European business cycle research is complicated by the fact that data of the individual European economies are not always completely comparable. One reason for the limited comparability of the data is the different procedures applied in the seasonal adjustment of the time series, which regards both the method of seasonal adjustment and the pre-treatment of series (elimination of outliers, calendar adjustment). The differences between the seasonal adjustment methods have been investigated in several papers (cf. Fischer, 1995; Höpfner, 1998; Speth, 1994). In these papers, criteria were developed which allow an assessment of the consequences of the different transformations. European business cycle research, however, is faced with a further problem: that of aggregation. Time series for the EU or EMU are calculated as the sum of the series of the individual economies. Seasonally adjusted aggregate series can be calculated either *directly* (i. e. by performing the seasonal adjustment to the aggregated original series), or *indirectly* (i. e. by adding the seasonally adjusted series of the countries). Currently, the indirect approach is applied in the EMU, and the choice of the seasonal adjustment method and the pre-treatment is left to the national statistics agencies.

In earlier research (Rietzler, Stephan and Wolters, 2000) it was investigated whether the application of different seasonal adjustment methods and different aggregation procedures can affect the behaviour of the series of the European aggregate. It was shown that, in theory, as long as linear seasonal adjustment procedures are applied, the seasonally adjusted series and the original series are co-integrated with the co-integrating vector (1, –1). The performed tests have proved that *all* seasonally

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adjusted series are co-integrated, irrespective of whether the adjustment was carried out with linear or non-linear procedures. Furthermore, it was found that if the series are adjusted for calendar effects, the seasonal pattern of the series stabilised and the elimination of the seasonal frequencies improved in all seasonal adjustment procedures.

However, co-integration of the differently adjusted and aggregated series means that, although the series develop alike in the long run, *differences may exist in the short run*. The differences in the short-run characteristics of the series may occur due to

- different order of aggregation (direct vs. indirect calculation of the aggregate);
- different seasonal adjustment methods;
- different pre-treatment of the series with regard to outliers and calendar effects.

For business cycle research, this observation may raise concern as this can mean that the assessment of the position in the business cycle and, in particular, the determination of turning points may depend on the chosen seasonal adjustment or aggregation procedure. Our paper is devoted to just this problem. We investigate whether the application of different seasonal adjustment methods, different pre-treatment of the series and different order of aggregation can change the assessment of the turning points of the European business cycle.

In the following, we will investigate these problems using the aggregated GDP series as an indicator of the macroeconomic activity in the EMU, which is therefore appropriate for representing the European business cycle. In Section 2, we will briefly discuss two definitions of the business cycle and problems of its measurement. In Section 3 we describe the Bry-Boschan methodology for determining turning points of a time series. In Section 4, we turn to the data set. Section 5 presents the results and Section 6 concludes.

2. Measurement of Business Cycles

Although business cycle analysis has a long tradition, definitions are not uniform. Most often, business cycles are described as recurrent fluctuations in the economic activity.[1] But, the amplitude and the duration of cycles need not be identical in different cycles and the causes of the fluctuations may differ. Modern business cycle research has therefore focused on the establishment of stylised facts of business cycles. But, so far no agreement has been reached regarding a generally accepted class of stylised facts or the criteria for determining such stylised facts. Therefore, the problems stemming from the still unresolved question of a uniform theoretical definition of the business cycle and a uniform procedure of measuring the business cycle have not yet been overcome. Two definitions of the business cycle are often used: the *classical cycle* and the *growth cycle*.

In the classical cycle approach, business cycles reflect fluctuations in the overall economic activity: expansion phases are characterised by positive and downturns by negative growth. Economic activity is measured using a business cycle indicator. This can be a composite indicator or a single indicator. A composite indicator has the advantage that it reflects the fact that the business cycle is often considered as the co-movement in a number of economic variables. However, for the construction of such an indicator the variables regarded as relevant for the description of "economic activity" need to be determined. A single index, such as GDP or industrial production, is clearly defined and may be earlier available than the composite index, as the latter often includes also lagging indicators.

In the classical business cycle approach changes in the potential output of the economy are not allowed for. Therefore, this approach can detect expansion phases even if capacities are under-utilised, which does not correspond with the interpretation of a business cycle as periods of higher and lower capacity utilisation (the growth cycle definition).

The definition of the business cycle as a growth cycle is based on the assumption that a business cycle is characterised by periods of different capacity utilisation. During expansion phases, the growth rate of total output exceeds the growth rate of potential output, whereas in downturns, the opposite is the case. In this approach, real (and most often seasonally adjusted) GDP is used as the indicator of economic activity. The difference between the potential output and actual output is the *output gap*.

The basic problem in this business cycle definition is the determination of the potential output. As potential output is not observable, a method for the calculation of the trend component must be chosen. Although we will not discuss the problems of detrending time series here (cf. Canova, 1993), we would like to stress that the calculated business cycle series depends heavily on the applied detrending method. Furthermore, such procedure is based on the assumption that the trend and the cycle components are independent, which is not undisputed (cf. Horn, 1995).

[1] "Business cycles are a type of fluctuations in the aggregate economic activities of nations that organize their production and distribution mainly in business enterprises; a cycle consists of expansion occurring at about the same time in many economic activities, followed by similarly general recessions, contractions and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration, business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own." (Burns/Mitchell 1946, 3)

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In our investigation, we applied both definitions of the business cycle. For the classical cycle we used seasonally adjusted GDP as the indicator of economic activity; for the growth cycle we calculated the deviations from the GDP trend, which was calculated as a Hodrick-Prescott-filter for quarterly data (λ = 1600).

3. The Bry Boschan Methodology for Determining Turning Points

For the determination of the turning points, we chose the Bry and Boschan methodology (Bry and Boschan, 1971), which was developed for the NBER in the 1970s. This method is a mechanical procedure, which, in addition, has the advantage that it can be run as a computer programme. This allows greater independence from personal interpretation and it enabled us to evaluate a large number of series using the same procedure. The fact that the chosen procedure is a mechanical one is explicitly regarded as an advantage, as we are interested in whether the different procedures *can* lead to different results. We are aware of the fact that, in practice, where mechanical procedures for the determination of turning points are chosen, the researcher will typically intervene if additional information and economic considerations support another interpretation of the data (cf. Bry and Boschan, 1971, 19; Lucke, 1998, 159). In our investigation, we refrained from such interventions.

The Bry and Boschan method has clearly defined steps and decision rules (cf. Table 1). It selects turning points under the constraints that a cycle cannot be shorter than 15 months, that a phase cannot be shorter than 5 months and that peaks and troughs must alternate. Because this method was originally developed for monthly data, we had to use the option for quarterly data, in which the quarterly data are split into three equal monthly values. In the output tables, we have assigned the turning points to the quarters again.

We decided to apply this procedure also to the output gap series, although this is not very common (cf. Lucke, 1995, 184). But, as we found that it might be difficult to determine the points of the maximum deviation from trend and as we were interested in the detection of *possible* differences between the series representing the cycle, we chose to apply the mechanical procedure also to the growth cycle.

Table 1

Procedure for programmed determination of turning points

a. Determination of extremes and substitution of values
b. 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).
c. Determination of corresponding turns in Spencer curve (extremes replaced). A. Identification of highest (or lowest) value within ± 5 months of selected turn in 12-month moving average. B. Enforcement of minimum cycle duration of 15 months by eliminating lower peaks and higher troughs or shorter cycles.
d. 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.
e. 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.
f. Statement of final turning points
Source: Bry and Boschan (1971, 21).

4. Data Set

As was already mentioned we used the seasonally adjusted GDP series as an indicator of the business cycle. The European business cycle is thus represented by the sum of the GDP series of the included countries. For an investigation of turning points, it is needed to analyse a sufficiently long time period, that is, a period which includes more than one cycle. Furthermore, the aggregate should include a large proportion of countries of the Euro-area, as well as large and small economies. Currently, the Euro-area comprises 12 countries. However, original time series of the national accounts calculated according to the SNA 95 and containing at least 80 observations exist only for four countries: France, Spain, the Netherlands and Finland. These countries produce about 40% of the Euro-area GDP.

For this reason, and to secure comparability with the mentioned previous research, we decided to use original series on GDP calculated according to the SNA 79; and to include those countries which have sufficiently long original series: West Germany, Italy, the Netherlands, Austria and Finland. These countries produce about 55% of the Euro-area's GDP. The time series have 84 observations, and the sample ranges from the first quarter of 1977 to the fourth quarter of 1997.

We investigated the impact of three seasonal adjustment methods, which are applied in the European context:

- the *Berlin method* (Version 4, BV4; cf. Nourney, 1983), which was used for the seasonal adjustment of national accounts at the German Statistical Office until the beginning of 2000;
- *X12-ARIMA* (or its predecessors X11 and X11-ARIMA; cf. Findley et al., 1998), which is used by the Bundesbank and the Statistical Office of the Netherlands;
- *TRAMO/SEATS*[2], which was developed in the Bank of Spain (BDE) and which is applied by Eurostat, the BDE, the Spanish Statistical Office (INE); the Italian Statistical Office (Istat); and the Austrian Economic Research Institute Wifo.

We found that the differences between the additive and the multiplicative version of TRAMO/SEATS are rather small. We therefore used the variant chosen automatically by *Demetra* (Version 1.4, release 4), Eurostat's seasonal adjustment package for X12-ARIMA and TRAMO/SEATS. The adjustment with BV4 was carried out with a specially programmed EXCEL macro produced at the DIW.

For the investigation, we calculated 17 different EU-5 GDP aggregates, which serve as the indicator of the European business cycle. We combined the following procedures:

- *seasonal adjustment vs. calendar and seasonal adjustment:* the series were seasonally adjusted without pre-treatment for calendar effects and after such pre-treatment;
- *direct vs. indirect adjustment:* the original series as well as the series that were adjusted for calendar effects were aggregated and adjusted in a different order. In the *direct* procedure, first the aggregate is calculated and the seasonal adjustment is applied to the aggregate of the original series. In the *indirect* approach, the series of the individual countries are first seasonally adjusted and the aggregate is calculated as the sum of the individually adjusted series.

Since we applied three methods and four procedures, we got 12 representations of the European business cycle. However, due to the fixed filter in BV4, the indirectly and the directly calculated aggregates are identical. In accordance with the current European practice, we calculated further aggregate series reflecting different aspects of the current procedures applied in the EMU. First, we calculated a further EU5-aggregate that was adjusted for calendar effects and indirectly adjusted with X12-ARIMA, where we included the German series adjusted with the parameters used by the Bundesbank. Second, we calculated mixed aggregates, i.e. aggregates, in which the series of the countries are adjusted individually, but with different seasonal adjustment methods. In the mixed aggregates, the series for Italy, the Netherlands, Austria and Finland are adjusted with the method that the respective statistical office uses; the series for West Germany was adjusted with different methods. Table 2 shows the composition of the aggregates and table 3 the detailed composition of the mixed aggregates.

Table 2

Composition of the aggregates

	Seasonally adjusted	Adjusted for seasonal and calendar effects
Adjusted directly	BV4 X12-ARIMA TRAMO/SEATS	BV4 X12-ARIMA TRAMO/SEATS
Adjusted indirectly with a single method	BV4 X12-ARIMA TRAMO/SEATS	BV4 X12-ARIMA TRAMO/SEATS Bundesbank
Adjusted indirectly with different methos	AGG1 AGG2 AGG3	–
	AGG4	

Table 3

Mixed aggregates

All aggregates	Italy, Austria: TRAMO/SEATS, Netherlands, Finland: X12-ARIMA
AGG1	Germany: BV4
AGG2	Germany: TRAMO/SEATS
AGG3	Germany: X12-ARIMA
AGG4	Germany: X12-ARIMA (Bundesbank)

5. Results

In this section, we will first comment the results for the classical cycle and then the results for the growth cycle. The results are presented in both graphs and tables. Tables 4 and 5 show all turning points in the several representations of the European business cycle.

[2] Cf. Gomez and Maravall (1997). We refer to TRAMO/SEATS even if no pre-treatment with TRAMO was carried out.

5.1 Classical cycle

5.1.1 Turning points in the series adjusted for seasonal effects with a single method

First, we investigated whether different turning points were found in the European aggregate series if the series was adjusted directly or indirectly. Figure 1 shows the results. In all series, three cycles are found; and two of the three cycles are dated alike. The third cycle is determined alike by four of the five series. Only in the series directly adjusted with X12-ARIMA, the end of the third cycle is determined two quarters earlier then in the other series. We conclude that the choice of direct and indirect aggregation has only small effects for the determination of turning points.

5.1.2 Turning points in the EU-5 aggregates adjusted for calendar and seasonal effects

To investigate the impact of calendar adjustment for the determination of turning points, we compare the series adjusted indirectly but with a single adjustment method with series adjusted for seasonal and calendar effects. Figure 2 shows that in the series adjusted for calendar effects with the regression method (cf. Rietzler, Stephan and Wolters, 2000; Dosse and Planas, 1996), only two cycles are found. However, in the aggregate which was adjusted with X12-ARIMA and which contains the GDP series for West Germany adjusted for calendar and seasonal effects by the Bundesbank, the same number of cycles and exactly the same turning points were found as in the series adjusted for seasonal effects only. In our view this shows that, first, the West German series dominates the EU aggregate and, second, that the calendar adjustment applied by the Bundesbank leads to less smoothed series than the regression method.

In addition, in the series adjusted for calendar effects with the regression method, the turning points differ more often. In the first cycle the peak is determined between the second quarter of 1981 and the first quarter of 1982, while the trough is found for all series in the fourth quarter of 1982. Turning points differ also in the second cycle, but only by one quarter. These results suggest that the (additional) adjustment for calendar effects can affect the determination of turning points in the European business cycle. The stronger smoothing of the series eliminates the short cycle in 1980. Instead, the series are characterised by a plateau between 1980 and 1982. Even small differences in the resulting series can in such circumstances lead to a different assessment of the turning points if a mechanical procedure is applied.

Table 4

Turning points of the European business cycle defined as a classical cycle

		Peak	Trough	Peak	Trough	Peak	Trough
		Seasonally adjusted series					
Indirectly/Directly	BV4	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q1
Indirectly	TS	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q1
Directly	TS	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q1
Indirectly	X12	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q1
Directly	X12	80 Q1	80 Q2	81 Q3	82 Q4	92 Q1	93 Q1
Indirectly	AGG1	80 Q1			82 Q4	92 Q1	93 Q1
Indirectly	AGG2	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q1
Indirectly	AGG3	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q1
Indirectly	AGG4*	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q2
		Calendar and seasonally adjusted series					
Indirectly/Directly	BV4			81 Q4	82 Q4	92 Q2	93 Q2
Indirectly	TS			82 Q1	82 Q4	92 Q2	93 Q2
Directly	TS			81 Q4	82 Q4	92 Q1	93 Q1
Indirectly	X12			81 Q2	82 Q4	92 Q2	93 Q1
Indirectly	X12 (Buba)*	80 Q1	80 Q4	81 Q3	82 Q4	92 Q1	93 Q1
Directly	X12			81 Q2	82 Q4	92 Q2	93 Q1

* The GDP series for Germany was seasonally adjusted with X12-ARIMA according to the Bundesbank. This implies working day calendar adjustment.

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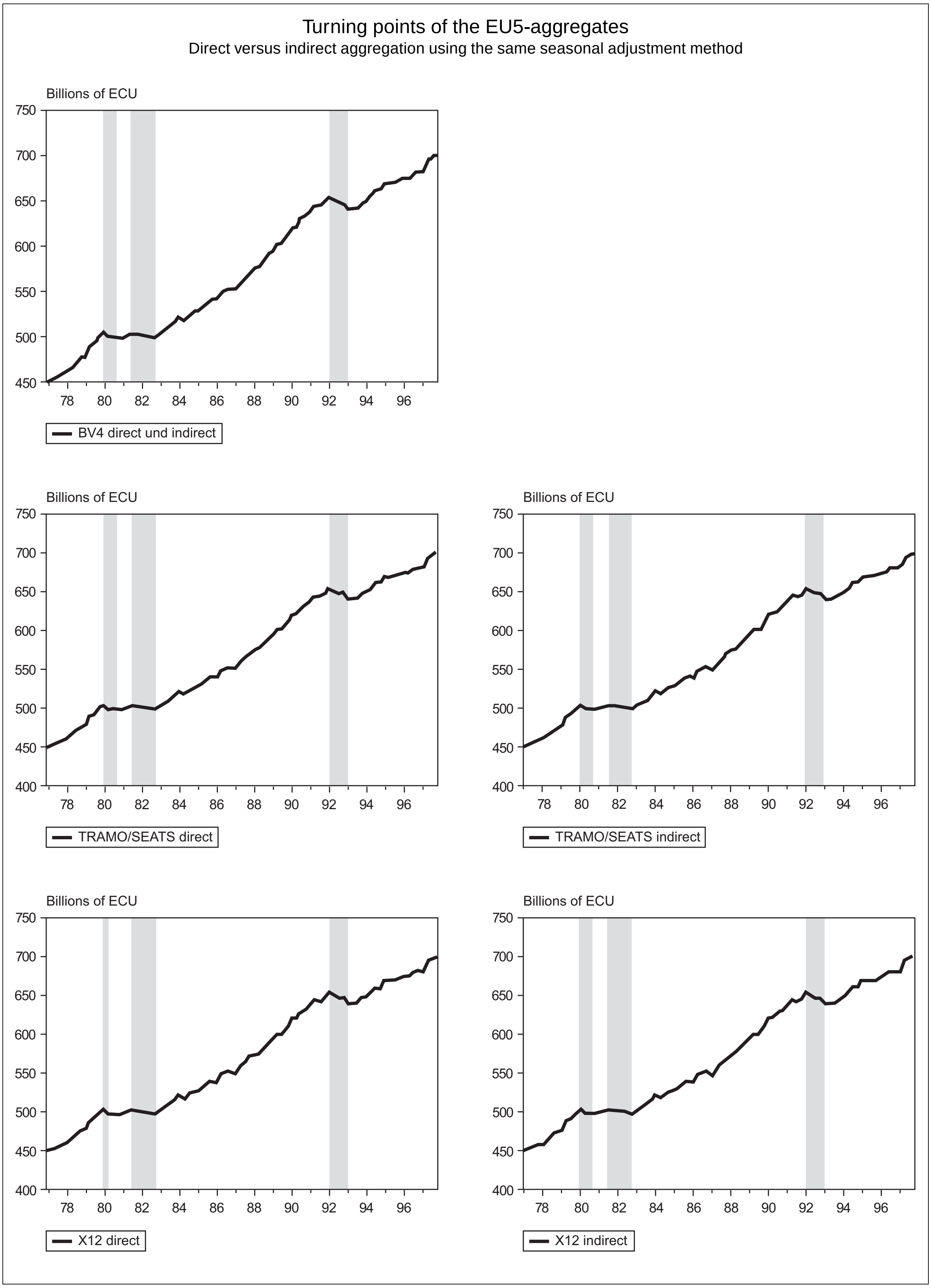
Figure 1


Turning points of the EU5-aggregates
Direct versus indirect aggregation using the same seasonal adjustment method
Billions of ECU
750
700
650
600
550
500
450
78
80
82
84
86
88
90
92
94
96
BV4 direct und indirect
Billions of ECU
750
700
650
600
550
500
450
400
78
80
82
84
86
88
90
92
94
96
TRAMO/SEATS direct
Billions of ECU
750
700
650
600
550
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450
400
78
80
82
84
86
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90
92
94
96
TRAMO/SEATS indirect
Billions of ECU
750
700
650
600
550
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450
400
78
80
82
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86
88
90
92
94
96
X12 direct
Billions of ECU
750
700
650
600
550
500
450
400
78
80
82
84
86
88
90
92
94
96
X12 indirect

Figure 2

Turning points of the EU5-aggregates

Series adjusted for calendar and seasonal effects versus series adjusted for seasonal effects only (indirect adjustment)

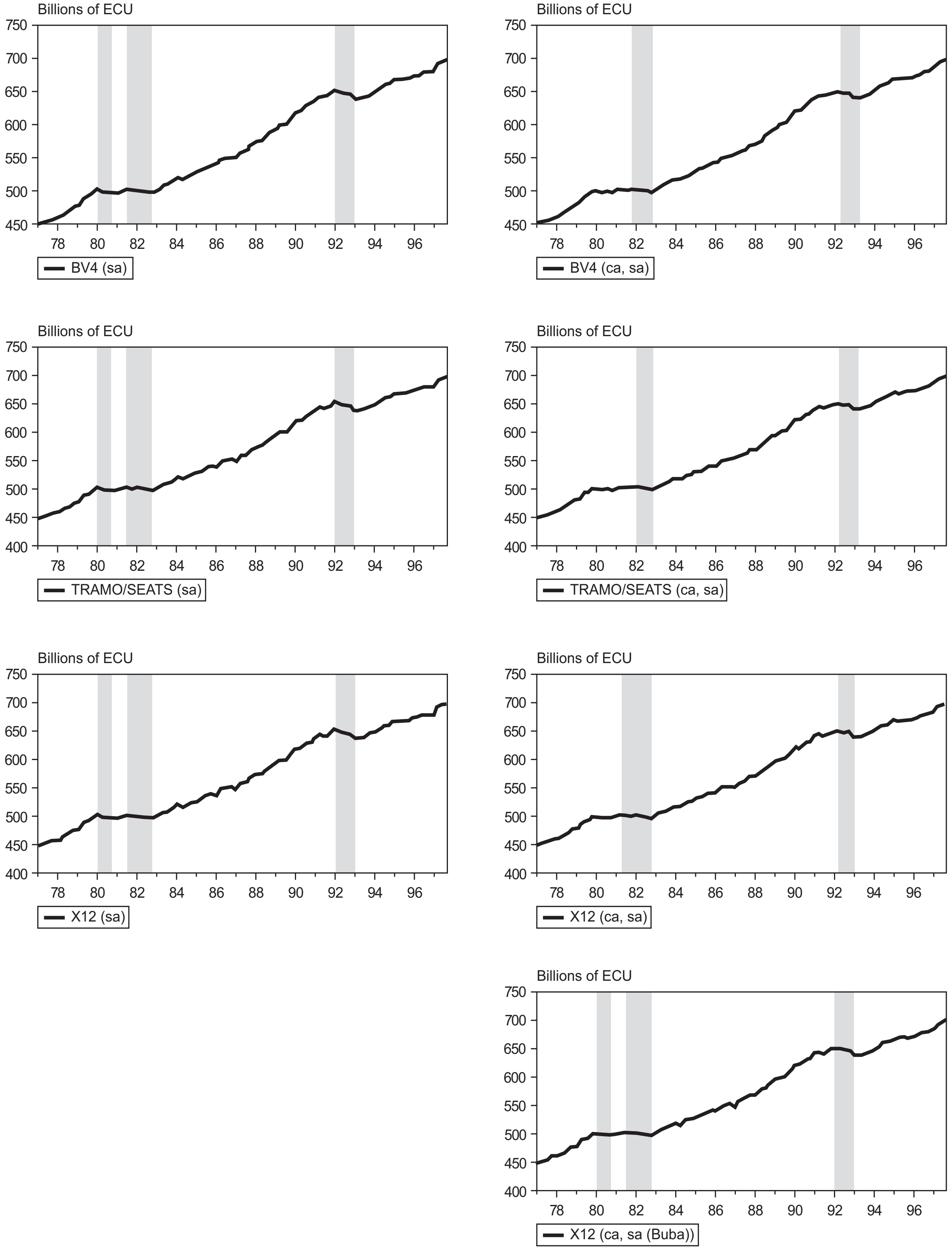

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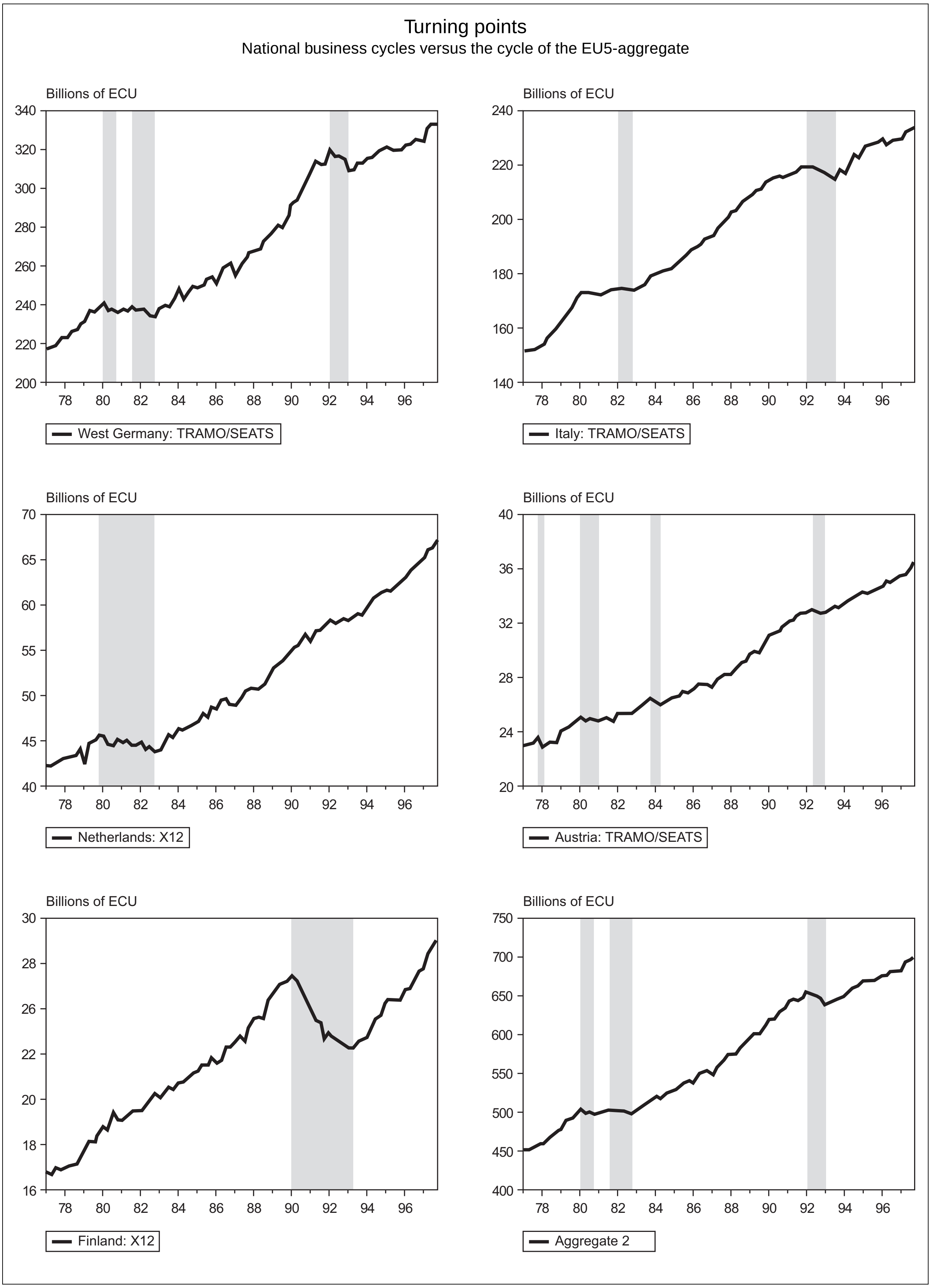
Figure 3



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5.1.3 Turning points in the mixed EU-5 aggregates

In order to assess the impact of a mix of different seasonal adjustment methods, we compare the turning points found in the series adjusted with the same method with the turning points in the mixed aggregates (cf. Table 3). Table 4 shows that the turning points found in the mixed aggregates are very close to those in the series adjusted with a single adjustment method. This result is surprising. We therefore compared the turning points in the series of the individual countries with the turning points in the aggregate series. Figure 3 shows the turning points in the series of the countries and the aggregate series AGG2, which is representative for the other mixed aggregates.

Figure 3 shows that the series of the large countries dominate the EMU aggregate. The turning points in the West German series correspond exactly with the turning points in the aggregate series. This result holds irrespective of the procedure chosen for the seasonal adjustment, i. e. for all mixed aggregates. In the Italian series, which was adjusted with TRAMO/SEATS, a cycle is found only in 1982 and in 1992/1993. The cycles in the smaller countries do not always correspond with the cycles found in the aggregate. In both the Dutch and the Finnish series, only one cycle is found. The peak of the Dutch cycle corresponds to the peak of the first German cycle in the early 80s, while the trough of the Dutch cycle is determined at the same time as the trough of the second German cycle in the 1980s. The peak of the Finnish cycle does not correspond with the development in another country, whereas the trough was found in 1993, close to the trough in the large countries. The Austrian series shows the most cycles. Only in the 1990s, the turning points correspond with those in the aggregate.

These results support the view that West Germany dominates the European cycle. Since we found no differences in the turning points between the German series adjusted with different methods, this will be the cause for the similar results for the mixed aggregates. However, as only five countries could be included, this result need not completely reflect the conditions in the EMU-12.

5.2 Turning points in the growth cycle

5.2.1 Turning points in the seasonally adjusted EU-5 aggregate

In order to assess the impact of the order of aggregation and seasonal adjustment for the determination of the turning points, we compared the directly adjusted with the indirectly adjusted aggregates. In all series we found five cycles and their turning points are quite similar (Figure 4). Differences are found in situations where the different pro-

Table 5

Turning points in the European business cycle defined as a growth cycle

		Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough
		Seasonally adjusted series											
Indirectly/ Directly	BV4		77 Q4	80 Q1	82 Q4	84 Q1	84 Q2	86 Q2	87 Q1	92 Q1	93 Q3	95 Q1	97 Q1
Indirectly	TS		77 Q3	80 Q1	82 Q4	84 Q1	84 Q2	86 Q2	87 Q1	91 Q2	93 Q2	95 Q1	97 Q1
Directly	TS		78 Q1	80 Q1	82 Q4	84 Q1	84 Q2	86 Q2	87 Q1	92 Q1	93 Q3	95 Q1	97 Q1
Indirectly	X12		78 Q1	80 Q1	82 Q4	84 Q1	84 Q2	85 Q3	87 Q1	92 Q1	93 Q3	95 Q1	97 Q1
Directly	X12		78 Q1	80 Q1	82 Q4	84 Q1	84 Q2	86 Q2	87 Q1	92 Q1	93 Q3	95 Q1	97 Q1
Indirectly	AGG1		80 Q1	82 Q4	84 Q1	84 Q2	86 Q2	87 Q1	92 Q1	93 Q3	95 Q1	97 Q1	
Indirectly	AGG2		77 Q3	80 Q1	82 Q4	84 Q1	84 Q2	86 Q2	87 Q1	91 Q2	93 Q2	95 Q1	97 Q1
Indirectly	AGG3		78 Q1	80 Q1	82 Q4	84 Q1	84 Q2	86 Q2	87 Q1	91 Q2	93 Q2	95 Q1	97 Q1
Indirectly	AGG4*	77 Q4	78 Q1	80 Q1	82 Q4			85 Q3	87 Q1	91 Q2	93 Q2	95 Q1	96 Q2
		Calendar and seasonally adjusted series											
Indirectly/ Directly	BV4		77 Q4	79 Q4	82 Q4	83 Q4	84 Q2	86 Q2	87 Q3	91 Q2	93 Q3	95 Q1	96 Q1
Indirectly	TS		77 Q3	79 Q4	82 Q4			86 Q2	87 Q1	91 Q2	93 Q2	95 Q1	96 Q1
Directly	TS		77 Q4	79 Q4	82 Q4			85 Q4	87 Q3	91 Q2	93 Q3	95 Q1	96 Q1
Indirectly	X12		78 Q1	79 Q4	82 Q4			85 Q3	87 Q1	91 Q2	93 Q3	95 Q1	96 Q1
Indirectly	X12 (Buba)*		78 Q1	79 Q4	82 Q4	84 Q1	84 Q2	85 Q3	87 Q1	91 Q1	93 Q3	95 Q1	96 Q1
Directly	X12		78 Q1	79 Q4	82 Q4			85 Q3	87 Q1	91 Q1	93 Q3	95 Q1	96 Q1

* The GDP series for Germany was seasonally adjusted with X12-ARIMA according to the Bundesbank. This implies working day calendar adjustment.

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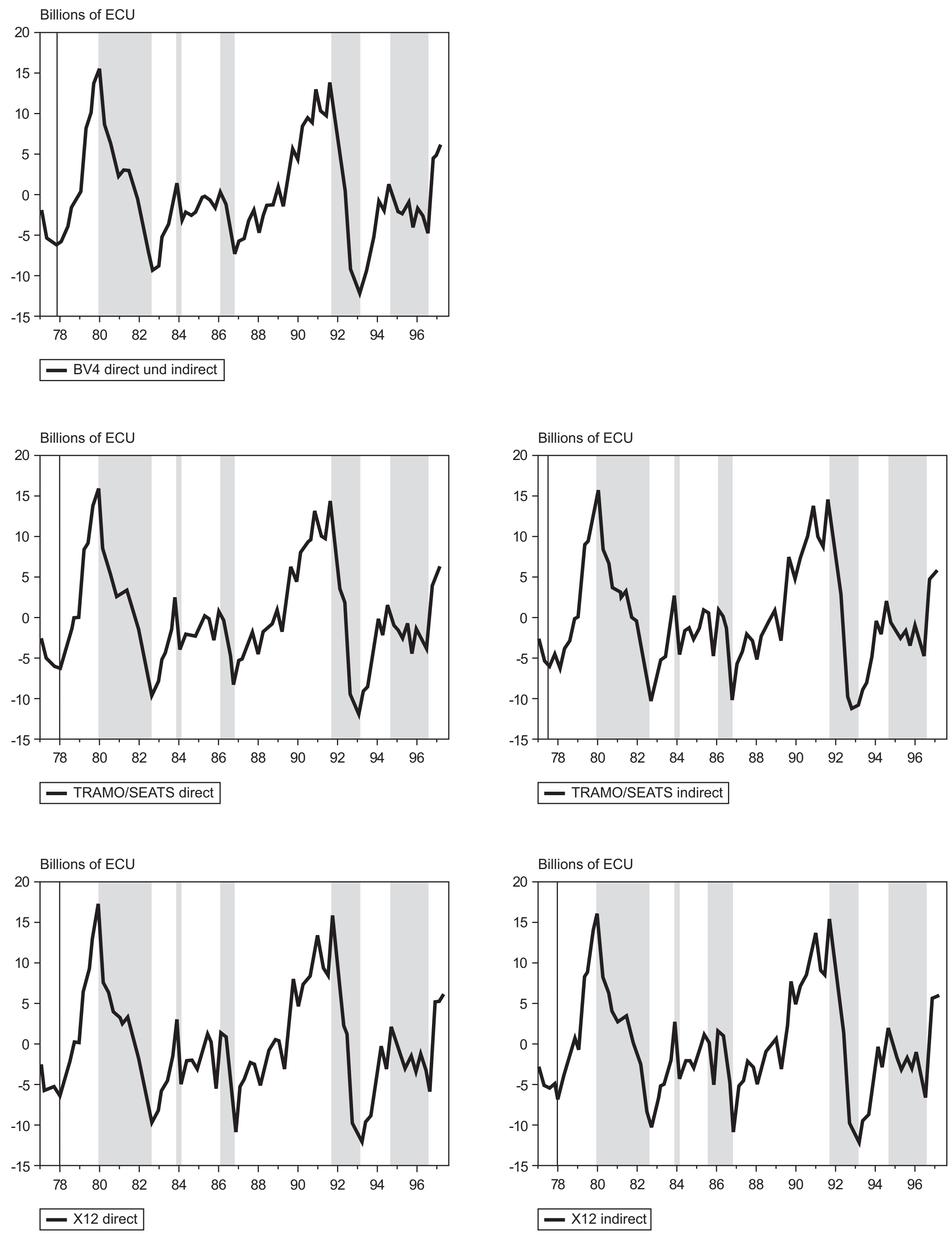
Figure 4

Turning points

Direct versus indirect aggregation using the same seasonal adjustment method



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cedures stress double peaks differently, so that the turning points are determined differently (cf. Table 5). This applies to the situation in the early nineties, where the turning point is determined in the second quarter of 1991 in the series adjusted indirectly with TRAMO/SEATS, while the turning point is determined at the second peak (in the first quarter of 1992) in all other series. The same phenomenon is responsible for the fact that the peak in the cycle in 1985/86 is found in the third quarter of 1985 in the series that was indirectly adjusted by X12-ARIMA, while in all other series this turning point is determined in the second quarter of 1986.

We conclude that, similar to the results in the classical cycle, the order of aggregating and seasonal adjustment affects the determination of turning points only slightly. Differences occur only at such points, where the applied transformations stress close peaks of similar magnitude differently.

5.2.2 Turning points in the EU-5 aggregates adjusted for calendar and seasonal effects

The comparison of series adjusted for seasonal effects only and those adjusted for seasonal and calendar effects shows that calendar adjustment does influence the determination of turning points. However, we could not find that these differences are systematic.

Figure 5 shows that in the aggregates adjusted for calendar effects with the regression method and seasonally adjusted with TRAMO/SEATS or X12-ARIMA the cycle in 1984 was not found. The cycle in 1985 and 1986 is — except for the series adjusted indirectly with TRAMO/SEATS — longer than that in the series adjusted for seasonal effects only. The cycle in 1991/1992 starts up to three quarters earlier than in the series adjusted for seasonal effects only. The end is determined in all series in the second half of 1993, so that the cycle found in the series adjusted for both calendar and seasonal effects is longer. By contrast, the cycle in the second half of the 90s is one year shorter in the series adjusted for calendar and seasonal effects. The only systematic result is that in the series containing the West German series adjusted for calendar and seasonal effects by the Bundesbank the cycle in 1983/84 is found. This supports our view that the German series dominates the development of the aggregate and that, in addition, the Bundesbank method for calendar adjustment smoothes the series less than the regression method. The series nevertheless differs significantly from the series adjusted for seasonal effects only.

5.2.3 Turning points in the mixed EU-5 aggregates

In order to assess whether the determination of turning points depends on the seasonal adjustment method, we compared the turning points in the series adjusted with the same method with turning points in the mixed aggregates. Table 5 shows that the determination of the turning points of the European business cycle is very similar. The only exception is Aggregate 4, in which the cycle in 1983/84 is not found. Furthermore, the peak in the mid-80s is determined in the third quarter of 1985, while this peak is found in the second quarter of 1986 in all other series. Differences occur also at the end of the sample period: the trough is determined in the second quarter of 1996, while it is found in the first quarter of 1997 in all other series. However, it can be concluded that, as Aggregate 4 is the series that contains a seasonally and calendar adjusted series for the largest economy, this result is not representative when comparing the turning points in the series adjusted with a single method and the mixed aggregates. We could not find major differences between series adjusted indirectly with a single method and the mixed aggregates. However, it is again interesting to investigate whether this result is caused by the fact that the large economies dominate the development of the aggregates.

In contrast to the results of the classical cycle, the comparison of the turning points in the series for the individual countries with those in the aggregate is more difficult to interpret. Figure 6 shows that the European business cycle is not dominated by the business cycle of one country. Instead, we found a number of phases that occur at the same time in a number of countries and which are therefore reflected also in the European business cycle.

- The peak in the first quarter of 1980 is found in West Germany, Italy and Austria and in the preceding quarter in the Netherlands.
- The trough in the fourth quarter of 1982 is found for West Germany and the Netherlands and, one quarter later, in Italy.
- The peak in the second quarter of 1986 is found in the Netherlands and in Austria. The following trough in the first quarter of 1987 is found in all national business cycles except Finland.
- The peak in the second quarter of 1991 is found for West Germany, and, one quarter later, in the Austrian series. The trough in the second quarter of 1993 corresponds with the German cycle. In Italy, the trough is found one quarter earlier, and in the Netherlands and in Austria two quarters later.
- The peak in the first quarter of 1995 corresponds with the national business cycles in West Germany, Austria, Finland. The trough in the first quarter of 1997 is found only in the Italian cycle.

We therefore conclude that, in the case of the growth cycle, no single country dominates the development of the European business cycle. Instead, we found that a number of national business cycles occur at approximately the same time, and that this is reflected in the development of

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Figure 5

Turning points

Series adjusted for calendar and seasonal effects versus series adjusted for seasonal effects only

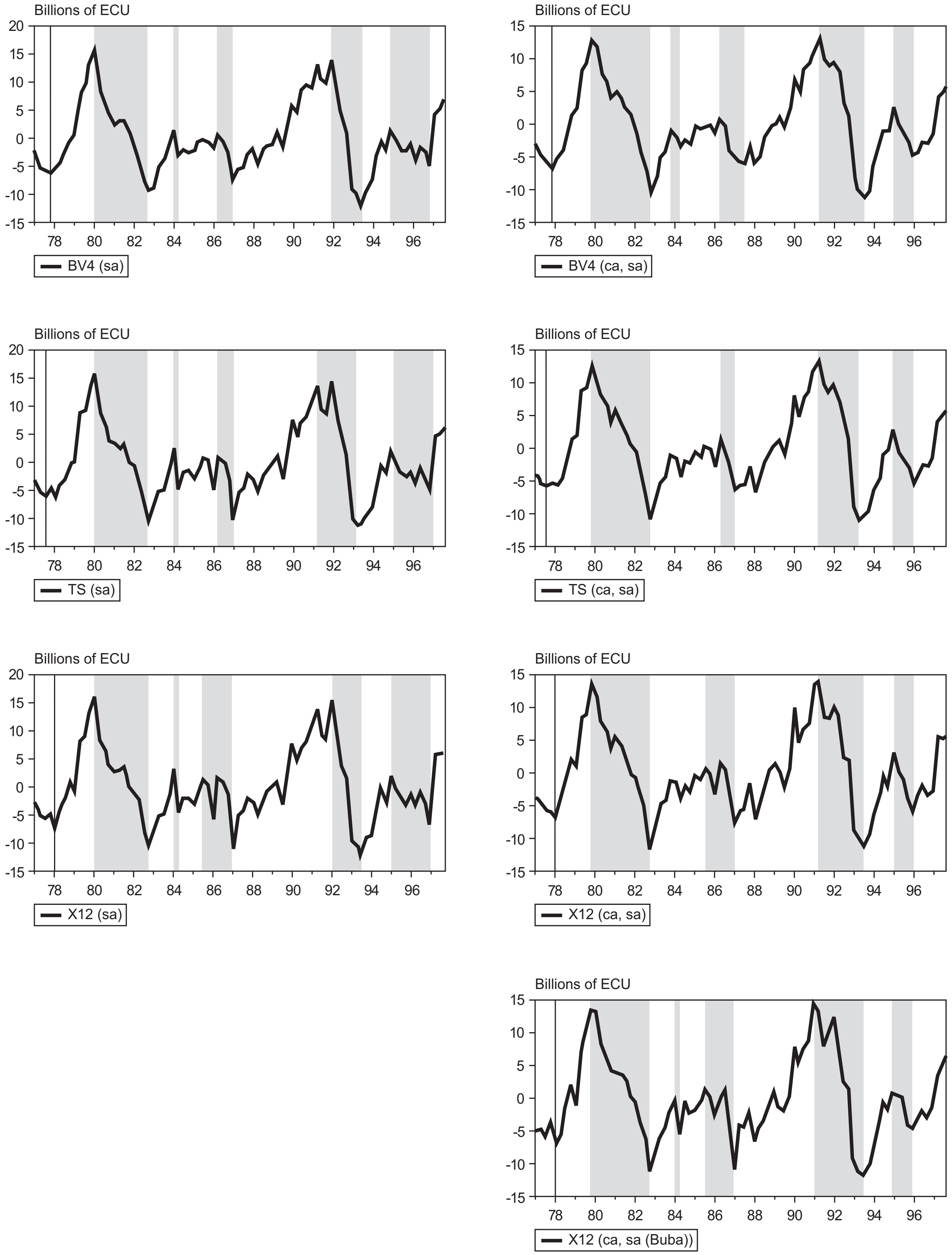

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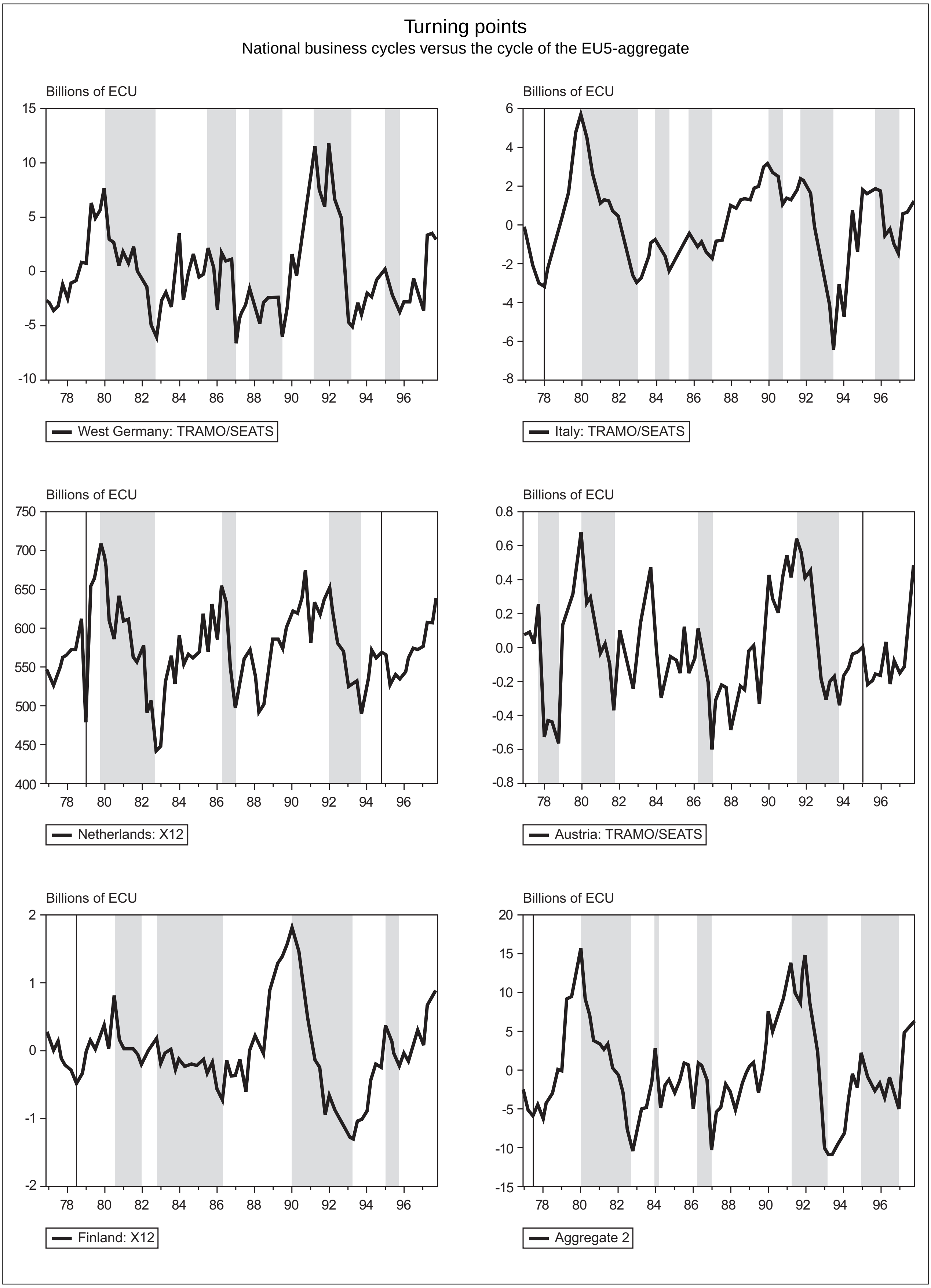
Figure 6



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the aggregate. In contrast to the classical cycle, which reflects changes in the level of economic activity and where the large countries dominate due to their weight in the aggregate, smaller countries can influence the development of the cycle in the growth cycle, as the weights of the countries do not depend on the size of the respective economy.

6. Conclusion

Our investigation was based on earlier research showing that the order of aggregation and seasonal adjustment and the chosen adjustment method do not influence the long-term characteristics of the aggregated time series, but that differences may occur in their short-term dynamics. For the current business cycle research for Europe this could mean that the assessment of the current position in the business cycle can depend on the chosen seasonal adjustment method, on possible pre-treatment of the series for calendar effects, and the order of seasonal adjustment and aggregation.

In this paper, we investigated the impact of the adjustment for seasonal effects with different seasonal adjustment methods, the possible pre-treatment for calendar effects and the different order of aggregation and adjustment for the determination of the turning points of the European business cycle. The European business cycle was represented first by the GDP series (referring to the classical definition of a business cycle as fluctuations in the level of economic activity), and then by deviations from trend (which corresponds to the definition of the cycle as changing capacity utilisation). Because we investigated the impact applying both definitions of the cycle, we could, at the same time, test whether the results differ. The turning points were determined using a mechanical procedure, which ensured that all series were treated alike. Personal interference was thus restricted to the choice of method.

The comparison of turning points in the classical and growth cycles has brought the following results:

1. The order of seasonal adjustment and aggregation has only minor effects on the determined turning points of the European business cycle.
2. If the series are pre-treated for calendar effects, turning points in the aggregated series can differ significantly.
3. It is not relevant whether the series were adjusted with a single method or with different methods (mixed aggregates).

Seen in the context of the earlier research, which established that the seasonally adjusted series as well as the series adjusted for seasonal and calendar effects are cointegrated with the original series, we can furthermore conclude that the results 1 and 3 show that even the differences in the short term dynamics are not so important as to lead to significant differences in the determination of turning points if the series are adjusted for seasonal effects only. It should be stressed that as we used quarterly data, this result may not hold for series that contain higher frequency data.

In aggregates that were adjusted for seasonal and calendar effects, the differences are much more significant. Whereas in the case of the aggregate containing the West German series adjusted for calendar and seasonal effects by the Bundesbank the turning points correspond roughly with those in the series adjusted for seasonal effects only, larger differences were found if the calendar adjustment was carried out with the regression method. Such adjustment removes smaller cycles and the resulting series are smoother than those not adjusted for calendar effects.

Table 6

Results for the classical cycle

<table>
<tr><th rowspan="2"></th><th colspan="3">Seasonally adjusted</th><th colspan="4">Adjusted for calendar and seasonal effects</th></tr>
<tr><th>BV4</th><th>TRAMO/ SEATS</th><th>X12</th><th>BV4</th><th>TRAMO/ SEATS</th><th>X12</th><th>X12 Buba</th></tr>
<tr><td>Directly adjusted</td><td>–</td><td>–</td><td>–</td><td>+</td><td>+</td><td>+</td><td></td></tr>
<tr><td>Indirectly adjusted with a single method</td><td>–</td><td>–</td><td>–</td><td>+</td><td>+</td><td>+</td><td>–</td></tr>
<tr><td>Aggregate 1</td><td colspan="3">–</td><td colspan="4"></td></tr>
<tr><td>Aggregate 2</td><td colspan="3">–</td><td colspan="4"></td></tr>
<tr><td>Aggregate 3</td><td colspan="3">–</td><td colspan="4"></td></tr>
<tr><td>Aggregate 4</td><td colspan="3"></td><td colspan="4">–</td></tr>
</table>

Table 7

Results for the growth cycle

	Seasonally adjusted			Adjusted for calendar and seasonal effects			
	BV4	TRAMO/ SEATS	X12	BV4	TRAMO/ SEATS	X12	X12 Buba
Directly adjusted	–	–	–	+	+	+	
Indirectly adjusted with a single method	–	–	–	+	+	+	+/–
Aggregate 1	–						
Aggregate 2	–						
Aggregate 3	–						
Aggregate 4				–			

The Tables 6 and 7 summarise the results. Table 6 contains the results for the classical cycle and Table 7 those for the growth cycle. Minus signs denote that we could not find major differences between the turning points of the aggregates seasonally adjusted with a single method and the aggregates that combine different seasonal adjustment methods and pre-treatment for calendar effects. Plus signs mean that the differences in the turning points are significant.

The major results of our investigation hold for both the classical and the growth cycle. However, the turning points found differ between the classical and the growth cycle. In the growth cycle, we found more cycles, and the cycles determined in the growth cycle and in the classical cycle do not always match.

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The authors would like to thank the participants of the workshop "Measurement Problems of Business Cycles in the EMU" in Berlin on 2 February 2001 for helpful comments. Furthermore, we are grateful to Bernd Lucke, who provided us with the computer programme of the Bry and Boschan methodology, and Jörg Breitung for helpful discussion.

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Zusammenfassung

Zur Bedeutung von Saisonbereinigungs- und Aggregationsverfahren für die Determinierung der Wendepunkte in einem Europäischen Konjunkturzyklus

Im vorliegenden Papier wird untersucht, wie sich verschiedene Arten von Saison- und Kalenderbereinigung sowie eine unterschiedliche Reihenfolge bei Saisonbereinigung und Aggregation auf die Bestimmung der Wendepunkte in einem Europäischen Konjunkturzyklus auswirken. Als gesamtwirtschaftlichen Konjunkturindikator für den Euroraum haben wir ein „EWU"-BIP verwendet, da so die Möglichkeit besteht, konjunkturelle Schwankungen anhand zwei verschiedener Konzepte — dem klassischen Zyklus und der Trendabweichung — zu messen. Die Wendepunkte wurden anhand eines Computerprogramms bestimmt, das den von Bry und Boschan entwickelten Algorithmus verwendet. Damit wurde sicher gestellt, dass die Einteilung der Konjunkturzyklen frei von subjektiven Einschätzungen ist.

Unabhängig vom verwendeten Messkonzept haben sich folgende Resultate ergeben:

1. *Die Reihenfolge von Saisonbereinigung und Aggregation spielt bei der Bestimmung der Wendepunkte in einem Europäischen Konjunkturzyklus keine Rolle.*
2. *Eine dem Saisonbereinigungsverfahren vorgeschaltete Kalenderbereinigung beeinflusst die Festlegung der Wendepunkte deutlich.*
3. *Für die Bestimmung der Wendepunkte ist es unerheblich, ob die einzelnen Zeitreihen des Aggregats mit einem einheitlichen oder mit verschiedenen Saisonbereinigungsverfahren bereinigt wurden.*