6. Dating the business cycle

Only part of the studies on business cycles restricts itself to co-movement analysis. Especially if studies are motivated by cyclical policy intervention (rather than by the identification of structural similarities), the dating of the business cycle is most important. The process of dating can be described as looking for turning points in the business cycle. There is a difference between the definition of turning points in the classical context of business cycle analysis – where the object of study are the absolute levels of some time series – and the interpretation of cyclical deviation. Figure 4 shows a stylised example of an economic time series – like GDP – consisting of a deterministic trend plus a cyclical variation.

Figure 4: Turning points in the classical and the cyclical deviations approach

Source: Own illustration.

In business cycle analysis turning points are defined in a different way as in geometrics. Whereas the first mark local minima and maxima the latter is the point where a graph starts to change the sign of its curvature.
If the cycle is defined in the classical way, as depicted by the trended bold line in the upper part of Figure 4, then point A represents one of the upper turning points occurring at time $t_A$ as it constitutes a local minimum. Following the deviations approach and observing only turning points of the extracted business cycle component, point B marks the upper turning point at time $t_B$. This point is derived by analysing only the stationary, bold line in the lower part of the figure, which should represent the business cycle according to the deviations approach. It can easily be seen - as it is a well-known fact - that the turning points according to the cyclical deviations approach (bold line in the lower part) lead the ones of the classical definition (bold line in the upper part)\(^85\).

If instead the focus of interest lies on growth rates (growth rate cycle approach), the result is again different turning points. The dotted line in the lower part of Figure 4 represents the growth rates of the series. When interpreting the business cycle as a sine function (like it is done here with the bold line in the lower part), growth rates follow a cosine function as this is its first derivative. This series of growth rates is illustrated by the dotted line in the lower part of Figure 4 (for graphical reasons it has been linearly transformed). It reaches its peaks earlier (e.g. at time $t_c$) than the others\(^86\), which is in part due to its asymmetric construction.

As for their importance, turning points have been given special names. In the classical approach, the lower turning points are called troughs, which are followed by a phase of recovery leading into a period of expansion whose end is marked by the upper turning point, the peak. Thereafter, a contraction takes place followed

\(^{85}\) The length of the lead is related positively to trend growth and negatively to the amplitude of the series. The higher trend growth, the more it is capable of delaying the downward-sloping effect of the cycle on the whole series.

\(^{86}\) If a high frequency error term is included, the leading property of growth rates cannot be exploited for an earlier indication of turning points. This is especially true as it has been shown that taking first-order differences superimpose high frequency error terms.
by a recession ending with the next trough, which completes the cycle. The nomenclature is somewhat different in the deviation cycle approach. The local peaks of the business cycle component—as shown in the lower part of Figure 4—are often referred to as highs and the lower turning points are called lows. Phases between them are called expansions or contractions.

Having this sequential pattern of the business cycle in mind, dating the turning points has to fulfil several conditions. Firstly, every dating procedure—arbitrary or mechanical—has to ensure that turning points alternate. It must not occur that the turning point following a peak is again a peak. Secondly, the period between the turning points should not be too short in order to allow some economically meaningful process of recovery or contraction. Furthermore, turning points should represent some local minima or maxima according to certain criteria. Several methods have been developed to this end, but only the most important shall be explained here.

6.1 The expert approaches

To this class belong all approaches which are mainly based on more or less subjective evaluations, rather than on a mechanical method. The most prominent approach in this area is the dating schedule set up by the NBER. Here, a Business Cycle Dating Committee publishes officially the turning points calendar for the US economy. According to the NBER, a recession is characterised by "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales." This gives insight into the database that forms

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87 Examples for alternative methods not reported here are proposed by Diebold – Rudebush (1987), Wecker (1979), Hess – Iwata (1997) or Neftci (1982).

the backbone for the NBER dating procedure. The term "normally visible in real GDP" is not only a hint at the subjectivity of this approach, but has something to do with the availability of GDP, i.e. usually only at a quarterly frequency.

Before this dating can be done, several steps to identify the cycle take place, which have already been described above. Despite its subjectivity, the dates resulting from this approach are not only the official ones, but serve as a benchmark for many innovative new dating methods. This is probably due to the fact, that this approach is adopted by experts who can take into account specific developments in the economy as well as in the underlying time series which could otherwise be misinterpreted if treated in a purely mechanical way. For the same reason, Breuss (1984) argues in favour of a re-evaluation of identified turning points by using external knowledge about the characteristics of time series. In case of doubt whether a turning point is dated exactly, an ad-hoc intervention should take place\textsuperscript{89}.

This was probably the reason why a similar procedure has recently been adopted for the euro area. With the formation of a currency union in 1999, demand for a business cycle dating calendar has emerged with a view to giving adequate guidance to economic policy. To this end, the Centre for Economic Policy Research (CEPR) has set up a committee similar to the one of the NBER for determining the dates of turning points. Its definition of a recession is quite close to that of the NBER, but accommodates for euro area characteristics.

Unlike the NBER, the CEPR focuses on the spread between the EU Member States, whereas the former seems to focus more on sector differences. Furthermore, the CEPR refers to quarterly instead of monthly developments, which has to do with the fact that the

\textsuperscript{89} The author cites as an example a higher-than-usual economic activity resulting from a front-loading of private expenditure in anticipation of a planned tax rise, which could wrongly be interpreted as an upper turning point.
most reliable economic information for the euro area is only available on a quarterly basis.

Most interestingly, the CEPR concentrates on growth rates. The interpretation of growth rates makes a dating procedure not only sensitive to superimposed error terms (making such dating a poor guide for policy interventions), but also mixes up trend and cycle movements. From a theoretical point of view, it makes a decisive difference whether slow growth results from a gradually sloping trend or a sharp fall in the business cycle.

6.2 The Bry-Boschan routine

The best-known methodical approach is the algorithm proposed by the NBER economists Bry – Boschan (1971). This non-parametric method can be applied to seasonally-adjusted trended as well as de-trended monthly time series and tracks quite well turning points for the US as set by the NBER Business Cycle Dating Committee.

This approach starts with a possibly necessary de-trending procedure and the removal of outliers according to some standard deviation criterion. Subsequently, a sequence of smoothing filters is applied, each followed by running the dating procedure. The smoothing process starts with the filter performing the highest degree of smoothness and goes down consecutively till the original (unsmoothed) time series is dated. The final turning points are dated on the basis of the original series, but must be consistent with all earlier dates according to the smoothed series. The specific points are found by checking for local minima and maxima and imposing some criteria for the minimum length of phases and cycles between them. If two or more peaks (or troughs) follow each other, then only the highest (deepest) one enters the dating output.

Disadvantages of the Bry-Boschan routine are that only the alternation of turning point signs and the phase-length impose restric-
tions for the identification of peaks and troughs. There is no possibility to take into account the amplitude of cyclical variations and, as it is a purely deterministic approach, nor the uncertainty encountered when choosing dates for the turning points.

As this procedure proposed by Bry – Boschan (1971) was developed originally only for monthly data, some amendments have been proposed to use it analogically for quarterly series\(^90\). The version used in this study is the one implemented in the BUSY software package developed by the Joint Research Centre of the European Commission (1993). There, de-trended time series are smoothed by a Spencer curve, which is a symmetric 2x7 moving average filter with the following weights

\[
v(L) = \frac{1}{320} \left[ 74 + 67(L + L^{-1}) + 46(L^2 + L^{-2}) + 21(L^3 + L^{-3}) + \\
3(L^4 + L^{-4}) - 5(L^5 + L^{-5}) - 6(L^6 + L^{-6}) - 3(L^7 + L^{-7}) \right]
\]

In order to compensate the loss of seven data points on either end of the series, the series is extended by extrapolating the growth of the first and last four observations. This smoothed series is used, first of all, for replacing outliers in the uncorrected series, which are detected by imposing that its standard deviation be a certain multiple of the series total standard deviation, to be defined by the user.

Following this, the series corrected for outliers is filtered by a 2 x 4 term MA term in the quarterly time series case. The output of this filter and the one generated by the Spencer curve are both scanned for common turning points, which are characterised by local minima or maxima with intervals of five periods\(^91\). Furthermore, a minimum phase length of 6 quarters is imposed, together with an alternation of the signs of the turning points.

\(^{90}\) Harding – Pagan (2002) is an example in this respect.

\(^{91}\) The size of the interval can be altered by the user.
An additional, less smoothed, series is calculated by further shortening to MA order according to a parameter called QCD (quarters of cyclical dominance). This QCD yields the minimum delay for which the average of absolute deviations of growth in the Spencer cycle is larger than that in the irregular component. This series is again checked for common turning points with the series as calculated before, subject to the same requirements for cycle length and the alternation of signs. As this last short filter is able to move close to the end of the series – while for the longer filters synthetic extrapolations had to be made – turning points found in the last or first two observations are dropped.

Versions of the Bry-Boschan routine used for dating the quarterly US-GDP time series have been quite successful in tracking the turning points as published by the NBER\(^92\).

### 6.3 Hidden Markovian-switching processes

Studies resorting to the method proposed by Hamilton (1989) try to represent the business cycle component by a Markov-switching autoregressive model. Here, the series examined is to be represented by a stochastic process that can switch between a contractive and an expansionary regime\(^93\). In its most general form, not only the mean \(\mu\) is allowed to vary between both states, but also the AR parameters \(\phi\) of order \(p\) and the variance of the error term (with assumed zero mean) \(e_i\).

\[
(31) \quad z_t = \mu_{s_t} + \sum_{i=1}^{p} \phi_{s_t} z_{t-i} + e_{s_t}^t
\]

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\(^92\) Examples for this kind of studies are King - Plosser (1994) and Harding - Pagan (2003).

\(^93\) In Artis - Krolzig - Toro (2004) a third regime is considered for some countries, in order to capture the effect of a break in trend growth in the second half of the seventies.
with $z$ being the analysed time series and $s_i = 1$ if the economy is in expansion and $s_i = 2$ if it is in contraction, implying that the mean is above or below the average mean of the total series

$$
(32) \quad \mu_{s_t} = \begin{cases} 
\mu_1 > 0 & \text{if } s_t = 1 \\
\mu_2 < 0 & \text{if } s_t = 2 
\end{cases}
$$

The probability of being in either state of the cycle evolves according to a Markov chain defined by certain transition probabilities for switching from one state to the other

$$
(33) \quad \text{prob}(s_t = i | s_{t-1} = j) = \varepsilon_{i,j} \in (0,1) \quad \forall i, j = 1,2
$$

Thus, the probability of being in expansion if the preceding period was also in expansion is $(1 - \varepsilon_1)$, or for a contraction following a contraction $(1 - \varepsilon_2)$, and the changes from one state to the other are $\varepsilon_1$ or $\varepsilon_2$, respectively.

The estimation of such Markov-switching models is quite complicated, since a global nonlinear process is combined with an unobserved component character. In practice, this is carried out with the Kalman filter technique in order to get Maximum-Likelihood estimators.

As a result, probabilities for each observation of being in either state are obtained, which can be transformed into a binary variable indicating contraction or expansion periods. The advantage of this procedure, compared with the non-parametric approaches, is that for all points in time it can be inferred whether the economy is expanding or contracting. Furthermore, the size of deviation plays a role in the identification process, so that minor ups and downs can be excluded from the dating calendar. The advantage of obtaining probabilities for turning points may be a

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94 Except for the very rare points where the probability for either regime is insignificant.
disadvantage at the same time. Usually, there remains a – hopefully small – number of time series points, for which it is inconclusive in which state the economy is. As they are located between expansions and contractions, such points become the focus of interest. If they have to be identified, only a judgemental evaluation can help.

6.4 Threshold autoregressive models

Threshold autoregressive models (TAR) represent a further method of a model-based dating procedure. Here, different regimes (in the case of business cycle analysis there will again be two of them: contraction and expansion) are modelled, with a threshold \( r \) for their identification and with a certain threshold delay \( d \) to which the threshold refers. The structure is basically the same as in (31)

\[
(34) \quad z_t = \mu + \sum_{i=1}^{p} \phi_i z_{t-i} + \epsilon_t
\]

but the process of determining the state is different, in that it depends on a certain threshold (the threshold delay), which has to be exceeded

\[
(35) \quad z_{st} = \begin{cases} 
\mu_1 + \sum_{i=1}^{p} \phi_1 z_{t-i} + \epsilon_1 & \text{if } z_{t-d} > r \\
\mu_2 + \sum_{i=1}^{p} \phi_2 z_{t-i} + \epsilon_2 & \text{if } z_{t-d} < r
\end{cases}
\]

This approach is rather flexible, as for various regimes different auto-correlation behaviours can be modelled as well as separate error term variances. The TAR model is a piecewise linear model which shows non-linear global behaviour. As first steps, the threshold delay \( d \), the threshold \( r \) and the order of the AR polynomials for either state have to be estimated. After applying an identification
procedure of both processes, the turning points mark the dates of change from one state to the other. As in the case of the Markov-switching model, restrictions for the amplitude of deviations can be formulated and – as it is a probabilistic approach – probabilities for being in a contractive or expansionary state can be generated. However, this can also be seen as problematic, as outlined in the case of the Markov-switching model.

95 A good presentation of this kind of approach is given by Tsay (1989).