10. Concluding remarks

The location of business cycle turning points is still an important task for economic policy decisions. They mark the points for initiating and terminating economic policy interventions targeted to smooth business cycle variations over time.

Approximately every ten years, the Austrian Institute of Economic Research publishes results on turning points relating specifically to the Austrian business cycle. Whereas business cycle theory advances only gradually over time, the methodical tool box for the extraction and evaluation of such cycles proceeds very fast. As national economies have become more and more integrated over time, the analysis of business cycles has to take such interrelations into account. Furthermore, the responsibility for monetary policy in the euro area has been delegated by its member states to the ECB, which justifies an approach to business cycles in an international context. In order to capture these interdependencies, the present study also includes Germany – Austria's largest trading partner – as well as the euro area as a whole.

It makes an important difference whether turning point analysis is carried out in real time or in retrospect. Whereas the former is important for economic policy decisions to be taken early enough to smooth the cycle, the latter is a precondition for developing a real time dating procedure. Furthermore, there is a trade-off between dating turning points at the recent time margin and the precision of their location in the past. This advises in favour of a separation of both procedures and the present study concentrates entirely on establishing a dating calendar for the past. In order to achieve reliable results, several observations at the beginning and the end of the time series were sacrificed.

To shed light on the transmission mechanism of business cycle variations, data disaggregated by sectors have been used for this study. According to Burns – Mitchell (1946), business cycle variations show up in different sectors of the economy. This feature had
been brought to bear in our study, by defining the international business cycle according to a multivariate approach using information by sectors.

The present study starts with an overview on the specific steps to be taken for dating the business cycle. It discusses various theoretical concepts establishing the base for different approaches for extracting cyclical variations. Filter techniques in the time as well as in the frequency domain are presented beside model-based approaches with or without assuming a specific structure. Their theoretical properties, shortcomings and implications, as documented by various empirical and theoretical studies, are examined.

Based on this information, it was decided to concentrate on three filtering methods in order to clean for a trend or to extract directly periodic variations of business cycle nature: the first-order-difference filter, the Hodrick-Prescott filter and the Baxter-King band-pass filter.

In a next step, several approaches to determine the business cycle were presented. On the basis of these considerations, the univariate, popular and rather good comparable method of ad-hoc declaration of special cycles included in gross value added without agriculture and forestry as well as a multivariate interpretation derived by a dynamic factor model has been chosen for the present study. For dating the outcome, only the Bry-Boschan routine was used. Thus, a comparison of three filtering methods alternatively combined with the ad-hoc method of selection of the business cycle and a multivariate determination has been retained. All of these respective outputs have been dated by the Bry-Boschan routine, so that we obtained six dating calendars for the Austrian business cycle, including as well all other series considered.

The least reliable results are those based on data transformed by first-order differences. This method cleans only for stochastic trends of order one, which is a rather specific kind of trend. Furthermore,
it has been shown that this type of filter does not only leave the rather erratically moving high frequencies above the business cycle spectrum inside but superimposes them, instead. Despite this, it has been shown that the impact of this superimposition on the detection of lead and lag structures between time series is only marginal. Results of cross-correlations and coherence statistics are just reduced in their size (and significance) compared with the other filtering methods. Only for those series where these high-frequency components themselves possibly show some cross-correlation, overall cross-correlations shifted upward. This was the case for construction, where weather conditions interfere with the production of several sectors.

Differences between HP- and BK-filtered data concerning cross-correlations and coherences were quite small. The HP filter is able to cancel out trends of deterministic or stochastic nature up to an order of four and leaves high-frequency variations above the business cycle spectrum inside, but without superimposing them. The minor difference between comovements of HP- and BK-filtered data mirrors the dominance of business cycle variations in most of our time series, so that the inclusion of high-frequency parts disturbs this picture only to a minor extent.

From a theoretical point of view, the BK filter captures best the idea of the business cycle concept. The researcher can make explicit what he or she defines as business cycle variations. For the present study, a frequency band retaining all cycles between two and eight years' length has been used. In order to filter out these frequencies rather sharply, we allowed six observations on either end of all time series to be sacrificed. In doing so, the problem of leakage (i.e. keeping frequencies outside the desired band wrongly inside and filtering correct ones out) has been reduced significantly.
Based on this method superior to the others, we found that cross-correlation\textsuperscript{128} and coherence statistics give support for a broadly coincident behaviour of the whole set of time series. The German GDP seems to lag the Austrian gross value added (excluding agriculture and forestry), whereas the German gross value added is found to be coincident. This small lag of German GDP makes for a synchronised comovement of total euro area GDP, whereas it shows a lead when Germany and Austria are excluded from it. However, none of the results are significant for well-founded statements to be made. Interestingly, none of the series covering manufacturing leads the cycle, whereas the sector of financial intermediation and rental services (NACE J+K) of both countries show a lag, which is not in conflict with theory.

Whereas the picture of leading and lagging properties based on cross-correlations and coherences seems to be rather stable across different filtering methods, the Bry-Boschan procedure for detecting turning points reacts rather sensitively in this respect. For series where local minima and maxima are in close neighbourhood, the criteria used by this dating algorithm are getting arbitrary. In our study, this is the case for the series including high-frequency variations: the HP-filtered series and especially the first-order-differenced data. In these cases it appears that the first turning point detected in such a series is crucial for dating the others.

As an alternative to our ad-hoc determination of the series which carries the reference business cycle information, we set up a dynamic factor model. The idea behind this procedure is to find one or more common factors reflected by a large part of our observed time series – possibly shifted by different leads or lags – in order to represent a large part of the total variation of the whole data set. These common factors can be regarded as the main driving force behind all economic time series. Therefore they can be regarded

\textsuperscript{128} Cross-correlations based on band-passed filtered data correspond to the concept of dynamic correlation developed by Croux – Forni – Reichlin (1999).
as business cycle variations. This method was originally developed to reduce the complexity of large data sets but all of them covering only a short time span. Recent research on this topic\textsuperscript{129} has shown that a reduction in the number of time series used does not necessarily lower the quality of the output, but that a reasonably selective approach eliminating series with a high content of idiosyncratic behaviour can indeed improve the results.

In the present study, only economic data deemed to react to the business cycle have been used to set up the dynamic factor model. Furthermore, all series describing similar aggregates have been cancelled, leaving only one of them inside. This should avoid a bias of the common component towards special variations appearing in several time series. As an example, only gross value added excluding agriculture and forestry of one country has been included, but not total gross value added or GDP, too. In order to avoid a bias towards the German business cycle, only series for Austria, Germany and the euro area adjusted for both countries have been considered.

We extracted two dynamic factors on the basis of their eigen values ordered by size. With these two factors, we were able to explain more than 60 percent of the total variation of the data set. Again, results for BK-filtered data were highest (close to 70 percent), suggesting that idiosyncratic variability is an issue more important for higher frequency components. Apart from this, the pattern of highly synchronised co-moving series across all observed frequencies was confirmed by our dynamic factor model results. Only the financial intermediation and real estate service sector shows a considerable lead of four quarters vis-à-vis the Austrian business cycle.

Generally, dating the common component included in each of the time series reduces the number of cycles detected by the Bry-

\textsuperscript{129} See e.g. Boivin – Ng (2006) or Inklaar – Jacobs – Romp (2003).
Boschan routine, as compared with just filtered series. This is quite in line with theory, as the dynamic factor model is used for cleaning idiosyncratic cycles. Only in the case of first-order-differenced series, the number of cycles detected increases. This can be explained by the fact that the large number of ups and downs of just first-order-filtered time series is reduced by the dynamic factor model by idiosyncratic ones. This reduction led to a lower number of local minima and maxima, making it easier for the Bry-Boschan routine to locate them.

Therefore, the BK-filter approach seems to be for theoretical as well as for practical reasons, the superior preparation for dating a cycle. Comparing the dating calendars for the Austrian business cycle of just BK-filtered series with the ones represented by their common component, one can observe that the number of cycles is lower in the latter case. A short-lived cycle reflected in just filtered Austrian gross value added (without agriculture and forestry) starting with a trough in 3Q1983 and a following peak one year later has been recognised as of idiosyncratic nature and was therefore filtered out. The absence of this cycle for that period is confirmed by all studies compared with in chapter 9. They neither show this cycle for the euro area nor for Austria.\footnote{Only three studies provide a comparable dating calendar: Artis – Krolzig – Toro (2004), Hahn – Walterskirchen (1992) and the dating calendar for the euro area by the CEPR.}

There is only one further significant difference between just BK-filtered series and the ones transformed by the dynamic factor model, namely a trough following the peak around the change of the year 1994-1995. Whereas this is dated in the first case in the second quarter of 1997, it is located in the first quarter of 1999 by the common component approach. To check this again, results are compared with other studies. Unfortunately, only one of the studies presented in chapter 9 can be compared for this time span. Artis – Marcellino – Proietti (2004) confirm both troughs and
locate a peak in-between in the second quarter of 1998. Obviously, this peak is too low to be captured by our Bry-Boschan routine, hence it was ignored.

In Figure 9 these differences in the dating calendars are illustrated graphically. Both series show spikes of negative amplitude in the second quarter of 1997 and the first quarter of 1999. Looking at the thin line (representing just BK-filtered data), the trough in 2Q1997 is deeper than the one observed in 1Q1999. For the bold line representing the common component based on BK-filtered data, it is the other way round. Obviously, part of the amplitude in 2Q1997 has been considered as idiosyncratic. Since the Bry-Boschan routine considers within a close neighbourhood only the turning point with the largest amplitude, we get different dates for the troughs. The peak detected by Artis – Marcellino – Proietti (2004) in 2Q1998 is too close to the high peak in 2000, which is the reason for the Bry-Boschan routine considering it only as an intermediate turn, although it can be observed in both of our series in Figure 9.

If we define the business cycle as a domestic phenomenon, but accept influences from the international business cycle, then the dating calendar based on just BK-filtered series is the best choice. For those who regard the business cycle more as an international phenomenon, the dynamic factor model output is superior. If the settings prepared for our Bry-Boschan algorithm were to allow shorter cycles, also the peak described in Artis – Marcellino – Proietti (2004) would enter our calendars. Hence it depends on the preferences of the analyst or the economic policymaker, which calendar is most appropriate.

In general, the turning points in our study based on BK-filtered data largely correspond to the ones found when using more advanced business cycle extraction methods. Concerning the dates located by our Bry-Boschan routine, it became apparent that studies based on Markov-switching model show rather similar results.