3.2 Turning Points and the ifo Business Cycle Traffic Light

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3.2.1 Problem Outline

Experience shows that it is particularly difficult to foresee cyclical turning points, i.e., changes in the direction of economic development. Vital for such predictions are leading indicators, where the directional change of a leading indicator serves as a signal for a pending change in the economic regime (here: "*expansion*" or "*contraction*") and thus for a turning point.

However, in order to avoid generating too many turning point signals, not every change in direction of a leading indicator is considered a sufficiently valid signal. In many cases, *rule-based decision criteria* are used to classify the empirically observed changes in direction. According to the well-known "*three times rule*", for example, an economic turning point is only signaled when a leading indicator has indicated a new direction *three times in succession* (Nierhaus and Abberger 2014, Vaccara and Zarnowitz 1978). Alternatively, the numerical extent of the change in direction of an indicator can also serve as a decision criterion: If the change in the indicator is sufficiently large, this criterion signals a cyclical turning point from one economic regime to another. *Markov switching models (MS models)* can provide important information for this non-trivial decision, since they enable the translation of changes of a leading indicator into real-time probabilities for economic regimes (Hamilton 1989). For example, if an economy is in an expansion phase, a current decline in the leading indicator may still be within the usual fluctuation range and therefore be in line with the expansion phase. However, it could also be big enough to signal an imminent regime change towards a contractionary phase. MS models are designed to help with this decision.

In the following sections, the leading behavior of the ifo Business Climate Index at turning points in the German economy on a quarterly basis is first discussed. Subsequently, the monthly ifo Business Climate Index is modelled using an MS model.

3.2.2 Real GDP and ifo Business Climate Index

As early as the 1960s, the ifo Business Climate was defined as the geometric mean of the balances of the two survey components "business situation" and "business expectations for the next six months". The starting point for the approach of combining information on the current situation and the business outlook into a common aggregate was the assessment that neither variable alone adequately reflects the cyclical situation (Strigel 1971). This is because the assessment of the current situation should be supplemented by the companies' expectations of future developments in order to correctly capture the cyclical forces. Conversely, every observation of the business expectations should be enhanced by an assessment of the current situation.

For the statistical assessment of the leading characteristics of the ifo Business Climate at cyclical turning points, a reference series from official statistics must be selected. The cyclical component of the quarterly-, seasonally-, and calendar-adjusted real gross domestic product (GDP) is used as a macroeconomic reference series.[6] The gross domestic product is the most comprehensive aggregated measure of the economic performance of an economy. To adjust for trends in seasonally adjusted real GDP, the Hodrick-Prescott filter was used with the parameter value $\lambda = 1600$, as is customary for quarterly data. The remaining irregularities in the series were eliminated by additional HP filtering with the parameter value $\lambda = 1$. The HP filter is thus used as a bandpass filter (Artis et al. 2003).

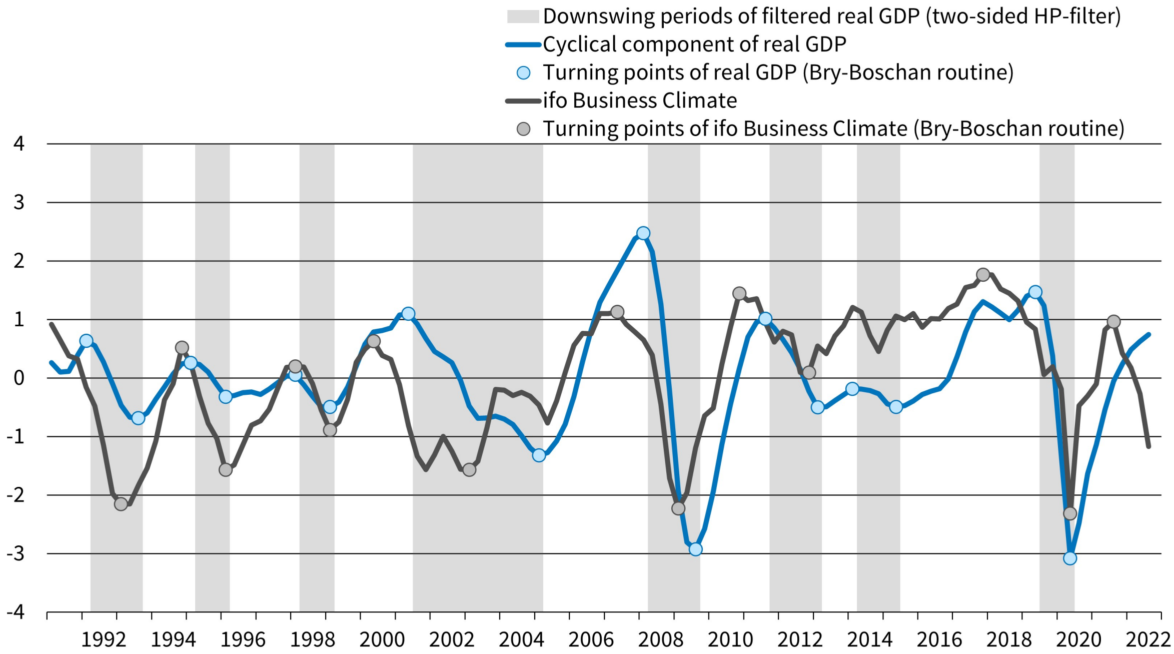
The analysis of the turning point signals from the ifo Business Climate Index is based on the seasonally- and calendar-adjusted time series published by the ifo Institute. It is therefore not a so-called real-time analysis, in which the data published at the respective points in time are used. Although the survey results of the ifo Business Survey are not usually revised, statistical adjustment for seasonal patterns can lead to subsequent changes in the seasonally-adjusted time series. However, in the Census X-13ARIMA-SEATS procedure used by the ifo Institute, the revisions are usually minor (Sauer and Wohlrabe 2015). Therefore, in the following procedure, one vintage of the ifo Business Climate Index is used. The real-time conditions mentioned in the following sections should therefore be understood in the sense of pseudo-real time.

In order to assess the turning point signals of the ifo Business Climate Index, historical turning points of the filtered real GDP must be dated. In Germany, unlike in the US, for example, there is no official cycle-dating. The chronological dating of economic turning points is therefore carried out here using the Bry-Boschan method (Bry and Boschan 1971). This algorithm determines the turning points of a time series following a sequential decision process and delivers intersubjectively comparable and therefore verifiable results.

The grey areas in Figure 3.3 mark the Bry-Boschan (BB) dated contract phases of the filtered quarterly real GDP. According to the BB procedure, there are a total of eight contraction phases in the period 1991 to 2022. A contraction phase averages 6.3 quarters (time span from the upper turning point to the subsequent lower); an expansion phase (time span from the lower turning point to the subsequent upper) averages 9.0 quarters. The periods between two consecutive upper/lower turning points average 15.5 quarters each.

[6] The usual transformation of GDP into rates of change over the previous year (year-on-year growth) is omitted here. Comparisons with year-on-year growth are the result of asymmetrical filtering and therefore phase-shifted. The phase-shift increases with the period of oscillation of the movement components. If the cyclical dynamics have a relatively high share in the variance of a series, the average phase-shift can reach several months (e.g., for a series with a cyclical oscillation period of 48 months, the phase-shift is exactly 6 months). The asymmetrical filtering shifts the transformed GDP series and its cyclical turning points backwards on the time axis, thus masking the actual leading behavior of the ifo Business Climate Index for the growth cycle. In this case, the lead time ifo Business Climate Index's lead time can be restored by transforming it to year-on-year growth rates and thus passing it through the same asymmetric filter as GDP (Goldrian 2005).

Figure 3.3: Turning points of the German Business Cycle, ifo Business Climate Germany and cyclical component of real GDP (two-sided HP-filter), standardized values



[a] Manufacturing, service sector, trade and construction. For 1991 - 2004: Manufaturing, trade and construction.
Seasonally adjusted with Census X-13ARIMA-Seats.

Source: Federal Statistical Office; ifo Business Survey; represention of the authors.

Figure 3.3 shows that the seasonally adjusted ifo Business Climate Index, aggregated to quarterly averages, correlates with the cyclical component of seasonally adjusted real GDP. Calculated over all data points, the closest correlation (0.59, measured at the maximum of the cross-correlation function) of the ifo Business Climate Index is found for a lead time of two quarters. In addition, it is clear that the ifo Business Climate Index is able to signal almost all turning points of the filtered real GDP at least coincidentally or – and this is true in the vast majority of cases – with a lead time (an exception is the extra cycle of real GDP between 2013 and 2015). For the economic analysis, it is also important that the statistical lead time of the ifo Business Climate Index is extended by a technical lead time due to the different publication dates: The ifo results for the respective past quarter are published two months before the official GDP data. Furthermore, they are not subject to larger revisions. For the first publications of GDP by the Federal Statistical Office, the official data basis is still incomplete. The results will therefore be revised several times.

3.2.3 Markov Switching and the ifo Business Climate Index

The early detection of turning points is particularly important for business cycle analysis. The estimation results of Markov switching models can provide important information for this purpose. In this model class, the parameters depend on stochastic regime variables. A linear model becomes more flexible with this approach because the parameters can take on different values depending on the regime in which the time series is located. Thus, it can be considered that the dynamics vary over time. In the following section, the first differences of the seasonally adjusted ifo Business Climate Index are modelled using a Markov switching approach (Abberger and Nierhaus 2008b, Abberger and Nierhaus 2010).

The first differences $\Delta y_t = y_t - y_{t-1}$ of the ifo Business Climate Index are modelled depending on an unobservable state variable s_t which is called state or regime at time ($t = 1, \ldots, T$; time variable). The modelling of the first differences implies that the change of the ifo Business Climate Index is considered. The aim is to assess whether a movement of the index indicates a change of regime or whether it is still in line with the previous regime. If the economy is in an expansion phase, for example, a falling ifo Business Climate Index may still be within the usual fluctuation range and therefore be in line with the previous regime. However, it can also already indicate a regime change. The MS model is designed to help with precisely this assessment.

In the present study, the number of regimes is limited to two. For $s_t = 1$ state 1 applies (on average, increasing climate), which is here equated with "expansion", for $s_t = 2$ state 2 applies (on average, decreasing climate; "contraction"). The probability with which the regime changes (or persists) from one period to another is, according to the assumption, time-invariant and depends only on the state of the previous period s_{t-1} (Markov assumption):

$$p(s_t = j \mid s_{t-1} = i) = p_{i,j}, i, j = 1, 2$$

In a Markov process with two states there are a total of four transition probabilities. For this, $p_{11} + p_{12} = p_{22} + p_{21} = 1$. The state variable s_t thus follows a first-order Markov process. The distribution of Δy_t (at given state i) is determined by density function:

$$f(\Delta y_t \mid s_t = i, \mu_i, \sigma^2) = \frac{1}{(2\pi\sigma^2)^{\frac{1}{2}}} e^{-\frac{(\Delta y_t - \mu_i)^2}{2\sigma^2}}$$

i.e. Δy_t is normally distributed with state-dependent mean value μ_i and constant[7] variance σ^2. For state 1, μ_1 applies, otherwise μ_2. The symbol θ is used to represent the vector of the total parameters ($p_{11}, p_{22}, \mu_1, \mu_2, \sigma^2$) of the MS model to be estimated.[8] The model can be estimated with the maximum likelihood method, whereby numerical optimization procedures are used due to non-linearities (Krolzig 1995). Beside the estimation of θ the MS model also provide estimates for so-called *smoothed regime probabilities* and *filtered regime probabilities*. These two probabilities differ in terms of the amount of information taken into account in the respective estimates.[9] The smoothed probabilities include the entire amount of information

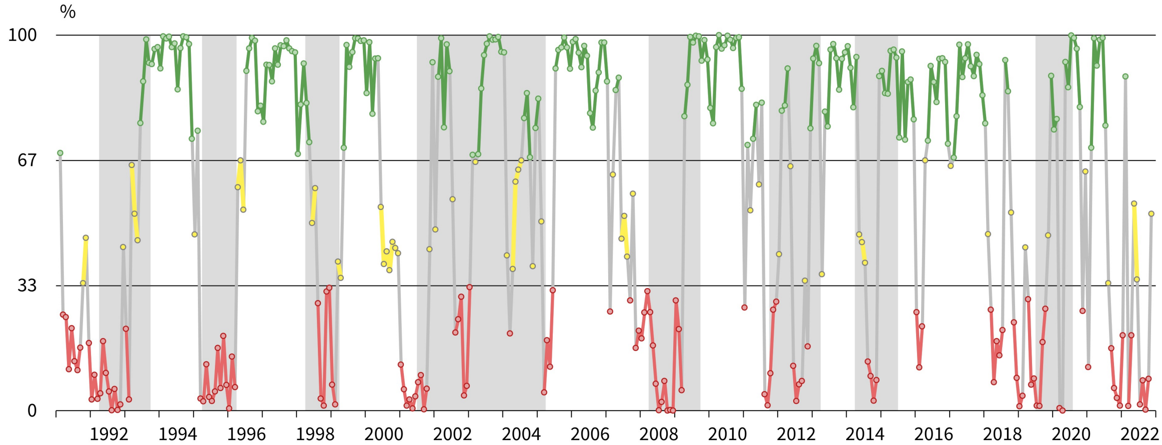
[7] The variance can also be modelled in a state dependent manner. This generalization is not necessary, however, for the present application.

[8] The unknown probability p_{12} follows from the relationship $1 - p_{11}$, the probability p_{21} from $1 - p_{22}$.

[9] However, this only applies to the adjustment of the state probabilities. For the estimation of the parameter

about the indicator, i.e., the entire time series. Thus, the available subsequent time series values are also used to estimate this probability at a certain point in time. In contrast, the filtered probabilities only focus on the amount of information available up to a certain point in time. These filtered probabilities are particularly interesting from a real-time perspective. In this chapter, therefore, the filtered probabilities are used.

Figure 3.4: ifo Business Cycle Traffic Light Germany - monthly probabilities for the expansion phase



ᵃ Manufacturing, service sector, trade and construction. 1991 - 2004: Manufacturing, trade and construction.
ᵇ Green = high, yellow = medium, red = low. Calculated on the basis of monthly movements in the ifo Business Climate Index Germany. Grey areas: Contraction phases of the filtered real GDP (two-sided HP-Filter).

Source: Federal Statistical Office; ifo Business Survey; representation of the authors.

To simulate real-time conditions as far as possible, the MS model is estimated on a monthly basis. Figure 3.4 presents the filtered monthly regime probabilities for the period 1991 to November 2022 (*ifo Business Cycle Traffic Light Germany*).[10] However, rules still need to be established for the economic classification of the estimated probabilities. A simple symmetrical classification rule is to speak of expansion/contraction whenever the corresponding regime probabilities are over/under 50%. A modified rule is used here: An expansion phase is present if the regime probabilities for this are greater than two thirds. Conversely, a contraction phase is present if the regime probability for this is less than one third. With probabilities between one third and two thirds, a situation of high uncertainty is assumed and no cyclical classification is made. Between January 1991 and November 2022, the ifo Business Cycle Traffic Light signals “expansion” in 51% of cases, “contraction” in 34% of cases and “Indifference” in only 15% of cases. The selectivity with regard to the two economic regimes is therefore considerable. Signals for economic turning points are found where the regime probabilities for the phases of expansion/contraction exceed the two-thirds mark for the first time. With

values μ_i and σ^2 the whole information is used.

[10] For the estimation of the filtered regime probabilities of the quarterly ifo Business Climate Index for the dating of the turning points according to Bry-Boschan, the software tools Grocer (version 1.81) and Scilab (version 6.0.2) were used. Grocer can be obtained from `http://dubois.ensae.net/grocer.html` and is a contribution to the Scilab program package (`http://scilab.org`).

probabilities between one third and two thirds, there is no cyclical classification and thus no turning point signal (Abberger and Nierhaus 2008b, p. 29).

Based on the monthly estimation approach, however, the ifo Business Traffic Light not only identifies the comparatively low-frequency GDP growth cycle, but also shows higher-frequency oscillations up to special economic developments. One example of this is the comparatively volatile development of regime probabilities in the years 2001 to 2005, which can be attributed to the shocks and uncertainties that occurred in a period which includes the 9/11 terrorist attacks in the USA in 2001 and the escalation of the Iraq conflict in 2003.

3.2.4 Conclusion

The ifo Business Climate Index can be modelled using a Markov switching approach. The monthly regime probabilities – shown in the ifo Business Cycle Traffic Light – provide interesting additional information for its interpretation. This is because the movement of the ifo Business Climate Index is converted by the MS model into probabilities for the two economic regimes of expansion and contraction, enabling timely turning-point forecasts for the overall economic situation. For example, the upper turning point of the cyclical component of real GDP in the third quarter of 2011 was diagnosed by the ifo Institute in autumn of the same year (Abberger and Nierhaus 2011a, p. 38). With the early signals provided by the MS model, a small number of false signals can even be accepted. In comparison, the traditional three-times-rule for early detection of turning points, which does not use any cardinal information from the indicator series, and is therefore somewhat more robust, is more conservative and signals economic turning points relatively late. This is because the three-times-rule means that you have to wait three months before a turning point is signaled for the first time. On the contrary, an MS model can set a turning point signal as early as the following month, assuming a correspondingly large change in direction of the indicator series. For this reason, non-linear approaches such as Markov switching models are now standard for forecasting turning points.