

OECD SYSTEM OF LEADING INDICATORS

Methodological Changes and Other Improvements

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November 2007

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Introduction

The OECD System of Leading Indicators was developed in the mid-1970s in co-operation with national experts of Member countries with the aim to provide early signals of turning points (peaks and troughs) between expansions and slowdowns of economic activity. This approach based on the cyclical properties of economic indicators can scarcely replace properly specified forecasting models, but it represents a relatively convenient and economic way of obtaining a broad-brush picture of aggregate economic activity from a large amount of data by construction of composite leading indicators (CLIs) for Member countries. CLIs have been published in the Main Economic Indicators (MEI) publication since December 1981. Today CLIs are compiled for 29 member countries and 6 non-member economies (Brazil, China, India, Indonesia, Russian Federation and South Africa) monitored by the organisation along with several zone aggregates.

The OECD system of Leading Indicators is based on the “growth cycle” approach where cycles are measured in the deviation-from-trend or ratio-to-trend series. The closest macroeconomic concept to growth cycles is the “output gap”. Fluctuations in the composite leading indicator and in the reference series can be considered as approximations of movements in the output gap. Although it should be stressed that OECD CLI are broad-brush indicators, they do not have an explicit forecast horizon, and the values of the indicators cannot be regarded as exact forecasts. The indicators are calibrated to have a good turning point match with an average lead time between 6 and 9 month.

The methodology used for the OECD Leading Indicator System has not been changed in any major aspect since the CLIs were first published in December 1981. This paper describes the OECD CLI system and presents an ongoing review that affects several elements of the system, but preserves its main building blocks and main characteristics. The OECD CLI system will remain a robust, non model based, heuristic system, with the continued intent to serve as a benchmark for competing Leading Indicator systems.

The ongoing review started in 2007. It revisits in more detail issues that were already tackled in de-trending methods study in 2002 and an overall Quality Review in 2004. Results of the review, and changes to the OECD CLI system are expected to be put in place in the first half of 2008. In what follows we give an overview of the OECD CLI system in its present state, and also present different options that we consider for various building blocks of the indicator system.

Main building blocks of the OECD CLI system

Reference series

Cyclical indicator systems are constructed around a "reference series" or "reference chronology". The reference series is the economic variable whose cyclical movements we intend to predict. By comparing the cyclical behaviour of potential CLI component series to the reference series makes it possible to determine whether these series are leading, coincident or lagging with respect to the reference series (or benchmark).

Ideally a variable that represents economic activity fluctuations in a wide sense would be used as the reference series. The OECD uses a single variable for that purpose: the index of industrial production (IIP). But other good candidates may exist such as a monthly Gross Domestic Product (GDP) or a composite coincident indicator. The OECD has explored the possibilities in monthly GDP series construction for G7 countries. 90% of the turning points

in the estimated monthly GDP series was either in the same quarter as those in the quarterly GDP or in an adjacent quarter. The main obstacle to switch to the monthly GDP for all OECD countries was data availability.

Component selection

Once the underlying cyclical behaviour of the reference series has been established the next step is to select the component indicators of the CLI. We search for series that meet several criteria. There has to be a plausible economic reasoning that relates them to the reference series. The series' cyclical movements have to lead the cycles of the reference series. Finally, the series need to have good quality in statistics terms. Therefore the selection of indicators is a complex process that requires some judgement and knowledge of data sources, economic concepts and also the application of econometric techniques.

Economic relevance

- economic significance - there has to be an economic reason for the observed leading relationship before the series can be accepted as an indicator;
- breadth of coverage - series with a wide coverage, in terms of the representation of the economic activity concerned, are preferred to narrowly-defined series;

Cyclical properties

The reference series and the CLI component candidate series at this stage of the selection process are all in their original form: expressed in their natural units or as indices, maybe seasonally adjusted, but in most of the cases not ready for immediate comparison with the reference series. To achieve comparability, we use various econometric techniques to separate the cyclical patterns of interest to business cycle analysis. We deal in detail with these techniques in a later section of this paper. We will commonly refer to the collection of these techniques as "complex filter" or "a sequence of filters", filters that separate the cycle from other parts of the time series. The filters are the following: frequency conversion (if necessary), outlier detection, seasonal adjustment, de-trending, smoothing and normalization. Given that we have already successfully applied these filters to the reference series and the CLI component candidates - thus having identified the cyclical part of the time series - we can continue the component selection procedure and test for:

- length and consistency of the lead of the indicator over the reference cycle at turning points;
- "cyclical conformity" between the indicator and the reference series - if the cyclical profiles are highly correlated the indicator will provide a guide, not only to approaching turning points, but also to developments over the whole cycle;
- absence of extra or missing cycles in comparison with the reference series;
- smoothness, that is, how promptly a cyclical turn in the series can be distinguished from irregular movements;

Practical considerations

- frequency of publication - monthly series are preferred to quarterly ones;
- absence of excessive revisions;
- timeliness of publication and easy accessibility for data collection and updating;
- availability of long time series with no breaks;

Variety of components

We classify candidate leading indicators into four categories based on economic rationale:

- early stage indicators; (new orders, order books, construction approvals)

- rapidly responsive indicators;(average hours worked, profits and stocks)
- expectation-sensitive indicators; (stock prices, raw material prices and expectations based on business survey data concerning production or the general economic situation)
- prime movers; (monetary and fiscal policy measures, terms of trade, foreign country variables etc.)

Although it is not always easy to equivocally classify our economic variables, and there are without doubt mixed type variables, we try to achieve a balanced composition of the CLI by including indicators from each category.

Composition

The selected cyclical indicators are combined and aggregated into various composite indicators. The best performing composite indicator is selected based on the same cyclical concordance criteria as those being used for single component series. The aggregation itself is done in order to reduce the risk of false signals, and to provide a cyclical indicator with better forecasting and tracking qualities than any of its individual components.

The reason why a group of indicators combined into a composite indicator should be more reliable is related to the nature and causes of business cycles. Each cycle has its unique characteristics as well as features in common with other cycles. But no single cause explains the cyclical fluctuation over a period of time in overall activity. The performance of individual indicators will then depend on the causes behind a specific cycle. Some indicators will perform better in one cycle and others in a different cycle. It is therefore necessary to have signals for the many possible causes of cyclical changes, i.e. to use a wide variety of potential indicators.

Once selected a number of steps are involved in combining individual indicators to obtain the composite indicator. Only the cyclical part of each component indicator is retained and normalized. Then the indicators may be inversed, weighted and lag-shifted to improve the quality of the composite indicator. Since not all components have the same series length, and in real time operation the most recent data is not available at the same time for all the components, a calculation threshold is set for the indicator. As a rule 60% of the components has to be available in order to compute the indicator. The differences in availability can cause breaks in the series if the calculation method does not treat these specific events. To smooth the series in points where availability changes, we chain link the indicators.

Some components may have counter-cyclical (inverse) behaviour compared to the reference series. A strong counter-cyclical behaviour can be as useful in the CLI construction as a pro-cyclical variable. Whether inversion improves the leading characteristics of a component candidate series becomes clear in the cyclical analysis stage of the indicator construction.

The lag-shifting is not done regularly in the present state of the OECD system. It is done in only one case, where the indicators selected for a particular country fall into two distinct groups of "longer-leading" and "shorter-leading" indicators. Combining the two types of indicators gave unsatisfactory results because of the interference between the two cycles. The alignment was improved by lagging the longer-leading group of indicators. The ongoing review of the OECD CLI system will evaluate whether the more frequent application of series shifting can improve the quality of the leading indicator.

The present OECD CLI system assigns equal weights to components in the aggregation procedure. We have to note though, that an implicit weighting is carried out by the normalization in the filtering stage. Series are weighted by the inverse of their standard deviation (their relative amplitude). Alternatively we could assign different weights to the component series depending, for example, on their past record in forecasting and tracking

cycles or their relative freedom from revisions. Weighting of the series could also follow from an optimization process. Setting up the optimization problem however is far from obvious in the broad brush world of OECD CLI: a loss function has to be defined. Weights can be optimally determined, but this optimality will only hold with respect to the specified loss function.

Presentation

The presentation of the CLI can be done in several forms. The key is to harmonize the form of the CLI with the form in which the reference series is presented. The following forms are all produced in the OECD CLI system:

1. The amplitude adjusted CLI vs. the de-trended reference series. This is the most straightforward way to present the CLI. The CLI is the average of de-trended and smoothed component series, and similarly the reference series is also de-trended and smoothed. The resulting pure cyclical series are comparable to each other. Indeed the final composition of the CLI is determined by trying several potential compositions, and selecting the composition with the best leading behaviour. The amplitude adjusted CLI is just this raw CLI rescaled (amplitude adjusted) to match the amplitudes of the de-trended reference series. Since the composition of the CLI is established in this form, the conformity between cycles in the CLI and the reference series will be best in this form. The turning point chronology published along with the indicators is also given with respect to this form. This form allows for “output-gap” type interpretations.
2. The trend restored CLI vs. the original reference series. The trend restored CLI follows from the amplitude adjusted CLI: we make it comparable with the reference series by multiplying the trend of the reference series (in index form or natural units) with the amplitude adjusted CLI. This transformation of the CLI allows us to see trending cycles, or classic business cycles. The trend restoration alters the position of peaks and troughs: peaks occur later and troughs occur earlier in the trend restored series than in the amplitude adjusted series. Please note that the OECD turning point chronology will not align optimally with the turning points in the trend restored CLI or with the turning points in the original reference series.
3. The annualized 6 month rate of change of the CLI vs. either the year on year growth rate or the reference series or its annualized 6 month rate of change. The 6 month rate of change series are calculated from the trend restored CLI. They are comparable with the growth rate series of industrial production or GDP growth rates. Some clients prefer to base their analysis on this form of the CLI since the reference series is most often published in this format by national statistics offices. A completely coherent cyclical analysis can be built on this form of the CLI also, but care has to be taken not to mix results and messages based on different forms of the CLI. The cyclical patterns in the 6 month rate of change series are similar to the ones that we observe in the amplitude adjusted series, however peaks and troughs in the two forms have different economic meaning and therefore should be interpreted differently. Peaks in the amplitude adjusted series means that the output-gap starts to decrease, whereas peaks in the 6 month rate of change means that the growth of the output gap eases, the amplitude adjusted series has an inflection point. (later it may or may not reach its peak)

Often the argument for switching to the 6 month rate of change form of the CLI is that it provides an extra lead compared to other forms. While in most cases this is true, in real life, complex economic cycles these extra leads are not stable (predictable). Moreover the cycles in the 6 month rate of change series are shorter and more frequent than in the amplitude adjusted series, thus occasionally leading to false signals. For further details see the technical note associated with the change in focus in the OECD CLI presentation in November 2007.

In addition to various forms of the CLI, we publish a list of turning point dates for the reference series. The turning point list is revised regularly: for G7 countries every month. The most recent turning points are labelled provisional, since the likelihood of revision is higher for these signals. To increase transparency and better readability of the CLI results, for G7 countries statistics of the leading characteristics (mean lead, standard deviation of lead times) is also published regularly.

Elements of the methodology: cycle identification

Our reference series and the CLI component candidates in their original form contain features (parts) that are irrelevant from the perspective of broad economic fluctuations; moreover they obscure the relevant cyclical movements. Therefore a sequence of filters is applied to the original series to separate the relevant parts from the irrelevant components. In the filter sequence we adjust the series for seasonal effects, remove rare outlier events, de-trend the series and smooth them, and finally normalize them (i.e. we adjust the mean and amplitude of the cycle). Some parts of the filter sequence are interchangeable: the order in which they are executed does not have large impact on the end result. The ongoing review of the OECD CLI system is likely to slightly rearrange the filtering order. The order of presentation follows the filter order after rearrangement.

Seasonal adjustment

A large proportion of economic time series exhibits seasonal variation. This variation is annual or has other infra-annual periodicities and may obscure variation in the business cycle. The seasonal adjustment in general occurs outside the OECD CLI system, either at the national data provider or in the central database of OECD Statistics. Therefore seasonal adjustment can be based on several methodologies: the most commonly used ones being the X-11 or X-12 methods developed at the US Bureau of Census or the TRAMO-SEATS method developed G. Caporello and A. Maravall at the Banco de España.

Frequency conversion

We prefer to use monthly time series in the construction of monthly CLIs. This is however not always possible. For certain countries and indicator types the monthly data availability may be scarce, or the equivalent monthly series do not meet the criteria set for length and series quality. In a few cases therefore we also utilize CLI components of a quarterly frequency. During the filtering process we transform the quarterly series into monthly series with simple linear interpolation, and we align the transformed monthly series based on the information we have about the quarterly series. For example if we use indicators from a quarterly business tendency survey, and we know that the survey took place in the first month of the quarter, then the interpolated series connects the first month of each quarter.

In the present filter sequence the frequency conversion takes place after de-trending and smoothing stage. The effect of making the conversion earlier or later within the filter sequence is not very strong. In the reviewed OECD CLI system the frequency conversion will occur at an early stage. With this repositioning all the filters, that come later in the sequence operate on monthly data only, therefore calibration and maintenance becomes easier. Moreover the series will be less jagged after de-trending and smoothing.

Outlier detection

We define outliers as rare and large shocks that affect the time series. They can be different in nature, but they have a common property: they are not a result of the usual data-generating process that governs the behaviour of the series. Usually they have a well identifiable cause: a

strike, a change in regulation etc. The typical outlier classes are: additive outliers (spikes), level shifts and transitory changes. Additive outliers are a consequence of temporary shocks, level shifts are caused by permanent shocks and transitory changes are shocks where - although the shock is temporary - the return to normal occurs through several periods. The presence of outliers adversely effects the seasonal adjustment and de-trending. The outliers' local and exceptional effect is spread out and built in undesirably into the trend and cycle estimates.

Optimally the outlier detection is carried out in the seasonal adjustment phase. However since we do not always have control over the seasonal adjustment, we will utilize the TRAMO module of the TRAMO-SEATS seasonal adjustment procedure to identify the outliers in each of the component series. For further information on TRAMO SEATS see for example: Maravall [2006] . TRAMO detects whether the optimal model is additive or multiplicative and selects an ARIMA specification for the time series. It uses the selected model to test for outliers. After the location and nature of the outlier has been identified, the outlier value can be replaced with an estimated value, which fits with the selected ARIMA model.

Although TRAMO's primary aim is to detect outliers, we plan to utilize TRAMO also to fit in missing values, to use by default its "additive or multiplicative model" decision and to calculate model based forecasts that help stabilize filters in later stages.

Cycle extraction (de-trending and smoothing)

The OECD CLI system uses the "growth cycle" or "deviation-from-trend" approach. This means that co-movements and similarities in patterns between the reference series and individual CLI components are evaluated between smooth and de-trended versions of these series. For this reason the cycle extraction is a crucial step in the filtering process. Therefore we deal with competing cycle extraction methods in considerable detail.

We can approach (think of) trends and high frequency irregularities in many different ways. There are two common ways to think of the trend, both of them somewhat extreme or corner cases compared to what we will finally attempt to reach. Firstly, a deterministic time trend, characterized by a constant b that adds to the series value each period. (In the additive case this yields a linear trend, the multiplicative case an exponential trend.) Secondly, a random walk type trend where the trend-like behaviour results from entirely random, but permanent innovations. The trends and cycles that we try to identify are between the above two extremes: the linear trend and the random walk. The resulting trends in the following methods are slowly moving series relative to the original time series, they are more responsive than the linear trends, but not all of the monthly innovations stay permanently with the trend like in the case of the random walk. The de-trended series may contain considerable amount of noise, which can be removed by smoothing, usually using a central moving average.

There is another way to look at the de-trending and smoothing problem. Instead of observing the series in the time domain we can treat the series as a complex sinusoid, built from simple sine waves of different wave length. The Fourier Transformation and the related mathematical theory tell us that for a wide range of time series this change of perspective is indeed possible. See Pollock [2006] to a thorough introduction to the related mathematical concepts.

Once we have the translation of our series from the time domain to the frequency domain, we can single out the cycles we are interested in. It is still debated what are the ideal cycle length to analyse when we talk about business cycles. What is a business cycle? How long should be a cycle? Or more closely related to the de-trending exercise what are the cycle length that we consider too short or too long to treat it meaningfully as a cycle? The early papers in cyclical analysis characterize movements between 1.5 and 8 years the cycle length of interest. Some more recent papers argued that modern economic cycles may last longer, and cyclical

fluctuations are smaller. (For example see Agresti and Mojon [2001] who endorse 10 years as the upper boundary for the business cycles in Europe.) The de-trending and smoothing methods chosen therefore should be aligned with our prior expectations on business cycles.

We will present how the Phase Average Trend method, the Hodrick-Prescott filter and the Christiano-Fitzgerald filter operate on the input time series to yield the pure cycle.

Phase-Average-Trend (PAT) method

This is the method used at present in the OECD CLI system. It is the modified version of the similar (PAT) method developed by the United States NBER. This method is used in combination with the Bry-Boschan turning point detection algorithm. The resulting medium-term cycle is smoothed by the MCD (month for cyclical dominance) method to yield the final smooth cycle.

The PAT method consists of the following set of operations:

- first estimation and extrapolation of long-term trend (75 month moving average);
- calculation of deviations from moving average trend;
- correction for extreme values; (not so efficient and versatile as the model based outlier correction outlined above.)
- identification of tentative turning points and determination of cyclical phases, i.e. expansions and contractions (Bry-Boschan routine);
- new estimation of the long-term trend; We proceed by calculating averages for each phase, smoothing the sequence of phase averages over three adjacent phases. Finally these smoothed values are positioned in the center of their corresponding phases and linearly interpolated.
- extrapolation of the long-term trend at the series ends to recover periods lost because of the centered moving averaging;
- calculation of deviations from PAT trend;

The implementation of PAT works in two modes: automated and manual (supervised) mode. The automated mode uses the turning points from the Bry-Boschan algorithm, the supervised mode accepts turning points entered by the user, and ignores Bry-Boschan values. As most of the parameters of the PAT procedure are fixed, the manual turning point setting is the way to fine-tune the system, and modify not plausible cycle results. The manual turning point setting gives the analyst a very strong and precise tool to intervene in the de-trending process. At the same time this targeted intervention possibility is one of the most criticized features of PAT. The rules or conventions that govern the intervention of the analyst are not easy to document, different analysts may come up with different turning point choices and as a consequence the PAT with manual turning point specification is a non-transparent, rather ad-hoc system.

The PAT method in automatic mode has a tendency to select cycles between 15 and 75 month, as a direct consequence of parameters fixed in the PAT software. These cycle lengths are somewhat shorter than the cycle lengths in which we are interested: 18 to 96 month. Therefore we have to intervene manually and remove minor cycles, and rerun the process in supervised mode. This sets in motion an iterative process. We run the trend calculation with input turning-points, afterwards we verify whether the turning points in the estimated cycle (i.e. the de-trended series) correspond to those input turning-points. If they do not match we rerun the trend calculation this time with the turning points observed in the cycle. Convergence is usually achieved in one or two iteration steps.

An internal study was conducted to compare the properties of the PAT method and the Hodrick-Prescott filter in 2002. This study concluded that the two de-trending methods extract similar growth cycles and turning points and in most cases have highly correlated

cyclical amplitudes. The PAT method was evaluated to perform better in the presence of level shift outliers, and to adapt better to variations in cyclical amplitudes in different series. At the same time it proved to be sensitive to turning point updates, and to give biased results if the turning point updates were not carried out in a timely manner. OECD is revisiting the study, carrying out tests between de-trending and smoothing methods, this time including PAT with MCD smoothing, a double HP filter and the CF filter. Preliminary results show that the series end behaviour of PAT is indeed poorer than that of the HP filter or CF filter.

The preliminary results of the new study on de-trending methods and some obvious operational deficiencies of PAT increased the likelihood that PAT will be replaced in the OECD CLI system. We noted some of these deficiencies in earlier paragraphs; we reformulate those and add a few further arguments:

- The PAT method is not sufficiently transparent for two reasons: firstly because the algorithm which produces the cycle estimates is not available in any major econometric software, secondly because it has to be operated with manual turning point insertion, which leads the method rather into the domain of arts than econometrics.
- The method has been developed four decades ago when computational power was more limited and software languages less developed. Methods that were designed and developed later in parallel with the evolution of real business cycles field of macroeconomics were built on new foundations, and PAT stayed unchanged since. The algorithm written in the 1970's was adapted to run on personal computers in the mid 1990's but preserved most of the limitations of the early implementation. (Many parameters are not modifiable, series that are longer than 50 years cannot be treated.)
- As the number of countries and zones included in the OECD CLI system increased (and it is likely to increase further) the resource intensiveness of PAT (especially turning point updates for all components) are a burden that urges OECD to shift to de-trending methods that need less maintenance after initial calibration.

The smoothing coupled with the PAT method is the so called MCD (month for cyclical dominance) moving average. This procedure ensures approximately equal smoothness between series and also ensures that the month-to-month changes in each series are more likely to be due to cyclical than to irregular movements. The data lost at the end of the series due to the moving average are restored with an extrapolation by regression over the end of the series. The time span of the MCD moving average value is defined as the shortest span for which the I/C ratio is less than unity. I and C are average absolute month-to-month changes of the irregular and trend-cycle component of the series, respectively. The maximum value of MCD is capped at 6 month.

The Hodrick-Prescott (HP) filter

The Hodrick-Prescott filter is one of the best known and most widely used de-trending method by macroeconomists. The filter was first described in Hodrick and Prescott (1997; follows from a working paper published in 1981). In its original form the trend estimate is a result of an optimization problem:

$$y_t = \tau_t + c_t$$

$$\min_{\tau_t} \sum_t (y_t - \tau_t)^2 + \lambda \sum_t (\tau_{t+1} - 2\tau_t + \tau_{t-1})^2$$

We decompose our initial y_t series into τ_t – the trend component and c_t the cyclical component, such that we minimize the distance between the trend and the original series and at the same time we minimize the curvature of the trend series. The trade-off between the two goals is governed by the λ parameter.

The optimization problem has a solution that can be represented by a linear transformation which is independent from y_t . (see Maravall and del Rio [2001]). This makes the filter very fast.

What was impossible with the PAT method is possible with the HP filter. We can transform the filter into the frequency domain and understand its effects on various cycles that make up the time series. While doing this exercise we can realize that the λ parameter determines the shape of the frequency response function of the HP filter and the cut-off frequency. The frequency response function shows how the filter affects certain frequencies, it shows which frequencies are retained and which are let through. The cut-off frequency is defined as the frequency where 50% is let through and 50% is retained from the original power of the cycle. Thus we can align the λ parameter with our goal to filter out economic cycles in a certain frequency range with the help of the transformation into the frequency domain. Before the frequency domain interpretation emerged there were only rules of thumb to set the λ parameter. Rule of thumb values later proved to be in line with values that had been determined by frequency selection criteria, i.e. separating the “trend” cycles with a wavelength larger than 8 years. See for example Maravall and del Rio [2001] to learn more on how the λ parameter translates to the frequency domain.

Properties of the HP filter:

- The cut-off region is not steep; meaning that leakage from cycles from just outside the target region can be significant. In engineering applications filter leakage is a sign of a poor filter. However in business cycle analysis there are arguments to support at least a small degree of desirable leakage. Since the frequency band of 1.5 to 8 years has been selected based on expert decision several decades ago, the boundaries 1.5 and 8 years should not be regarded as carved in stone. The filter leakage for example is letting strong 9 years long cycles to appear in the filtered series.
- It is asymmetric. With the exception of the central values the double HP filtered series are phase shifted compared to the underlying ideal cycle. Phase shifts vanish for a given observation as newer observations arrive.
- Series end revisions are frequent. All filters have relatively poor performance at the end of the series, which can be stabilized (improved) by forecasting the original series. Indeed we use the TRAMO method to forecast the series. The on-going study on de-trending methods, aims to select an ideal (good) forecast horizon for this stabilization effect. The series end behaviour of the filters is crucial. We search for a method that has a good balance between responsiveness and stability. It has small revisions, but quickly responds to changes in the underlying trends. In other words trend filters that converge quickly to their long term value are preferred.

We apply the HP filter twice to achieve a smoothed de-trended cycle. First we remove the long term trend by setting λ to a high value, and we preserve the business cycle frequencies and the high frequency components. Second time we apply the HP filter with a smaller λ , meaning that the cut-off frequencies are much higher, and this time we preserve the trend part of the filter results. The first step is de-trending the second step serves for smoothing.

The Christiano-Fitzgerald (CF) filter

The Christiano-Fitzgerald random walk filter is a band pass filter that was built on the same principles as the Baxter and King (BK) filter. These filters formulate the de-trending and smoothing problem in the frequency domain. Should we have continuous and/or infinitely long time series the frequency filtering could be an exact procedure. However the granularity and finiteness of real life time series do not allow for perfect frequency filtering. Both the BK and CF are filters approximate the ideal infinite band pass filter. The Baxter and King version is a symmetric approximation, with no phase shifts in the resulting filtered series. But

symmetry and phase correctness comes at the expense of series trimming. Depending on the trim factor a certain number of values at the end of the series cannot be calculated. There is a trade-off between the trimming factor and the precision with which the optimal filter can be approximated. On the other hand the Christiano-Fitzgerald random walk filter is asymmetric, and uses the whole time series for the calculation of each filtered data point. The advantage of the CF filter is that it is designed to work well on a larger class of time series than the BK filter, converges in the long run to the optimal filter, and in real time applications outperforms the BK filter. For details see Christiano-Fitzgerald [1999]. For these reasons we included only the Christiano-Fitzgerald filter in our study that compares different cycle detection methods.

The CF filter is a steep, asymmetric filter, that converges in the long run to the optimal filter. It can be calculated as follows:

$$c_t = B_0 y_t + B_1 y_{t+1} + \dots + B_{T-1-t} y_{T-1} + \tilde{B}_{T-t} y_T + B_1 y_{t-1} + \dots + B_{t-2} y_2 + \tilde{B}_{t-1} y_1, \text{ where}$$

$$B_j = \frac{\sin(jb) - \sin(ja)}{\pi j}, j \geq 1, \text{ and } B_0 = \frac{b-a}{\pi}, a = \frac{2\pi}{p_u}, b = \frac{2\pi}{p_l}$$

$$\tilde{B}_k = -\frac{1}{2} B_0 - \sum_{j=1}^{k-1} B_j$$

The parameters p_u and p_l are the cut-off cycle length in month. Cycles longer than p_l and shorter than p_u are preserved in the cyclical term c_t .

Normalization

The components of the CLI are normalized before aggregation. This step is necessary since the component series may be expressed in units on different scales, thus their amplitudes can vary not only because of their responsiveness to the cycle but also merely because of the chosen measurement unit.

In the present state of the OECD CLI methodology the normalization (standardization) is done by subtracting the mean of the series, then by dividing with its mean absolute deviation, and finally the series is relocated to have a mean of 100. Alternatively we could use the standard deviation of the series as a divisor.

Turning Point detection

Turning point detection in a strict sense is not part of the filtering sequence. However we could see, that for example the PAT de-trending method is intimately linked with the Bry-Boschan turning point identification algorithm. We find it convenient to present the turning point detection options at this stage, since it is an integral part of the component selection, and evaluating cyclical correspondence between series.

The Bry-Boschan algorithm (see Bry and Boschan [1971]) identifies local peaks and troughs in a smoothed version of the input series. Afterwards it checks minimum phase and minimum cycle length criteria and eliminates turning points that are not fulfilling these. The Bry-Boschan routine specifies a minimum duration of five months for a phase and fifteen months for a cycle. In various iterations less and less smoothing is applied to the input series, turning points are always slightly corrected. At the end of the process the turning points are sought in the original series within the five months on both sides of the turning points found at the preceding stage.

The main problem with the Bry-Boschan routine running in combination with the PAT method is that it tends to select too many turning points, thereby giving a long-term trend which is too variable. Relatively minor fluctuations may be selected by the routine and given the same weight as more important cycles. We have to note though that the number of

selected turning points is just partly related to the settings of the BB routine. They are in fact mostly inherited from the PAT procedure which tends to filter out cycles that are shorter, and the MCD procedure which does not smooth strongly enough a number of series.

The double HP filter and the CF filter yields much smoother cycles, therefore the Bry-Boschan routine can be simplified. The smooth cycles do not require several iterations; it is sufficient to locate the peaks and troughs of the series sequentially, meanwhile respecting phase and cycle-length constraints.

There are several other turning point dating alternatives. Bruno and Otranto [2004] in their paper give an exhaustive classification of turning point dating methods coupled with cycle identification methods. Parametric methods operate in fully model based settings, usually in hidden variable Markov Switching type models, deriving from Hamilton [1989]. The adaptation of these turning point dating methods to the OECD CLIs is not straightforward. The non-parametric methods from the Bry-Boschan family harmonize best with other elements of the OECD CLI system. Variants like the one presented in Harding and Pagan [2003] of the Bry-Boschan method will be evaluated during the ongoing OECD CLI system review.

Plans and future work

The OECD CLI system undergoes a major review while keeping its conceptual framework and its broad-brush nature intact. The various modifications follow from the 2004 OECD CLI quality review recommendations, and from internal studies conducted since.

In an attempt to achieve clearer and more concise communication of the OECD CLIs in November 2007 the focus of CLI related publication shifted towards the amplitude adjusted form of the CLI. Before this date trend restored CLIs and 6 month rate of change of the CLIs were mixed in publications, which caused difficulties in interpretation. This step is just a first step in a sequence of upcoming changes.

The changes will be framed by a substantial redesign of the CACIS (Cyclical Analysis and Composite Indicators) software: an internally developed software used for CLI related analysis. The new version will have improved analytical capabilities (allowing to test the various options outlined in the current paper.), it will be modular and easier to expand, and it will communicate with the OECD statistics production environment, so that indicators composed in the analytical segment can be effortlessly transferred into production. Studies related to properties and effects of the outlier filtering, stabilizing forecasting, various de-trending methods and various composition options will be carried out. Based on the results of these studies we will modify the methodology and we will proceed by reviewing OECD CLI for all countries and zone aggregates that are part of the OECD CLI system.

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Further documents related to the OECD CLI system can be found on the OECD Business Cycle Analysis webpage: <http://stats.oecd.org/mei/default.asp?rev=2>