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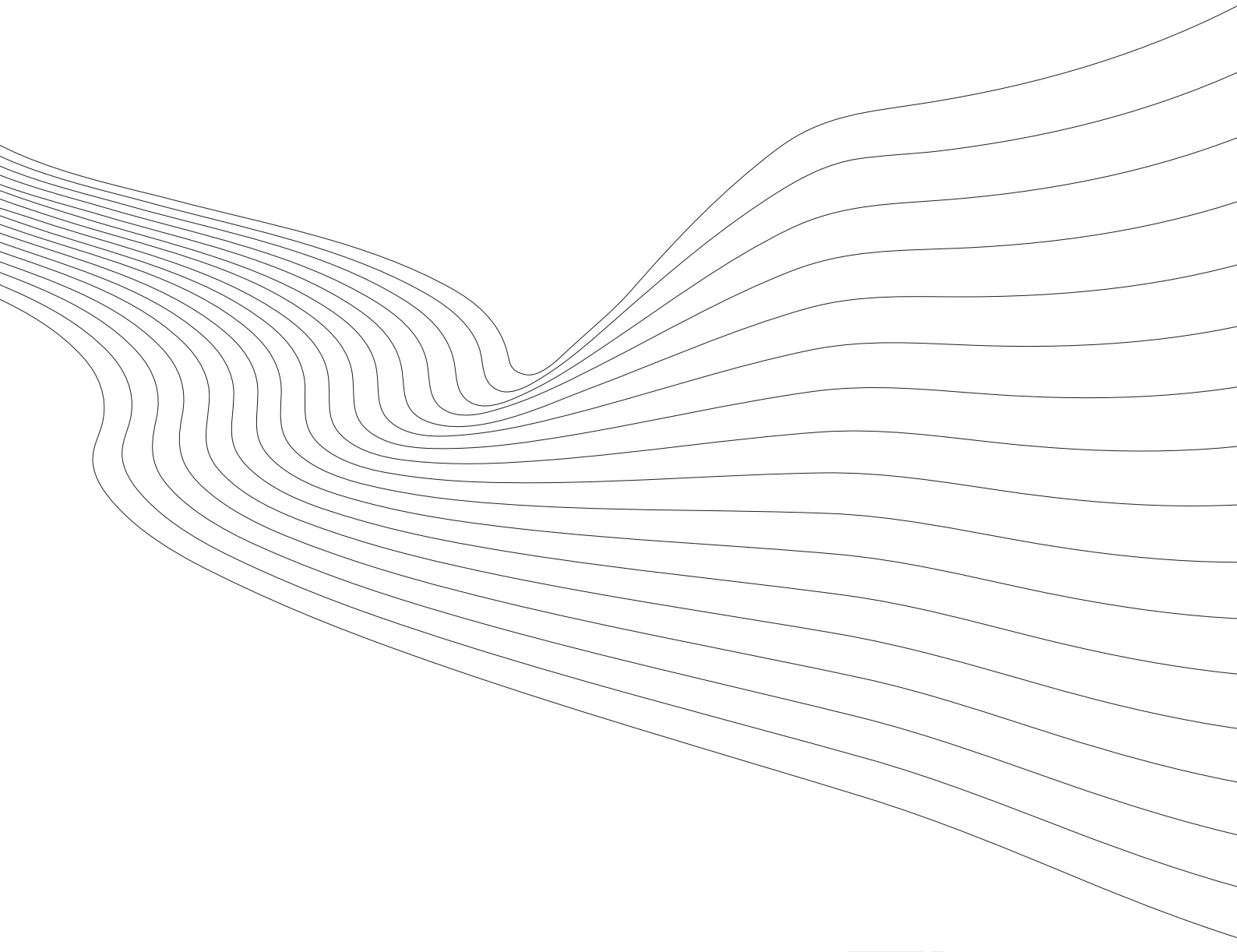

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The KOF Economic Barometer, Version 2014: A composite leading indicator for the Swiss business cycle*

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Abstract: This paper presents a composite leading indicator for the Swiss business cycle corresponding to the growth rate cycle concept. It is the result of a complete overhaul of the KOF Economic Barometer that has been published by the KOF Swiss Economic Institute on a monthly basis since 1976. In line with this tradition, the calculation of the new KOF Barometer comprises two main stages. The first consists of the variable selection procedure; and in the second stage these variables are subsequently transformed into one leading indicator. Whereas in the previous versions of the KOF Barometer six to 25 variables survived the first stage, the new – less discretionary and more automated – version of the first stage is much more generous. Currently, out of a set of 476 variables resulting in 4356 transformations thereof that are tested in the first stage, 219 variables manage to enter the second stage. The increased number of variables underlying the second stage allows a relatively stable and robust KOF Barometer – compared to its previous versions – that has hence no longer to rely on filtering techniques to reduce the noise in the final indicator. In a (pseudo-) real-time analysis the characteristics of the new KOF Barometer are compared to the previous versions and other alternatives.

JEL classification: E32; E37

Keywords: Business cycles; growth rate cycles; composite indicators; leading indicators; principal component analysis; real-time simulations

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1. Introduction

The KOF Economic Barometer is one of the most prominent leading indicators for the Swiss business cycle. Its first version was introduced in 1976. It has in the past undergone two main revisions: in 1998 and 2006, respectively. This paper describes in detail the third revision and the resulting fourth version, developed in 2013 and implemented in 2014.

The 2006 version of the KOF Barometer was largely fitted on data representing what nowadays is often labelled the Great Moderation. The Great Recession and the subsequent euro crisis during the last few years had strong effects on business cycle characteristics and thus certainly posed a challenge also the KOF's composite leading indicator. Since the Great Recession, the cyclical ups and downs in the world economy appear to be occurring at a faster pace than before. Especially for the filter used in the 2006 version of the KOF Barometer, i.e. the Direct Filter Approach as described by Wildi (2008), which was calibrated on pre-crisis information, these changes in the economic environment have left their marks. Furthermore, in recent years the number of time series that are potentially helpful in explaining cyclical developments in Switzerland has substantially increased. For most, the business tendency surveys conducted by the KOF Swiss Economic Institute have been broadened by including many additional branches and sectors of the Swiss economy. By now these time series have a long enough history to also be taken into account in the construction of our leading indicator. Finally, the demand for receiving timely information on economic developments with a substantial news value and at the same time a high degree of transparency has substantially increased in recent years. Not only, but especially the use of the above-mentioned Direct Filter Approach gave the 2006 version of the KOF Barometer a black box character and with hindsight led to a phase shift that, although it increased reliability in detecting turning points, reduced its leading characteristics.

Combining these findings, we therefore at the outset of this revision stated the objective – within the tradition of the KOF Barometer – to develop a new version that can be published without a final filtering stage. This requires a pre-filtered reduction in the noise component, brought about by a much broader set of underlying variables. Indeed, the new KOF Barometer fulfils these objectives and turns out to be much faster in detecting and capturing cyclical movements of the Swiss economy.

Another new objective was to define a procedure by which in the future the new KOF Barometer would be able to both learn from recent developments and allow for new variables, e.g. coming from additional surveys conducted at the KOF Swiss Economic Institute, to enter. In contrast to previous versions of the KOF Barometer, in which the underlying variables did rarely change during the lifespan of the respective version, the new one will in an automated fashion be able to change the set of underlying variables. Hence, over the course of time, different vintages of the 2014 version of the KOF Barometer will exist.

The rest of this paper is set up as follows. After giving some historical background information highlighting the traditions underlying the KOF Barometer in Section 2, the construction of the KOF Barometer, Version 2014, is explained in Section 3. Subsequently, Section 3.7 analyses the time series characteristics of the new KOF Barometer and compares it to its predecessors. To get a feeling for how sensitive the new KOF Barometer is to some of the decisions made and described in Section

3, a number of alternative versions are presented and confronted with the new KOF Barometer in Section 5. We end with some conclusions.

2. Historical background

2.1. General principles

Since its introduction in 1976, the KOF Economic Barometer has been designed as a composite leading indicator for the Swiss business cycle. With major revisions in 1998 and 2006, so far three versions have been published. This document describes the fourth.

The 1976 version of the KOF Barometer relied on the identification of underlying variables by both cross-correlation analyses with a reference series reflecting the Swiss business cycle and the knowledge of business cycle experts working at KOF at that time.[1] It comprised one leading variable from the construction sector, one from manufacturing, two reflecting labour market conditions, one measuring real money supply (using M1) plus the Swiss stock market index. It was computed in levels corresponding to GDP at constant prices and presented as the deviation from its trend according to a non-linear low-pass filter. The interpretation of this KOF Barometer thus relied on the relative deviations of both KOF Barometer and GDP and from their trends.

In 1997, one of the six original variables, the stock market index, had lost its lead and was eliminated from the KOF Barometer (Marty, 1998). This, along with the difficulty to interpret the relative deviations from trend plus a major revision in Swiss National Accounting standards, which had considerably affected the KOF Barometer's reference series, led the KOF institute to consider a major revision of its Barometer. The resulting 1998 version indeed represented a complete overhaul, and the new leading indicator was the first to resort to the growth rate cycle concept as the quantitative representation of the Swiss business cycle. The new reference series was computed as the year-on-year growth rate of quarterly GDP. Moreover, the indicator selection focussed largely on the qualitative survey data as collected by KOF. Six variables were identified to have had a stable lead to this particular reference series. Three of these were at a monthly frequency and based on the KOF manufacturing industry survey: (1) the annual change of incoming orders, (2) the change of the order backlog compared to the previous month and (3) the expected purchase of intermediate goods. The remaining ones were available at a quarterly frequency: (4) the judgement of wholesale inventories from the corresponding KOF survey, year-on-year (y-o-y) change of the real order backlog in the construction sector provided by the SBV (Schweizerischer Baumeisterverband) and the evaluation of the financial situation in the coming 12 months from the consumer sentiment survey at that time collected by the BWA (Bundesamt für Wirtschaft und Arbeit).[2] Subsequently, these six variables were low-pass filtered with the ARIMA-X11 tool (smooth component) to remove the noise, i.e. information that is not necessarily useful when measuring the business cycle. From these filtered series, the first principal component was extracted. The resulting principal component, a standardised variable, was updated monthly and published in monthly press statements without further transformation. It therefore by constructing had a mean of zero and a standard deviation of

[1] See Marty (1998) for further details regarding the first version of the KOF Barometer and its first revision.

[2] Note that the underlying time series are stemming from qualitative tendency surveys. The qualitative answers were quantified using the so-called balance statistics, i.e. the difference between the percentage good/increase and the percentage bad/decrease answers. Conceptionally, these qualitative survey results do not contain a trend.

one. According to the monthly press statements released by KOF at those times, it was to be interpreted as a qualitative indicator for the Swiss business cycle with a lead of six to nine months.

By 2005, the KOF Barometer had lost much of its self-proclaimed lead, and – as researchers became aware of the endpoint problem associated with symmetric filters – it became clear that the short lead that could still be observed ex post, had hardly ever been present in real time.[3] Another major overhaul was hence called for. As for the previous versions of the KOF Barometer, also in the 2006 version the fundamental building blocks remained the identification of theoretically valid variables with empirically established leads with respect to the reference series and the aggregation of these series into a composite indicator. While the 2006 version kept with the tradition of using cross-correlation analysis and expert knowledge to select the variables that entered the principal component extraction procedure, two important changes were introduced.[4]

Firstly, particular sectors whose business cycles did not move synchronised with the Swiss economy as a whole were treated separately. To this end, separate reference series were defined for the financial sector, the construction sector and remaining (by far largest) part of the Swiss economy, referred to as a "core", allowing the selection of underlying variables using cross-correlation analyses and expert judgement. The modular reference series corresponded to the y-o-y growth rates of sector-specific real value added. The three modules – financial, construction and the residual "core" – were subsequently aggregated to the KOF Barometer using their annual value added shares of the preceding year, so that the scaled KOF Barometer corresponds to the y-o-y growth of Swiss real GDP.

The 2006 version of the KOF Barometer comprises three modules, referring to 25 variables, 10 monthly and 15 quarterly, from various sources, as shown below:

- Core GDP Module:
    - Three monthly variables from the KOF industry survey
    - One monthly variable from the KOF retail trade survey
    - One quarterly variable from the KOF hotels and restaurants survey
    - One quarterly variables from the State Secretariat for Economic Affairs (SECO) consumer survey
    - One monthly variable on advertising from media focus
    - One monthly and two quarterly surveys from the EU industry survey as published by the European Commission
- Banking Module
    - Six quarterly variables from the KOF banking survey

[3] See Stulz (2005).

[4] For in-depth descriptions and analyses of the 2006 version and its properties, see Gübeli and Wildi (2006) and Graff, (2010).

- Three monthly variables from the banking statistics of the Swiss National Bank
- One quarterly employment variables published by the Swiss Federal Statistical Office (SFSO)

- Construction Module
  - Three quarterly variables from the KOF construction survey
  - One quarterly variable from the KOF project engineering survey
  - One monthly variable on building permits (source: "Baublatt", calculation performed by KOF)

Finally, the filter as well as the moment used did change. Instead of filtering the identified variables before they entered into the principal component extractions, filtering was performed only once, at the final stage, i.e. after the first principle component had been extracted. Importantly, to circumvent (large) revisions in the KOF Barometer caused by the symmetrical low-pass filter used previously, the end-point stable Direct Filter Approach of Wildi (2008) was implemented instead.

2.2. Reflections on the KOF Economic Barometer revision released in 2006

As was to be expected, our routine monitoring started to reveal that some of the correlations of the underlying variables with the reference series observed when setting up the 2006 version of the KOF Barometer were getting less pronounced, and the leading properties show tendencies of weakening, too. As previous versions of the KOF Barometer, also the 2006 version referred to a relatively informal selection procedure to find the variables for its underlying modules. This procedure rested on both statistical information (cross-correlation and turning point analysis) as well as expert judgement. By its very nature, this implies that whenever an underlying variable loses its leading properties, or simply seizes to be published, the quality of the final indicator deteriorates.

Furthermore, the choice of the three sector modules in the 2006 version of the KOF Barometer was based on the consideration that they should be particularly useful to identify cycles for those sectors that are characterised by pronounced deviations from the overall business cycle. Given the data available in 2005, the only two sectors with a substantial share in GDP that were not significantly correlated with the overall Swiss business cycle and for which relevant survey indicators were available were "construction" (NOGA 45) and "financial intermediation without FISIM" (NOGA 65).[5] The third module was set-up to consist all remaining sectors and with more than 90 per cent of total value added was labelled "core GDP".

Unfortunately, after 2006, the "construction" module did not continue to show the high correlation with the official y-o-y growth rate of real value added for the construction sector as in sample. Whether this is due to a lack of the KOF survey results to reflect actual business conditions in the construction sector or to the validity of the (frequently revised) reference series remains an open question.

[5] According to international convention, the value added of "financial intermediation" includes so-called "financial intermediation services indirectly measured" (FISIM), which, due to construction, are highly correlated with overall economic value added. After subtracting the FISIM the resulting "independent" financial sector business cycle was no longer significantly correlated with the Swiss business cycle.

In addition to this, the other separate module in the 2006 version of the KOF Barometer, NOGA 65, was fitted on value added by the financial sector *excluding* the so-called FISIM (financial services indirectly measured). Shortly after the 2006 KOF Barometer was launched, the SFSO started to *include* the FISIM into the value added measure of the financial sector, i.e. NOGA 65. As a result, today's measure of value added in NOGA 65 turns out to be much more correlated with the overall economy than that available in 2006.

The 2006 version of the KOF Barometer addressed the endpoint (revision) problem by abandoning the previous smoothing procedure for the underlying variables with a symmetrical low-pass filter. Instead, it referred to unfiltered variables and applied an asymmetrical low-pass filter, the so-called Direct Filter Approach (DFA) of Wildi (2008), as a final step. Although the endpoint problem that plagued the 1998 version of the KOF Barometer was eliminated, this came at a price. With hindsight, the DFA induced a phase shift of up to one quarter reducing the leading characteristics of the final KOF Barometer. Nevertheless, as shown in Siliverstovs (2011), the 2006 version of the KOF Barometer has predictive power for GDP growth up to two quarters.

3. Construction of the 2014 version of the KOF Economic Barometer

3.1. Objectives of the revision

Due to changes of economic linkages and patterns, indicator models that are designed to signal economic developments based on observed correlations in the past tend to have a limited life span. The KOF Barometer is no exception.[6] During the last seven years, the world economy has gone through unique events that certainly affected economic developments also in Switzerland. The selection of variables that was optimal in 2006 is likely to be different nowadays. An important objective of this revision is to set up a mechanism that includes a standardised updating of the variables selected in the years to come. In this way not only changing economic relationships, but also the in the mean-time realised and for the future expected further increase in available time series reflecting business cycle conditions in Switzerland can be incorporated using a pre-set mechanism. The use of such a pre-determined procedure is expected to increase the lifespan of this particular version of the KOF Barometer substantially. Furthermore, by allowing many more variables to enter the final construction step we expect to increase the robustness and stability of the KOF Barometer.

Previous versions of the KOF Barometer always relied on specific filtering techniques to increase the signal-to-noise ratio. Whereas in the first two versions the use of a symmetrical low-pass filter led to the so-called endpoint problem, i.e. caused substantial revisions of the most recent observations of the KOF Barometer over time, the Direct Filter Approach used in the 2006 version introduced a large amount of complexity giving the KOF Barometer a black-box character. The use of these filters therefore is in conflict with our objectives: the KOF Barometer should be produced in a transparent way and should not be prone to substantial revisions.

Other objectives are very much in line with the tradition of the KOF Barometer. This composite leading indicator should reflect upcoming business cycle movements for the Swiss economy. As for previous versions of the KOF barometer, the two building blocks continue to be a) the identification

[6] Also in the past, this was the driving reason for revising the KOF Barometer.

of theoretically valid variables with empirically established leads with respect to a reference series reflecting the Swiss business cycle and b) the aggregation of these series into a composite indicator by extraction of the first principal component.

By this time literally allowing hundreds of variables to enter the aggregation procedure, i.e. many more series than in the past,[7] the importance of the principal component analysis within the overall constructing method has increased substantially.

3.2. Principal components analysis

Since we are dealing with a data panel, characterised by both high temporal (*T*) and cross-sectional (*N*) dimensions, we adopt an approximate static factor model like the one presented by Stock and Watson (2002a) that allows modelling the co-movement of numerous variables in terms of a few latent factors. Given the fact that we select the indicators entering our factor analysis according to their bi-variate congruence with the reference series of the Barometer, the first of these latent factors should capture the business cycle dynamics that is commonly shared by the variables in our dataset. According to this approach, the higher order factors should neither reveal a stable pattern, nor should the loading matrix suggest an interpretation of those factors other than noise and idiosyncratic properties of groups of indicator variables that bear no relationship to the Swiss business cycle.

The approximate static factor model for a *N*-dimensional multiple time series X_t assumes the following factor model representation featuring *k* common latent factors, F_t,

(1) $X_t = \Lambda F_t + e_t$,

or in matrix notation

(2) $X = F\Lambda' + e$,

where $X=(X_1,\ldots,X_T)'$ is a *T*x*N* matrix, $\Lambda= (\Lambda_1,\ldots, \Lambda_N)$ is a *N*x*k* matrix of the factor loading coefficients, and $F=(F_1,\ldots F_T)'$ is a *T*x*k* matrix of common factors. The idiosyncratic error term $e=(e_1,\ldots e_T)'$ is variable-specific and has the corresponding dimension of *T*x*N*. The idiosyncratic disturbances can be both serially and cross-sectionally correlated. The approximate static factor model relaxes restrictive assumptions of the classic factor analysis that requires cross-sectional and temporal independence of the idiosyncratic disturbances. Stock and Watson (2002a) showed that under fairly general conditions on the error terms the latent factors can be consistently estimated using the principal components (PC) analysis. Observe that in order to rule out scale effects, we perform the principal components extraction referring to the correlation matrix rather than to the covariance matrix of the selected indicator variables.[8] This is mandatory, as the variances of our transformed indicators series differ greatly for purely technical reasons that should not affect the weight given to a particular variable.

[7] The first KOF Barometer comprised six variables, and the predecessor or the latest KOF Barometer, the 2006 version, still referred to no more than 25 variables.

[8] Notice that this yields the same results as standardising the indicator variables X_t prior to conducting a principal components analysis based on the covariance matrix.

For any arbitrary number of common factors k ($k < \min\{N,T\}$) estimates of Λ and F_t are obtained as a solution to the following nonlinear least squares minimisation problem:

$$(3) \qquad \left\{\hat{F},\hat{\Lambda}\right\} = \underset{F,\Lambda}{\operatorname{argmin}} \frac{1}{T}\sum_{t=1}^{T}(\mathrm{X}_t - \Lambda\,\mathrm{F}_t)'(\mathrm{X}_t - \Lambda\,\mathrm{F}_t) \quad s.t. \quad \Lambda'\Lambda = I_k.$$

After concentrating F_t out by setting $\hat{F}_t = (\hat{\Lambda}'\hat{\Lambda})^{-1}\hat{\Lambda}'X_t$, the optimisation problem above transforms into the equivalent problem:

$$(4) \qquad \hat{\Lambda} = \underset{\Lambda}{\operatorname{argmax}} \quad trace\left[\Lambda'\left(\frac{1}{T}\sum_{t=1}^{T}\mathrm{X}_t\mathrm{X}_t'\right)\Lambda\right] \quad s.t. \quad \Lambda'\Lambda = I_k.$$

This latter optimisation problem is solved by setting $\hat{\Lambda}$ equal to the eigenvectors corresponding to the k largest eigenvalues of the sample correlation matrix of X_t. The estimator of common factors is given by $\hat{F}_t = \hat{\Lambda}'X_t$.

Alternatively, the first principal component can be defined as the linear combination of variables with maximal variance. The subsequent principal components are similarly defined with an additional restriction that their loadings must be orthogonal to all previously calculated principal components. Formally,

$$(5) \qquad \hat{\Lambda}_k = \underset{\Lambda_k}{\operatorname{argmax}}\ \operatorname{var}\left[\mathrm{F}_k\right] \quad s.t. \quad \Lambda_k'\Lambda_k = 1 \quad and \quad \Lambda_k'\Lambda_j = 0 \quad for \quad all \quad j < k.$$

Factors are estimated as before by $\hat{\hat{F}}_k = X\hat{\Lambda}_k$, where F_k and Λ_k are the k^{th} columns of F and Λ matrices, respectively. Hence principal components analysis has the following interpretation. The first principal component explains as much variation in the data as possible. The second explains as much of the remaining variation in the data PC as possible after extraction of the first, and so on. In this way principal component analyses reduces the dimensionality of a large set of interrelated variables, while retaining as far as possible the information (variation) present in the data set.

How many principal components are required to reproduce the data? Actually, as outlined above, we do not really consider the dimensionality of the data set submitted to the principal component extraction to be an issue in our particular case. In contrast to heuristic analyses that aim at revealing the dimensionality of a data set, we condition ours to be highly correlated with one and the same reference series. This makes it one-dimensional by construction. Accordingly, a solution with more than one principal component would run counter to our approach. Indeed, analysing whether subsequent principal components have any meaningful interpretation and stable relationship with the reference series allows us to assess the appropriateness of our approach. We will return to this in Section 5.

Apart from these considerations, we also conduct a formal test on how many principle components are needed to describe the underlying data. For this, we follow Ahn and Horenstein (2013). They propose to select the number of factors based on the sequence of ratios of adjacent eigenvalues λ_k of the sample correlation matrix of X_t arranged in a descending order:

(6) $ER(k) = \lambda_k/\lambda_{k+1}$, $k=1,2,\ldots,k_{max}$,

where "*ER*" stands for "Eigenvalue Ratio". According to Ahn and Horenstein (2013), the optimal number of factors k_{ER}^{*} is selected as follows:

(7) $$k_{ER}^{*} = \max_{1 \le k \le k_{\max}} ER(k).$$

The authors show that this procedure leads to a consistent estimator for the number of underlying factors. Given our a priori considerations, the Eigenvalue criterion should confirm that the appropriate number of factors indeed equals one.

3.3. Business cycle measurement

To make sure that all variables that enter the principal component analysis contain a substantial amount of information regarding the latent variable, i.e. the Swiss business cycle, we apply a selection procedure. In light of the tradition of the KOF Barometer, this is largely done based upon cross-correlation analyses and requires defining a so-called reference series that reflects the business cycle concept we have in mind, i.e. an ex-post realisation of our latent variable. Hence, before describing the selection procedure underlying the new KOF Barometer, we first need to clarify in somewhat more detail what we mean with the Swiss business cycle and how we try to ex post measure it.

Business cycles are recurrent sequences of alternating phases of expansion and contraction among many economic activities (Burns and Mitchell, 1946). The business cycle reflects the common information and synchronicity simultaneously observed in different branches and demand components. In practise, the term "business cycle" turns out to be somewhat ambiguous, as it can refer to conceptually three different ways of measuring economic fluctuations. In the seminal work of Burns and Mitchell (1946), the so-called classical cycle is used. It looks at the fluctuations in the level of economic activity. The deviation cycle (also called growth cycle), focuses on fluctuations in economic activity around its potential. Finally, the growth rate cycle concentrates on fluctuations in the growth rate of economic activity.[9]

[Insert "Figure 1: Concepts of business cycles" about here]

Using simulated data, Figure 1 shows these three concepts in case of a stylised output measure that tends to increase over time. The classical cycle can directly be derived from this output measure. Peaks are found mid-2002 and mid-2007; troughs in mid-2004 and mid-2009. To construct the deviation cycle, a trend measure is needed, which is subsequently subtracted from the output measure. This results in peaks in early 2002 and early 2007; troughs in early 2004 and early 2009. Hence, in case of an upward trend, the growth cycle leads the classical cycle.[10,11]

[9] For detailed elaborations of these conceptual issues, see Harding and Pagan (2005) and Proietti (2005).

[10] Furthermore, in case the trend is strong enough (relative to the variance of the series) peaks and troughs in the classical cycle might occur quite infrequently making this concept also in such a situation less attractive.

[11] Note that to measure the growth cycle one requires an estimate of the trend. Given that this is not directly observable its measurement complicates matters substantially in practice.

The growth rate cycle in turn uses growth rates of the output measure. To construct growth rates two data points over time are compared. As a consequence there are several ways in which growth rates can be calculated. One common way is to compare the current month with the same month one year ago. This results in the year-on-year (y-o-y) growth rate. Another option is to compare the current month with the previous month, i.e. the month-over-month (m-o-m) growth rate. Either case will result, in the artificial example depicted in Figure 1, in a lead against both the growth and the classical cycle. Furthermore, in this example, the m-o-m growth rate shows turning points about half a year sooner than y-o-y growth rates.

As in the previous two versions of the KOF Barometer, we adopt the concept of growth rate cycles, i.e. expansions (contractions) are identified by increasing (decreasing) growth rates. While the previous KOF Barometer referred to the year-on-year growth rate of GDP as reference series to reflect the growth rate cycle, the new instrument targets the same concept using a more current growth rate like the quarter-over-quarter or the month-over-month growth rate. As these latter ones are known to lead the former, the task to find leading variables is now harder than before.

The obvious candidate to measure output is seasonally adjusted (real) GDP. GDP data in Switzerland is published at a quarterly frequency. The KOF Barometer, however, is a monthly indicator. In the selection stage, therefore, a monthly reference series is to be preferred. To accomplish this, the level of seasonally adjusted (real) GDP is interpolated using the Denton additive method.[12] This procedure assures that the interpolated monthly observations add up to the published quarterly value.[13] These monthly GDP series allows the construction of growth rates at a monthly frequency.

A disadvantage of using m-o-m or quarter-over-quarter (q-o-q) growth rates is the high volatility of these series. Measurement errors, weather effects, working day effects and other distortions sometimes have huge effects on these changes. These figures can also be quite sensitive to the chosen seasonal adjustment procedure. This often makes the underlying business cycle less visible in these data. The aim of the KOF Barometer is to signal the underlying business cycle – not high frequency fluctuations triggered by for example distortions or seasonality. Therefore, the reference series is smoothed in a very transparent way. We apply a symmetric 13 months moving average to our monthly observations. The average is centred on the observation at time t. Since the values for months t-6 and t+6 reflect the same month in two different years, these receive half the weight compared to the other observations.[14]

[12] The objective of the Denton additive method is to temporal distribute the quarterly values to a monthly frequency in such a way that it keeps the difference between the estimated monthly series and an indicator series as constant as possible, subject to quarterly constraints. Since in the present case a constant is used instead of an indicator the additive Denton method is similar to the Boot, Feibes, Lisman first-difference approach. For a discussion of various methods for temporal disaggregation see Chen (2007).

[13] This procedure is not endpoint stable. To construct a value for period t, it also uses information in period t+1 and beyond. For this reason, the application of the Denton method is restricted to the construction of the (ex-post) reference series.

[14] We also experimented with more sophisticated filters. One popular filter we elaborated is the Henderson filter of various lengths. The Henderson filter is quite popular in economic time series analysis and is for example an essential part of the X12-ARIMA procedure developed by the U.S. Census Bureau. It can be interpreted as a low-pass filter. However, in the present setting we observed no substantial advantages of this

[Insert "Figure 2: Potential reference series for the 2013-vintage of the KOF Economic Barometer" about here]

Figure 2 shows – using the GDP vintage as published by the Swiss Federal Statistical Office (SFSO) and State Secretariat for Economic Affairs (SECO) in the summer of 2013 – the different (filtered) growth rates that can be used to proxy for the Swiss business cycle. Although the different measures of the growth rate cycle all look very similar, they differ in one aspect. The m-o-m growth rates have a lead over the q-o-q growth rates which in turn lead the y-o-y growth rates. We opt to take that monthly reference series that overall is quickest in signalling Swiss business cycle developments: the m-o-m growth rates.

3.4. The selection of variables

3.4.1. The pre-selection of the pool of potential variables

Based upon an internal request to all KOF business cycle experts to identify potentially relevant indicator series for the KOF Barometer re-launch, we have collected in total 476 time series that are expected to have a close relationship to the Swiss business cycle. Information about this pool of variables is presented in Table 1. It provides a short description of all variables used including the original sources.

[Insert "Table 1: Variables used in the selection process" about here]

The likelihood of spurious correlations is minimised on the basis of the best judgement by the experts that recommend a particular series to the pool of indicators for further consideration. As especially international data can be spuriously correlated with the Swiss business cycle, we decide to be restrictive regarding their inclusion. We opt to only include highly aggregated survey data for the five largest regions of the world and the eleven most important trading partners of Switzerland. Whereas, the first stem from the Ifo World Economic Survey, the latter are taken from business tendency and consumer surveys in these countries.

To further reduce the likelihood of spurious regressions, we beforehand determine the expected sign of the correlation between the respective variable and the reference series. Only correlations with the theoretically correct sign are taken into consideration in the selection procedure. Table 1 also contains information on this pre-set sign.

An information overlap could occur when the same results from the KOF survey are used at different NACE aggregation levels. We avoid such information overlap by beforehand determining the aggregation level at which variables are considered. As a closer look at Table 1 reveals, this is allowed to differ between sectors.

We distinguish between variables that are available at the monthly and at the quarterly frequencies.[15] The monthly variables are used as they are, whereas the quarterly variables are

filter in contrast to the simple 13 months moving average. So it was decided to use the easier and especially more transparent method.

[15] Indicators that are available at daily frequency, like interest rates and stock market indices, are aggregated to a monthly frequency by taking monthly averages.

converted to monthly frequency by assigning the value in a given quarter for all months in this quarter. [16]

For the qualitative KOF survey questions, we allow the plus, minus, equal and the balance (percentage plus less percentage minus) to potentially enter. Furthermore, depending upon its characteristics, a potential variable can be transformed using logs and/or differences. Since the transformations are differences or monotone,[17] we apply the same sign restrictions as for the original variables. In case the equal answers are used, there is no sign restriction imposed. Furthermore, whereas taking differences of survey variables that result from questions referring to changes over time can be questioned and therefore not allowed,[18] it does make perfect sense to do this for so-called assessment (i.e. level) questions. For those variables that are likely to contain a unit root, i.e. are I(1), we *only* allow changes (one-, three- and twelve-month differences for monthly variables and one- and four-quarter differences for quarterly variables) to be used in the selection procedure. Most variables can be assumed to be stationary, i.e. I(0). In those cases we also allow their levels to enter.[19]

As expected, some of the variables are affected by seasonality, and practically all series show evidence of noise. We do not try to increase the signal-to-noise ratio by sending the variables through low pass filters, as this is bound to lead to instability at the endpoints of these variables. However, in order to remove seasonality we do pass all variables and their transformations (except for the four-quarter and twelve-month differences for quarterly and monthly variables, respectively) through the X-12-ARIMA seasonal adjustment procedure developed by the U.S. Census Bureau.[20]

Regarding irregular movements in the variables, our method refers to a large number of variables, and assuming that noise is uncorrelated across these many variables, it should more or less cancel

[16] Because we do not want to mix information from other variables with those of a potential variable as that might artificially improve the leading characteristics of a potential variable, we cannot apply something like the Expectation Maximisation algorithm to estimate the missing monthly observations in the quarterly time series. We have nevertheless experimented with the Expectation Maximisation algorithm. The resulting first principal component showed more erratic behaviour than that based on simple assignment of observed quarterly values to all months in this quarter, i.e. we observed a substantial reduction in the signal to noise ratio due to application of this algorithm. We also opted not to use a univariate version of the Denton method for filling in the missing observations in the quarterly time series as its application would result in revisions of the imputed values and thereby of the KOF Barometer when new observations become available. This is in particular of importance when producing the KOF Barometer in real-time (see Section 3.6).

[17] In case we use the minus answers, the sign restriction is reversed, i.e. a positive sign restriction is changed into a negative one and vice versa.

[18] For instance, at the start of a cyclical upswing firms will increasingly answer that production has increased relative to the previous period. Consequently, the first difference of this change question will in this case have a lead. However, in case a new production plateau is reached, i.e. the peak is not followed by a cyclical downswing, the first difference will already signal a downswing that has not and – depending on the economic environment – might for the time-being not materialise. This potentially leads to overshooting in both directions and can be considered to be (potentially) spurious.

[19] The automated selection procedure described in the next subsection will make sure that at the end only at most one transformation of a variable will ultimately make it into the principle component analysis.

[20] Once estimated, the seasonal factors are kept constant in real-time until the next vintage of the KOF Barometer is created. In this way we avoid revisions within a vintage of the KOF Barometer brought about by the recursive application of the seasonal adjustment procedure.

out in the final principal component. In particular, if the selected variables are measured independently, a considerable part of the noise should be taken care of by the principal component extraction that identifies the common variance of the variables rather than the noise and idiosyncrasies that are particular to specific variables.

3.4.2. The automated selection procedure

With the release of the quarterly System of National Accounts (SNA) by SECO after the annual SNA has been published by the SFSO, we will once a year, normally in September, re-run our variable selection procedure. The aim of the automated selection procedure is to select variables that have both a substantial lead to and a high correlation with the reference series.[21] To achieve this, we in essence narrow the set of pre-selected variables down based on in sample cross correlations of the variables (using all eligible transformations as described in the previous Section 3.4.1) with the reference series, where the sign of the correlation has to match its pre-determined realisation (i.e. based on economic judgement) and no more than one transformation of a variable is allowed to enter. We identify the phase shift to the reference series that maximises the correlation in absolute terms. Subsequently, we are faced with a trade-off between the strength of the absolute correlation between a variable and the reference series and the lead of the former to the latter. For that we define a utility function and select the "best" transformation of any original series according to that. Finally, the variance of these variables is collapsed into a composite indicator as the first principal component (see Section 3.2).

Prior to initialising the variable selection procedure, variables for which the values are not yet released due to a publication lag are shifted forward to achieve a balanced panel at the end of the sample. In doing so, we exactly follow the "vertical realignment" procedure applied in Altissimo et al. (2007) for the same purpose. In comparison to other methods devised for dealing with this ragged-edge problem, like filling them with forecasts based on autoregressive models, the realignment method introduces no past revisions in our composite indicator – something that we want to avoid as far as possible. This information on the publication lag is imposed until the selection procedure is re-run and the next vintage of the KOF Barometer is produced.[22]

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[21] Following the seminal contributions of Stock and Watson (2002a, 2002b), most forecasters resorting to principal component or factor analysis in order to construct composite indicators tend to include as many variables as possible, provided they appear intuitively plausible. More recently, however, it is argued that one should be selective in the choice of variables from which one or more common factors or principal components are to be extracted; see e.g. Boivin and Ng (2006) and Bai and Ng (2008). If data are too noisy, i.e. they contain variation that have little, if any, resemblance to variation in the reference time series, one is better off by throwing these noisy variables away rather than keeping them in. As discussed in Boivin and Ng (2006) such situation may arise when a factor that is dominant in a small data set becomes a dominated factor in a (much) larger data set. Bai and Ng (2008) test various variable selection procedures based on hard- and soft-thresholding and report improvement in out-of-sample forecast accuracy of factor models based on pre-selected (targeted) variables compared with factor models based on all available data. Jacobs et al. (2011) suggests an information measure based on Kullback-Leibler criterion for variable selection into factor models rather than relying on external regressions as in Bai and Ng (2008).

[22] In case the publication of some indicators is delayed, interrupted or abolished before the selection procedure is re-run, the resulting missing values are imputed using the Expectation-Maximisation algorithm of Stock and Watson (2002b) using in-sample information from the rest of the variables in the panel. In case the publication lag is shortened, then in order to avoid backward revision of the KOF Barometer the publication lag determined in September for the current vintage is kept the same.

As noted above, the selection procedure is based on estimated sample cross-correlations between a candidate variable and the reference time series. The sample size for computing cross-correlations is set to a 10-year sliding window. This is introduced to reduce the dependence on distant past observations and allows for a (relatively) timely update of the pool of leading variables. A variable is selected into the pool of leading variables if the following criteria are met:

- A variable has valid observations throughout the defined observation window used in the cross-correlation analysis.

- The sign of the cross-correlation complies with the exogenously imposed sign restrictions. This implies that we use one-tailed test for those variables for which these sign restrictions are explicitly specified and two-sided test for those variables without sign restrictions.

- The cross-correlations between a variable and the reference time series are computed using a symmetric lag/lead window of 7 months in either direction. Only those variables are retained, for which the maximum (absolute) cross-correlation is found at the lead range specified between zero and six months.

- The computed cross-correlation surpasses a defined threshold. For that, we use the following result stating that sample cross-correlations at lag *h* between two independent stationary time series has the asymptotically normal (*AN*) distribution

(8) $$\hat{r}_{yx}(h) \sim AN\left(0, T^{-1}\left[1 + 2\sum_{j=1}^{\infty} r_y(j) r_x(j)\right]\right)$$

  where $r_y(j)$ and $r_x(j)$ are the respective autocorrelations at lag *j*, and *T* denotes the sample size, see Brockwell and Davies (1987, p. 400). The use of variable-specific autocorrelations implies that the variance of the asymptotic distribution and the derived relevant threshold values under the null hypothesis of independence are also specific for each variable. A maximum order of autocorrelation function used in Equation (8) is selected using the $l_4 = int[4(T/100)^{(1/4)}]$ criterion as described in Schwert (1989, p. 151). In order to ensure that the finite-sample estimate of the variance in Equation (8) is positive, we use the Bartlett kernel as in Newey and West (1987). We use the usual *z*-test statistic in the form of the ratio of observed maximum cross-correlation and its standard deviation as shown in Equation (8). Since under the null hypothesis of independence the distribution of the *z*-test statistic is approximated by the standard normal distribution we use critical values from the standard normal distribution. A 5% significance level is applied.

- Cross-correlations are computed for combinations of different transformations ((log) level and (log) changes) and different presentations (e.g. for surveys we consider net balances, share of equal answers, as well as shares of positive and share of negative answers) of the same variable. However, we allow only for one transformation to enter the pool of leading variables. Since various forms differ in magnitude of computed maximum absolute cross-correlations and the recorded leads, we use the following utility function to select the transformation of the indicator: $U = \left|\hat{r}_{yx}^{\max}\right| (lead + 1)^p$ with *lead* taking values between zero and six. The exponent parameter *p* is set to 0.5, allowing for a decreasing marginal utility of higher leads. This utility function is needed to address the trade-off between the size of the

cross-correlation and its lead. It is typical that larger cross-correlations occur at smaller leads, implying that in order to benefit from the leading properties of individual variables one has to sacrifice some transformations that have higher cross-correlations at shorter leads. That transformation of a variable with the highest value of the utility function *U* is selected into the pool of leading variables.[23]

We extract the first principal component from the pool of transformations of those variables that meet the above selection criteria. Within the 10-year selection window, the extracted first principal component has by construction a mean of zero and a standard deviation equal to the squared root of the largest eigenvalue of the correlation matrix. We subsequently standardise the first principal component to have a standard deviation of one. The final KOF Barometer is constructed by multiplying this standardised version by 10 and adding 100. As a result the KOF Barometer fluctuates around the mark 100, which denotes its average value for the 10-year in-sample window. Values above 100 indicate that the underlying growth rate cycle is in a phase above its long-run average, and values below 100 indicate the opposite.

3.5. Yearly updates in September

As noted above, in the construction of the new KOF Barometer, we first produce a reference series. This is based on seasonally adjusted quarterly (real) GDP as released by SECO after the first release of the annual System of National Accounts (SNA) by the SFSO.

Each year in summer the SFSO publishes a new vintage of the Swiss annual SNA. Based upon that, the SECO revises the quarterly SNA. These are typically published in September. As these releases often imply substantial revisions in past data, this is for us a natural moment to update our reference series and re-run the automated process to select the variables that go into the KOF Barometer. As a consequence, every year – after the release of the quarterly SNA by SECO based on the annual SNA by the SFSO – a new vintage of the KOF Barometer will be released.[24]

There are three reasons why each new annual vintage of the KOF Barometer can lead to revisions in past values. First, the 10-year information window that we use is shifted by one year. Hence, one year of new information will be added and the oldest year will be removed. Changed economic relationships will thereby be reflected. Second, new variables might have become available and some might no longer be published. This might lead to changes in the set of variables entering the selection procedure. Third, existing GDP data might be revised, also potentially causing relationships to change.[25] For all three reasons the set of selected variables underlying the KOF Barometer might change each September.

[23] We apply the utility function to those transformations of a variable for which the cross-correlation with the reference time series satisfies the restrictions on sign, significance and lead.

[24] The reference series underlying the variable selection and the scaling of the 2006 version of the KOF Barometer ends in 2003. It was published in autumn 2004 and corresponds to the first GDP release by the Swiss Federal Statistical Office for 2003. Once the underlying indicators were hand-selected, neither extensions nor revisions of the reference series and the variables selected were implemented.

[25] Note that any data revisions in the variables underlying the KOF Barometer will instantaneously result in revisions of the KOF Barometer. Experience tells that these revisions in the kind of (survey) data we use for the KOF Barometer are in general very minor.

3.6. Construction after the end of the reference period

Above we have described the construction of the KOF Barometer covering the 10-year reference period. For the current vintage, constructed in September 2013, this implies that the data reflects the sample from January 2003 until December 2012. In this section we describe how values for the KOF Barometer outside of the reference period are created. For the current vintage that implies values for the period January 2013 until the next quarterly GDP release by SECO after the SFSO has released a new annual GDP figure. This normally takes place in September, at which time a new vintage of the KOF Barometer will be constructed.

The out-of-sample period conceptually consists of the two parts. The first part corresponds to the period for which variable values are available until August 2013. The second sample extends until (normally) August 2014 requiring recursive computation of the KOF Barometer in real time. Hence, the conceptual difference between the two parts is merely that whereas the observations for September 2013 until August 2014 are based upon information that has just been released that month, the initial eight observations are using data that is older and might in the meantime have been revised. One way of putting this, is that whereas the first eight observations are produced in pseudo real time, the subsequent twelve are constructed in real time.

Independent of this, the construction of the KOF Barometer outside of the reference period is straightforward and follows the following five steps:

- Except for year-over-year differences, the seasonal factors determined by the X12-ARIMA seasonal adjustment procedure are subtracted from all variables and its transformations. As mentioned in Section 3.4.1, these seasonal factors are kept constant until the next annual vintage of the KOF Barometer is constructed.
- We standardise the variables entering the KOF Barometer using their means and standard deviations estimated for the 10-year reference window.
- The first principal component is constructed by multiplying standardised variables with the values of the loading coefficients derived for the reference period.
- We scale the constructed first principal component by the value of the standard deviation of the first principal component computed using the reference window.
- We construct the KOF Barometer values by multiplying the standardised principal component by 10 and adding 100.

Hence, we only use parameter values derived from the principal components analysis (and the seasonally adjustment procedure) as applied to the reference period when aggregating the new values of the underlying variables to obtain values of the KOF Barometer in (quasi-) real time. This five-step procedure thereby ensures that, in the absence of data revisions in the underlying variables, there will be no revisions in the KOF Barometer either.

3.7. Construction before the start of reference period

Using a 10-year window in the variable selection procedure naturally implies that the computed barometer correspondingly starts at the beginning of the 10-year window. To allow researchers to use longer time series, we extrapolate a vintage of the KOF Barometer backwards in time. This

computation is complicated by the fact that the number of variables that are available decreases as one moves further in the past. Figure 3 illustrates the problem. It shows the number of variables that are available for computation of the KOF Barometer for each month from 1991 onwards.[26] Most of the variables that were selected into the pool of leading indicators as of September 2013 start in 1999 or 2000. Hence, when computing the KOF Barometer backwards we have to realise that the number of underlying variables reduces substantially.

[Insert "Figure 3: Extrapolating the KOF Economic Barometer backwards" about here]

The presence of missing observations in data panel spanning the period from January 1991 until March 2001, a so-called "ragged-edge" problem, makes it impossible to apply the standard principal components analysis for extraction of common factors, as it is carried out for the 10-year reference period. In order to circumvent this problem of missing observations we employ the procedure suggested in Stock and Watson (2002b). They show how the Expectation-Maximisation (EM) algorithm together with the principal components analysis can be used to estimate common factors in the presence of such data irregularities as missing observations.

Let a Tx1 variable X_i be a variable with missing observations. Collect the valid observations of the variable X_i into a T^Ox1 vector X_i^O. Let A_i be a T^OxT selection matrix that maps the variable X_i with some missing observations to the vector with observed values X_i^O:

(9) $X_i^O = A_i X_i$.

The matrix A_i needs to be a matrix of a full row rank and its typical elements are appropriately placed zeroes and ones. In case a variable X_i has no missing observations, i.e. $X_i^O = X_i$, the A_i matrix is an identity matrix.

The EM algorithm consists of the following steps. First, the missing observations are substituted with the random draws from the standard normal distribution. As a result we can apply the principal components analysis using this balanced dataset and obtain initial estimates of both factors $\hat{F}_t^{(0)}$ and loading coefficients $\hat{\Lambda}^{(0)}$. Next, in the E-step of the EM algorithm we compute the updated values of the variables with missing observations $X_i^{(j)}$ using the following formula:

(10) $$\hat{X}_i^{(j)} = \hat{F}^{(j-1)}\hat{\Lambda}_i^{(j-1)} + A_i'(A_i'A_i)^{-1}(\mathrm{X}_i^O - A_i\hat{F}^{(j-1)}\hat{\Lambda}_i^{(j-1)}),$$

where $\hat{F}^{(j-1)}$ is a Txk^* matrix of common factors and $\hat{\Lambda}_i^{(j-1)}$ is a k^*x1 vector of loading coefficients from the previous iteration, with k^* indicating the number of common factors extracted from the data set. This formula is applied to each variable X_i with missing observations. The updated vectors at iteration j are collected into the balanced dataset $\hat{X}^{(j)}$. The principal components analysis (the M-step) is applied to $\hat{X}^{(j)}$ obtaining new estimates of $\hat{F}_t^{(j)}$ and $\hat{\Lambda}^{(j)}$. These estimates are further used in the E-step in order to obtain the next dataset $\hat{X}^{(j+1)}$, which can be used in order to get

[26] January 1991 as earliest data point is chosen to match the starting date of the KOF Barometer Version 2006.

updated estimates of $\hat{F}_t^{(j+1)}$ and $\hat{\Lambda}^{(j+1)}$. The iterations between the E- and M-steps are carried out until some pre-specified convergence criterion is met.

In practice, in order to use the same values of the loading coefficients for backward calculation of the KOF Barometer as used in the 10-year window of the variable selection procedure, we keep these loading coefficients fixed when applying the EM algorithm. The resulting 2013-vintage of the KOF Barometer is displayed – together with its reference series – in Figure 3.

4. Comparing the new KOF Economic Barometer with other major composite leading indicators in the world

The KOF Barometer is certainly not the only leading indicator in the world. In that sense, it might be worthwhile to shortly compare our set-up with those of prominent leading indicators produced by other institutes.

The composite leading indicators of both the OECD and The Conference Board first of all differ regarding the underlying business cycle concept. The OECD indicator focuses on growth cycles. To measure this cycle, de-trended GDP is used.[27] The trend is removed by applying the Hodrick-Prescott filter (Hodrick and Prescott, 1997). On the other hand, The Conference Board indicators target economic expansion and contraction. In this sense, the indicators try to signal the classical business cycle, which looks at fluctuations in the level of economic activity.

Furthermore, both are based on comparatively small sets of variables. These variables are "hand-selected".[28] The OECD composite leading indicator for Switzerland currently consists of six variables. Three of them stem from the KOF business tendency surveys (assessment of stock of finished goods in manufacturing, tendency of order inflow in manufacturing, and production tendency in manufacturing), one is taken from the SECO consumer survey (expected economic situation) and the other two are the UBS 100 share price index and silver prices. The leading indicator of The Conference Board for the United States and the euro area consists of respectively ten and seven variables which were selected after an intense selection process.[29]

This parsimony is not a flaw in general. However, it implies that economic experts continuously monitor the suitability of each variable. If problems are identified, variables have to be replaced with others. The previous KOF Barometers were based on a similar philosophy as the above mentioned indicators. Given the importance of the KOF Barometer and the institutional surrounding in Switzerland, the new KOF Barometer tries to reduce the impact of economic experts. The composition of the KOF Barometer and its construction is intended to be very transparent and non-subjective in nature. For that we allow a much larger number of variables and have formulated and apply strict rules for the selection of these variables.

[27] Since 2012 the OECD uses monthly de-trended GDP as reference series. Before; the de-trended index of industrial production was used (see Fulop and Gyomai, 2012).

[28] See OECD (2012) and The Conference Board (2001, p. 13-15) for descriptions of the respective selection processes.

[29] See: http://www.conference-board.org.

At the other end of the spectrum of composite indicators are those that even use more variables to form the composite indicator than the new KOF Barometer. An example is the first generation of Eurocoin, an indicator published by the Centre for Economic Policy Research (CEPR) and the Banca d'Italia.[30] The original version of Eurocoin is a cyclical indicator for euro area economy and includes almost 1000 variables.[31]

The second generation Eurocoin the so-called NEW Eurocoin was introduced in 2007. In this version the authors are more restrictive regarding variables entering the indicator. They selected 145 variables according to three main criteria: (i) a sufficient time series span (at least starting in 1987), (ii) a high correlation and leading property with respect to GDP growth, and (iii) released in a timely manner by statistical agencies.[32] The database they use is organised into homogeneous blocks, i.e. industrial production indexes (41 series), prices (24), monetary aggregates (8), interest rates (11), financial variables (6), demand indicators (14), surveys (25), trade variables (9) and labour market series (7). Similar to the new KOF Barometer, the Eurocoin uses the underlying month-over-month growth rate cycle as reference and focus on measuring changes at the business cycle frequency. Therefore, the philosophy of the new KOF Barometer is closer to that of Eurocoin as to the above mentioned indicators of the OECD and The Conference Board.

5. Characteristics of the KOF Economic Barometer in (pseudo-) real time

5.1. Producing different 'older' vintages

Applying the in Section 3 described procedure using the reference series as available in September 2013 results in the 2013-vintage of the KOF Barometer. Both are shown in Figure 4. As explained, the years 2003 until 2012 are used in the variable selection phase. The last few columns of Table 1 report which variables and transformations have been selected.

[Insert "Figure 4: The 2013-vintage of the KOF Economic Barometer together with its reference series" about here]

The values for the KOF Barometer from January 2013 onwards are out-of-sample values. To assess the out-of-sample performance of the KOF Barometer we need a substantial number of observations and we therefore create 'older' vintages of the 2014 version of the KOF Barometer. This will also – in Section 5 – allow us to analyse the robustness of both the selection and the construction procedure over time.

In a first step, we need to create reference series as they would have been applicable in previous years, i.e. we use real-time vintages of previous GDP series. Ideally, also the databases of variables that go into the selection procedure would have to be reconstructed as to represent the actual information available in previous years. For technical reasons this is hardly feasible. Since most of our variables result from surveys and therefore undergo relatively minor revisions – if at all – this problem is substantially alleviated in practice. Hence, regarding the database of potential variables, we rely on what is often labelled a pseudo real-time setup. As our current framework relies on a

[30] See: http://eurocoin.cepr.org

[31] See Altissimo et al. (2001).

[32] See Altissimo et al. (2007).

substantial number of variables to enter the final principal component analysis stage and this number substantially reduces when going back in time (see Figure 3), we opt to construct our first pseudo real-time vintage in September 2006. The corresponding sample used in the cross-correlation analysis is April 2001 until December 2005 for that "first" vintage. The subsequent vintages of the KOF Barometer use an expanding window in the cross-correlation analysis until the underlying sample reaches 10 years. This is achieved in September 2012, when the sample used in cross-correlation analysis is January 2002 until December 2011. In September 2013, the corresponding 10-year window spans the period January 2003 until December 2012.

[Insert "Figure 5: Different vintages of the monthly reference series used in the correlation analyses" about here]

As mentioned in Section 3.5, due to revisions in real GDP, the changing sample period and the pre-selection of variables that go into our selection procedure, both the reference series and the KOF Barometer undergo revisions. The real-time vintages of the reference time series are displayed in Figure 5 and the eight pseudo-real time vintages of the KOF Barometer each calculated using the real-time information set available in September of the respective vintage year are shown in Figure 6.

[Insert "Figure 6: Different vintages of the KOF Economic Barometer" about here]

Table 2 summarises the results of the cross-correlation analyses of the corresponding vintages of the KOF Barometer with the respective vintages of the reference time series. Each cross-correlation analysis was done using the information available in September of the respective years. The table reports the number of selected variables in each vintage of the KOF Barometer, the maximum cross-correlation between the KOF Barometer and the reference time series and the corresponding lead of the cross-correlation function maximum. The final two columns report the contemporaneous cross correlation and the cross correlation when using a lead of six months. The KOF Barometer mostly has had an estimated one-month lead with respect to the reference time series for all vintages except for the vintages of 2008 and 2009. In those cases, the estimated lead was two and zero months, respectively. The corresponding value of the maximal cross-correlation is very high ranging from 0.81 to 0.92, depending on the vintage.

[Insert "Table 2: In-sample correlation analyses across different vintages" about here]

An in-sample measure to assess the quality of an economic indicator is the Months-for-Cyclical-Dominance (MCD) measure. MCD requires estimates of the irregular and the trend-cycle component of a time series. See Abberger and Nierhaus (2009) for a discussion of its concept. MCD is defined as the shortest span of months for which the ratio of the absolute percentage changes of the irregular to the absolute percentage changes of the trend-cycle component is less than unity. Thus MCD provides a guide for interpreting short-term fluctuations of a time series. The smaller the MCD the stronger is the signal in the indicator. As shown in the last column of Table 2, the MCD measure for the 2012- and 2013-vintages of the KOF Barometer equal 1. Hence, according to this measure the KOF Barometer is a reliable indicator with strong signals.[33]

[33] Older vintages have larger MCD values. We believe that this is due to the somewhat shorter in-sample period used in the variable selection procedure.

5.2. An out-of-sample comparison with the reference series

The results so far are purely based on an in-sample analysis and need to be supplemented by an analysis of the out-of-sample performance of the different vintages. As shown in Figure 7, for each vintage (except presently for the 2013-one) we have 20 out-of-sample observations, each constructed as described in Section 3.6. Eight of these are produced in September and reflect the first eight months of the respective year. The remaining 12 are the monthly observations as produced until the next vintage is constructed. These out-of-sample values are now used to analyse the out-of-sample performance of the new KOF Barometer and compare it with that of the 1998 and 2006 versions of the KOF Barometer.

[Insert "Figure 7: Out-of-sample values of KOF Economic Barometer vintages" about here]

To assess the out-of-sample fit of the three versions of the KOF Barometer we need an appropriate reference series. Although all refer to the growth rate cycle as business their cycle concept, the 2014 version uses a smoothed month-on-month growth rate as reference series, while the 1998 and 2006 versions aimed at the year-on-year growth rate. To give all of them a fair chance, we opt to use both reference series as benchmark and analyse leads of up to 6 months of these KOF Barometers.

Since the KOF Barometer and the reference time series are measured on different scales, it is necessary – for the sake of comparison – to unify these scales. As by construction the vintages of the 2014 version of the KOF Barometer are scaled to a mean of 100 and a standard deviation of 10 within each reference window, the corresponding vintages of both the 1998 and 2006 versions of the KOF Barometer as well as the two reference time series were transformed in such a way that they also have the same mean and standard deviation during the same time span as the 2014 version of the KOF Barometer.

Observe that over the period for which out-of-sample values of the Barometer are compared with the reference time series, different vintages of the reference time series are available. For example, the comparison of 20 out-of-sample observations of the 2006 Vintage of the KOF Barometer Version 2014, covering the period January 2006 until August 2007, is done in the following way: The first 12 monthly observations are compared with the appropriately scaled vintage of the reference time series, based on the smoothed m-o-m growth rate, that is computed in September 2007. This vintage of the reference time series correspondingly ends in December 2006. The next 8 observations (January 2007 until August 2007) are compared with the vintage of the reference time series computed in September 2008. The following 20 out-of-sample observations of the 2007 Vintage of the KOF Barometer Version 2014 are compared in the same manner with values of the vintages of the reference time series computed in September of the years 2007 and 2008, etc. The same time frames are used when comparing appropriately scaled earlier versions of the KOF Barometer with both reference time series. Given data availability the overall sample for out-of-sample comparison is January 2006 until December 2012, which consists of 7 partially overlapping subsamples, each corresponding to the yearly vintages of the KOF Barometer Version 2014.[34] The

[34] There are no corresponding observations of the reference time series based on the m-o-m smoothed growth rate for the 2013 Vintage of the KOF Barometer Version 2014, as the vintage of the reference time series produced in September 2013 ends in December 2012.

first 6 sub-samples have a length of 20 months and the last one, corresponding to the 2012 vintage of the KOF Barometer, contains 12 months, i.e. January 2012 until December 2012.[35]

The benchmark against which the out-of-sample fit of competing indicator models is compared is a no-change forecast fixed at the value of 100. The distance between out-of-sample values of the KOF Barometer and a reference time series was measured in terms of the Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE). The difference between these two measures is that the former more heavily penalises larger deviations than the latter.

The results of comparing out-of-sample values of the KOF Barometer (2014, 2006 and 1998 versions) with both specifications of the reference time series are presented in Table 3.[36] In the first row of both the upper and lower part of that table the values of RMSE and MAE corresponding to the benchmark forecast are presented. The out-of-sample fit for the indicator models is presented as a ratio of the indicator-specific RMSE or MAE values to those of the benchmark model. Correspondingly, values of these ratios below one indicate that an indicator model is characterised by a better out-of-sample fit than the benchmark model and values above one indicate the opposite. In order to assess statistical significance of differences in measures of fit we report *p*-values of the Diebold-Mariano test statistic.[37]

[Insert "Table 3: Out-of-sample forecast accuracy of the KOF Economic Barometer" about here]

For the month-over-month real GDP growth, the KOF Barometer Version 2014 displays for all leads a closer out-of-sample fit than the Versions 1998 and 2006. For the Version 2014, the largest relative improvement of slightly less than 40% (either in terms of RMSE or MAE) over the benchmark model is observed at a lead of zero. Whereas this improvement is significant at a 5% level, this is not the case for the corresponding (albeit much smaller) improvements observed when using Versions 1998 or 2006. In terms of RMSE both Versions 1998 and 2006 display a relative improvement of about 4%

[35] This information on the timing of the out-of-sample comparison corresponds to the analysis of contemporaneous values of the KOF Barometer and the reference time series. Exploring leading properties of the KOF Barometer by comparing its lagged values with those of the reference time series correspondingly shortens the period used in this out-of-sample comparison.

[36] Observe that for each window of 20 out-of-sample observations, which are used to compare the fit of the three versions of the KOF Barometer, for the Version 2014 of the KOF Barometer the first eight months of the year are calculated in September of that year. This gives an informational advantage for the Version 2014 over the Versions 1998 and 2006, if one uses real-time values for comparison. Since the stable end-of-sample filter is used to construct the Version 2006 of the KOF Barometer this informational advantage is of a minor, if any, importance. However, this is not the case for the Version 1998 of the KOF Barometer that undergoes sometimes non-negligible revisions from month to month. Hence, in order to rule out this informational advantage of the new version of the KOF Barometer over the older versions in this out-of-sample comparison, we opted for a conservative approach. Namely, we evaluated the out-of-sample fit of the Versions 1998 and 2006 by using observations from the corresponding vintages of these two older versions computed in the last month of each of 20-observation windows. For example, for comparison of the out-of-sample fit for the first 20 observation window (January 2006 – August 2007), we use the vintages of the Versions 1998 and 2006 computed in August 2007. This actually creates an informational advantage for the two older versions of the KOF Barometer.

[37] Note that we use the $l_4 = int[4(T/100)^{(1/4)}]$ criterion as described in Schwert (1989, p. 151) in order to truncate the autocovariance function when computing the estimate of the standard deviation of the mean loss differential used in the Diebold-Mariano test statistic.

and 14% at the zero lead, whereas in terms of MAE the Version 1996 posts a relative worsening of fit of about 7% and the Version 2006 achieves a relative improvement of about 10%.

The results of the out-of-sample comparison when using year-on-year growth rates as reference series are summarized in the bottom part of Table 3. For all three versions of the KOF Barometer the reported ratios are below one for all leads. This indicates a superior out-of-sample fit of all versions with respect to the benchmark model. However, the relative performance between the versions themselves differs at different leads. Whereas the 1998 and 2006 versions perform relatively better at the shorter leads, for longer leads the 2014 version outperforms.

The observed reduction in RMSE or MAE is about 60% at the zero lead for the 1998 and 2006 Versions against the corresponding reduction of only about 35-40% for the 2014 version. This can be explained by the fact in the previous version of the KOF Barometer the variables were selected while using year-on-year growth rates as reference time series.

At longer leads the situation reverses, with the 2014 version outperforming the older versions. For example, at a lead of six the reduction in the accuracy measures is about 35% for Version 2014 against a corresponding reduction of only up to 20% for the two earlier versions. According to the Diebold-Mariano test this improvement in forecast accuracy is statistically significant at the 5% level for Version 2014, whereas for Versions 1998 and 2006 it is not. As illustrated in Figure 2, month-over-month growth rates usually clearly lead year-on-year growth rates by several months. In that sense, it is no surprise that the 2014 version has more pronounced leading properties than the previous versions.

These results all point to the improved leading properties of the 2014 version of the KOF Barometer relative to its previous versions. When using the m-o-m reference series, the new version always outperform the older versions in our out-of-sample exercise. When using the y-o-y reference series, this is the case for leads of 4 or more months.

5.3. Performance in forecasting GDP

In this section we investigate how well the new KOF Barometer fares in out-of-sample forecasting of actual quarterly real GDP growth (instead of our synthetic monthly reference series). As official GDP data is published at a quarterly frequency, we aggregate our KOF Barometer by taking the average of its monthly values, following the classical "bridge-equation" approach. Consequently, in the forecasting exercise we assume that the forecast is produced at the end of each quarter (*t*), when monthly values of the KOF Barometer are available for each month in that quarter, but no GDP statistics for that quarter have been published yet.

We conduct the forecasting exercise by closely simulating information flows in real time. That is at every forecast origin we only use information available to the forecaster at that moment time, i.e. we use real-time GDP vintages and pseudo-real time vintages of the KOF Barometer Version 2014 and historical vintages of the KOF Barometer Version 2006 and Version 1998.

The out-of-sample forecasting performance of the KOF Barometer is investigated by means of the ARDL model allowing for a two-quarter lag of the dependent variable and the KOF Barometer. The final model used for generating forecasts is selected using Autometrics – the automated model selection procedure described in Doornik (2009). We assess the now- and forecasting accuracy of

the models containing the KOF Barometer up to a horizon of two quarters. As each forecast is simulated to take place at the end of a quarter for which no official GDP data has been released, our first forecast concerns quarter *t* and is often labelled as nowcast. Subsequently, forecasts for *t*+1 and *t*+2 are produced. Denoting forecast horizon as *h*, for nowcasts we have *h = 0*, whereas for one- and two-quarter ahead forecasts *h = 1* and *h = 2*, respectively.

Hence, our ARDL model used for nowcasts is:

(11) $y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \varepsilon_t,$

where the lag structure corresponds to the availability of both GDP data and the KOF Barometer in real time. As mentioned above, whereas observations for the KOF Barometer are available at the end of the quarter, this is not the case for GDP; only observations until the previous quarter are available for GDP.

The corresponding ARDL model used for generating a next-quarter forecast is:

(12) $y_{t+1} = \delta_0 + \delta_1 y_{t-1} + \delta_2 y_{t-2} + \lambda_0 x_t + \lambda_1 x_{t-1} + \lambda_2 x_{t-2} + \mu_t,$

and that a *two-quarter ahead forecast* is:

(13) $y_{t+2} = \eta_0 + \eta_1 y_{t-1} + \eta_2 y_{t-2} + \theta_0 x_t + \theta_1 x_{t-1} + \theta_2 x_{t-2} + \nu_t,$

In each case, the benchmark model is a second-order univariate autoregressive model, i.e. the same model without the inclusion of the KOF Barometer. Observe that these specifications correspond to the direct forecasting approach, allowing for different forecasting models at each forecasting horizon (Marcellino, Stock, and Watson, 2006).

Forecast samples are 2006Q3-2013Q3, 2006Q4-2013Q3, and 2007Q1-2013Q3 for nowcasts, one- and two-quarter ahead forecasts, respectively, resulting in 29, 28, and 27 out-of-sample evaluation of forecast accuracy for *h = 0, 1, 2*, respectively. Model parameters are estimated using a rolling window starting in the first quarter of 1991. Taking into account observations lost by taking lags of the indicator, the size of the rolling window is 58 observations and kept fixed for each forecasting origin. The forecast accuracy is assessed by comparing first-available SECO estimates of the GDP growth in the respective quarter. These first official estimates are available after two, five, and eight months after the respective now- and forecasts.

[Insert "Table 4: Out-of-sample forecast accuracy of the quarterly real GDP growth rates" about here]

The summary of out-of-sample forecast accuracy of the competing (AR vs ARDL) models is presented in Table 4. The reduction in terms of RMSE brought about by the ARDL model with the KOF Barometer Version 2014 is about 14%, 5%, and 6% for forecast horizons *h = 0, 1* and *2*, respectively. The corresponding reduction in terms of MAE is about 10%, 3%, and 11%. We assess statistical significance of differences in out-of-sample forecast accuracy by using the test suggested in Clark and West (2007) specifically designed for comparing forecast accuracy when using nested models. According to the Clark and West test the null hypothesis of equal forecast accuracy between the univariate AR and ARDL models can be rejected at the 1% significance level for nowcasts and two-quarter ahead forecasts and at the 10% significance level for the next-quarter forecasts.

In comparison with the two older versions of the KOF Barometer, the gains in forecast accuracy of the Version 2014 are most pronounced for the two-quarter ahead forecasts, i.e. *h=2*. At this forecast horizon, the Version 2014 is the only one that reports ratios of RMSE and MAE to those of the benchmark autoregressive model that are below one. As the forecast horizon shortens, the relative gains in forecast accuracy of the Version 2014 over its older versions diminish. For *h=1*, the Version 2014 is only marginally better irrespective of which measure is used (RMSE or MAE). For *h=0* it is slightly better than Version 1998 and slightly worse than Version 2006 when using RMSE for comparison. In terms of MAE, both the 1998 and 2006 versions display a slightly better forecast accuracy than Version 2014 for *h = 0*.

The fact that Version 2014 displays the largest gains in forecast accuracy for the forecast horizon of two quarters both with respect to the univariate benchmark model as well as the Versions 1998 and 2006, which noteworthy fare worse than the benchmark model for *h=2*, serves as a further evidence that the new version of the KOF Barometer does have substantially improved leading properties relative to its older versions. This is fully consistent with the results reported in Section 4.2 where the out-of-sample fit of the three versions of the KOF Barometer regarding different reference series is discussed.

6. Robustness checks

To assess the robustness of our procedure and to analyse the consequences of some of the crucial specifications of the selection algorithm and the aggregation procedure, we now produce some a priori plausible alternative specifications. These alternatives are compared to the actual 2014 version of the KOF Barometer using the same the pseudo real-time out-of-sample set up as introduced in the preceding section.

6.1. The one-dimensional structure

The new KOF Barometer no longer uses modules (and measurement models). Extracting the first principal component of all variables selected amounts to assuming a one-dimensional structure of the relevant information in the indicator set. The KOF Barometer Version 2006 was constructed using the multi-modular structure described in Section 2.2, whereas Version 2014 is characterised by its mono-modular structure. An important advantage of not beforehand categorising the different variables into modules is that it allows flexibility regarding analysing the sources of changes in the KOF Barometer. We can look into the contribution of varying variable groups to suit the prevailing situation. For instance, when there is an exchange rate shock we are able to look at those variables that are closely related to the exchange rate, whereas when there is a monetary policy interest rate change we concentrate on variables closely linked to interest rates. These two groups of variables might in practise partly overlap in the uni-modular structure without causing interpretation problems. Furthermore, and as discussed in Section 2.2, the multi-modular structure did – with hindsight – not perform as well as expected.

Given the other changes in the 2014 version of the KOF Barometer, however, this time might be different. It is therefore of interest to investigate whether the elimination of the multi-modular structure actually is justified based upon the information we have. To this end, we construct a

version of the KOF Barometer with a multi-modular structure quite similar to the one in the 2006 version.

We proceed according to the following general steps. First, we decide upon the relevant modules. Second, we define groups of variables that are specifically related to each of these modules. Third, we construct the module-specific reference time series according to the definition of the growth rate cycle applied in creating the reference time series for the 2014 version. Third, we apply the selection procedure described in Section 3.4.2 to each of the modules. Fourth, we extract the first principal component from each of the selected pools of leading indicators and use an OLS regression in order scale these to match location and scale of the module-specific reference time series. Finally, this multi-modular version of the KOF Barometer is then created by aggregating the module-specific components according to their shares in annual real GDP in the previous year.

For reason of comparison, we would prefer to preserve exactly the same modular structure as in the 2006 version of the KOF Barometer. However, it turns out that none of the variables attached to the construction module matches the selection criteria in our sample. Therefore, we are forced to abandon the construction module and are left with the banking module (NOGA 65) and the core GDP module. As in the 2006 version, the latter is comprised of the three measurement models (exports, consumption and manufacturing).[38] In order to match the scale of the benchmark KOF Barometer, the bi-modular KOF Barometer is standardised to have a mean of 100 and standard deviation of 10 in the 10-year in-sample period.

Figure 8 shows the 2013 vintage of both the uni- and bi-modular versions of the KOF Barometer together with the relevant reference series. The correlation between the two versions of the KOF Barometer is with 0.96 high. In sample, the uni-modular version has (with a value of 0.722) a marginally higher correlation with the reference series than the bi-modular one (correlation: 0.721).

[Insert "Figure 8: Comparing the 2013-vintage to a version using a bi-modular structure" about here]

In a similar way as described in Section 4.1, we have "re-"constructed older vintages of this bi-modular version. This has revealed substantial vintage-to-vintage instability that is caused by aggregating several first principal components from modules and models. Any changes in the set of variables selected inside a module or model that only contains a relatively small number of variables will lead to sizeable revisions in its first principal component and subsequently in the overall KOF Barometer. After all, the weights of each module or model do not depend on the number of variables.

Summarising, there do not appear to be any practical advantages of using a multi-modular structure over the uni-modular one. Moreover, by abandoning the multi-modular design we avoid substantial revisions when moving from one vintage to the next.

[38] Whereas about the same number of variables are in total chosen, about 10 percent of these are assigned to the Banking module. Of the remaining 90 percent, more than three quarter contains of variables assigned to the industry measurement model.

6.2. The relevance of higher order principal components

The KOF Barometer is constructed using the first principal component. Our final indicator is constructed as such to be highly correlated with a lead to our reference series, which we consider to be a good measure of the Swiss business cycle. We need to assure ourselves that by disregarding any higher order factors that result out of the principal component analysis, we do not throw away further significant and reliable information regarding our reference series.

The eigenvalues for the data used in this paper are arranged in descending order and the three with the highest eigenvalues are shown in Table 5 for all pseudo-real time vintages of the KOF Barometer computed in September of each year.[39] The corresponding *Eigenvalue Ratio* (*ER*) function, as defined in Section 3.2, is displayed in the second part of that table. Using the formal selection criterion of Ahn and Horenstein (2013), we find that − as expected −the optimal number of factors, k_{ER}^{*} is equal to one for all the pseudo-real time data vintages of the KOF Barometer.

[Insert "Table 5: Comparing the first principle components with higher-order ones" about here]

Table 5 shows how each of these principal components fares in terms of magnitude and corresponding lead or lag regarding the maximum cross-correlation with the respective vintage of the reference time series. The first principal component consistently displays the by far largest maximal value of the cross-correlation function with the reference time series. In addition, its lead/lag relationship is stable across the different vintages. This does not hold for the higher-order principal components; there the lead/lag relationship with the reference series is highly unstable moving from -7 to +7 months across vintages. An inspection of the cross-correlations of the first three principal components reveals that only for the first principal component we find a stable positive relationship with the reference series. For the second principle component we find about as many negative correlation coefficients as positive ones. In case of the third principle component all coincident correlations are close to zero. The correlations increase in strength with leads and lags, but the lead-lag structure and the corresponding signs of the correlations do not show any regularity. Last but not least, despite close inspections of the factor loadings of the higher order principle components, we were not able to detect any meaningful pattern that allow an interpretation as latent variables related to the Swiss business cycle.

To summarise, close investigation of the higher order principal components confirms what we expected to result from the selection algorithm: Neither of them reveals a stable pattern, nor does the loading matrix suggest an interpretation of those factors other than noise and idiosyncratic properties of groups of indicator variables that bear no consistent relationship to the Swiss business cycle. Once the first principle component is taken into account, any partial correlation of higher order principal components with the reference series has thus to be regarded as spurious. Hence, the data confirm that the one-dimensional approach results in the most robust specification of the factor model.

6.3. The consequences of using a different reference series

The reference series used to select the leading variables is constructed in a simple, transparent, and therefore easily reproducible way. Nevertheless, it consists of three more or less independent steps:

[39] Table 5 only shows the results for the first three principal components. The following conclusions are confirmed and further strengthened when looking at higher order components.

the interpolation of quarterly GDP levels into monthly GDP levels, the calculation of m-o-m growth rates and applying a centred moving average (13 quarters with the first and last carrying half the weight of the others) filter to reduce the noise. Obviously different decisions regarding each of these steps could have been taken.

Another popular method of temporal disaggregation is based on the Kalman filter and smoother. This approach allows the interpolation and smoothing parts to be done in one step. A well-defined theoretical model is needed for this. To analyse the sensitivity of our choices, we employ as an alternative the Kalman filter and smoother suggested in Mariano and Murasawa (2003) to produce a smooth monthly reference series representing the Swiss business cycle.

Let us denote the observed quarter-on-quarter growth rate of real GDP as y_t. We treat this quarterly time series as a monthly variable which is only observed in the third month of each quarter. Its values for the first and second month of each quarter are treated as missing values. Let y_t^* denote the unobserved monthly growth rate of real GDP. Mariano and Murasawa (2003) suggest using the following approximate relationship between the observed and latent variables:

$$(14) \qquad y_t = \frac{1}{3}y_t^* + \frac{2}{3}y_{t-1}^* + y_{t-2}^* + \frac{2}{3}y_{t-3}^* + \frac{1}{3}y_{t-4}^*.$$

We also assume that the dynamics of monthly GDP growth rate is governed by two components:

$$(15) \qquad y_t^* = \beta f_t + u_t,$$

where f_t is a latent factor that follows a first-order autoregressive dynamics $f_t = \alpha f_{t-1} + v_t$, where $v_t \sim NID(0,\sigma_v^2)$ is an i.i.d. normal random variable, where the identifying restriction is $\sigma_v^2=1$.[40] The idiosyncratic component u_t is also assumed to follow a first-order autoregressive process $u_t = \phi u_{t-1} + \omega_t$ with $\omega_t \sim NID(0,\sigma_u^2)$. Inserting expression for y_t^* into the expression for y_t one obtains:

$$(16) \qquad y_t = \beta\left(\frac{1}{3}f_t + \frac{2}{3}f_{t-1} + f_{t-2} + \frac{2}{3}f_{t-3} + \frac{1}{3}f_{t-4}\right) + \left(\frac{1}{3}u_t + \frac{2}{3}u_{t-1} + u_{t-2} + \frac{2}{3}u_{t-3} + \frac{1}{3}u_{t-4}\right).$$

The models can be casted into a state-space form with the state vector:

$$(17) \qquad s_t = \left(f_t, f_{t-1}, f_{t-2}, f_{t-3}, f_{t-4}, u_t, u_{t-1}, u_{t-2}, u_{t-3}, u_{t-4}\right)'.$$

The parameter vector $\theta = (a, \beta, \phi, \sigma_u^2)$ can be estimating by maximising the likelihood function. The reference time series is obtained by successive application of the Kalman filter and smoother in order to recover the state vector. By using the estimates of the state vector s_t, in particular its first component f_t, and the estimate of β parameter, allows us to compute the monthly growth rates, $\hat{y}_t^* = \hat{\beta} f_t$. We annualise the estimated smoothed monthly growth rates by the following formula:

$$(18) \qquad \hat{y}_t^{*\,ann} = (\hat{y}_t^*/100+1)^{12} - 1)*100.$$

[40] For ease of presentation the constant term is omitted from the state-space form, meaning that the parameter estimation is done on demeaned data. Afterwards the data are re-scaled to have a non-zero mean.

The resulting reference time series is, together with the reference series as described in Section 3.3, shown in Figure 9. Both versions of the reference time series are produced using the information set available in September 2013. With a correlation coefficient of 0.976 both show very similar developments suggesting that for this vintage the subsequent selection procedure will mostly select the same variables as before and the resulting KOF Barometer will perform similarly.

[Insert "Figure 9: Reference series based upon a Kalman filter approach" about here]

Although both ways to produce a reference variable result in a very similar time series for the 2013-vintage, it is to be noted that for several earlier GDP vintages, we did encounter convergence properties of the non-linear numeric optimisation algorithm used in the Kalman filter approach. This is clear when looking at the different pseudo-real-time vintages of the Kalman filtered reference series as shown in Figure 10 that can be compared to those in Figure 5. This unstable performance implies that, compared to the simple and more robust approach described in Section 3.3, the Kalman filter approach would need a substantial amount of fine-tuning and therefore expert judgement in order to obtain sensible results.

Even when taking the obvious problem vintages out, the figure still highlights what we consider to be a more general problem when moving to the use of more sophisticated filter approaches: these alternatives tend to be quite sensitive to revisions and new information contained in GDP series released annually in September. Given convergence problems when constructing the earlier vintages of the reference time series, we abstain from any further analysis of this version of the KOF Barometer, especially its comparison with other versions for which the historical vintages are readily available.

[Insert "Figure 10: Different vintages of the Kalman filtered reference series" about here]

6.4. Dynamic factor analysis as alternative for the second stage

The common component in our panel of selected variables is extracted using static principal components analysis following the diffusion-index approach of Stock and Watson (2002b). It is instructive to compare a common factor from this kind of static principal components analysis with one extracted using a dynamic factor model. To this end, we employ a specification of the dynamic factor model suggested in Giannone et al. (2008). The approach of Giannone et al. (2008) is particularly useful for real-time forecasting using a large number of variables, when various blocks of data are released at different points in time and with different publication lags resulting in a so-called "ragged edge" problem.[41]

Giannone et al. (2008) suggest estimating the common factor using the following two-step procedure. In the first step a common factor is extracted from a balanced panel. Then the parameters of the corresponding state-space model of the dynamic factor model are estimated using this common factor. Once the parameters of the state-space model are determined, the Kalman filter is used in order to obtain an estimate of the common factor.

[Insert "Figure 11: Dynamic versus static factor analysis" about here]

[41] See Siliverstovs (2012) and Siliverstovs and Kholodilin (2012) for an application of the Giannone et al. (2008) dynamic factor model for nowcasting Swiss GDP growth.

Figure 11 displays the benchmark version of the KOF Barometer and the appropriately scaled common factor estimated by means of the dynamic factor model of Giannone et al. (2008). The parameters of the dynamic factor model are estimated using pseudo-real time vintage reflecting data availability in September 2013. The common factors extracted by means of the principal components analysis and the dynamic factor model display, with an in-sample correlation coefficient of 0.998, a very high degree of coherence. This allows us to conclude that nothing is gained from using a more sophisticated method of extracting common factors from the panel of leading indicators. The extraction method based on the static principal components is just as good as the dynamic factor model.

6.5. The influence of the Great Recession

In this section we investigate the influence of the Great Recession on the performance of the KOF Barometer. This event can be considered extreme and as such might have a substantial influence on all vintages that include this period. In order to check for the sensitivity of the KOF Barometer, we try to cut off the Great Recession period from the reference series before carrying out the cross-correlation analysis. As it is not obvious what period is to be declared as crisis period, we experiment with several. As the underlying GDP data is originally quarterly, we take three-month steps that always include the fourth quarter of 2008 and the first quarter of 2009. This results in the following (monthly) potential crisis periods: 2008M4-2009M3, 2008M4-2009M6, 2008M7-2009M3, 2008M7-2009M6, 2008M10-2009M3 and 2008M10-2009M6. For each crisis period we construct the corresponding version of the KOF Barometer, by appropriately truncating observations in the 10-year sample windows used in the variable selection procedure.

The evaluation of different versions of the KOF Barometer is, as done in Sections 5.1 and 5.2, carried out by using out-of-sample information and evaluating how close these observations are to the corresponding vintage of our month-over-month reference time series.

The comparison is done for the vintages of the KOF Barometer constructed after the crisis period: September 2009, September 2010, September 2011 and September 2012. All except the last vintage contain 20 out-of-sample observations. Given that the 2013-vintage of the reference time series ends in 2012, we can use only the first 12 out-of-sample observations from the September 2012 vintage of the KOF Barometer. Using these 72 out-of-sample observations, corresponding to the sample January 2009 until December 2012, we compute performance statistics for contemporaneous values of the KOF Barometer and those leading the reference time series by up to six months. The number of observations differs with the lead, such that for the lead of six months we only have 64 observations left.

[Insert "Table 6: Out-of-sample forecast accuracy when taking the crisis out of the in-sample period" about here]

The results of the out-of-sample comparison against the benchmark version of the KOF Barometer are summarised in Table 6. The first row reports the RMSE and MAE values corresponding to the respective lead of the benchmark model, which is the 2014 version of the KOF Barometer. The remaining rows are ratios of versions excluding the above-defined periods relative to the benchmark model. Ratios above one indicate that the benchmark version demonstrates closer out-of-sample fit than the competing versions of the KOF Barometer; ratios below one indicate the opposite.

Most of the ratios are clearly above one. The corresponding improvement in either RMSE or MAE brought about by the benchmark version is up to 20% compared with the competing versions of the KOF Barometer that excluded the crisis period in the selection phase. In several cases this outperformance in out-of-sample fit accuracy is statistically significant at the 10%. The ratios below one are in the range of 0.96-0.99, and the corresponding Diebold-Mariano test statistics are never significant. This allows us to conclude that a special treatment of the crisis period by excluding observations from the variable selection procedure does not bring about any noticeable improvement in the out-of-sample fit of the barometer. Moreover, for several versions the performance even deteriorates in comparison to that of the benchmark version.

7. Conclusions

The KOF Barometer is designed to be a quantitative composite leading indicator for the Swiss business cycle. The principle building blocks are a) the identification of theoretically valid variables with empirically established leads to the reference series and b) the aggregation of these variables into a composite indicator. Thus, we adopt the basics of the traditional approach, the quantification of a not directly measurable process by means of a bundle of variables reflecting the underlying process, as well as the extraction of the joint variance of these variables as the first principal component.

The performance of the new version of the KOF Barometer is illustrated by means of historical simulation in the pseudo-real time. For this purpose, the historical vintages of the KOF Barometer, reflecting the information available to researchers in the past, were created. The performance of the KOF Barometer in matching dynamics of the reference time series was evaluated both in- and out of sample. The main conclusion is that the new version of the KOF Barometer demonstrates leading properties not only with respect to the synthetic reference time series based on the growth rate cycle concept of the business cycle, but also with respect to actual quarterly growth rates of the Swiss GDP.

The performance of the KOF Barometer was scrutinised by subjecting it to several robustness checks like the use of more than one principal components that are extracted from the pool of leading variables, the use of the multi-modular structure that is similar to that of Version 2006 of the KOF Barometer, the use of a dynamic factor model rather than a simple static principal component analysis for extracting of common dynamics among the leading variables, the use of a different reference time series based on the use of the Kalman filter rather than a simple moving-average filter, and finally its performance in comparison with the 1998 and 2006 versions of the KOF Barometer. As an overall conclusion from the results of these robustness checks we can state the developed new 2014 version of the KOF Barometer successfully withstands these attempts to develop a better version and none of the tried modifications delivers a systematic improvement in the leading properties of the 2014 version of the KOF Barometer.

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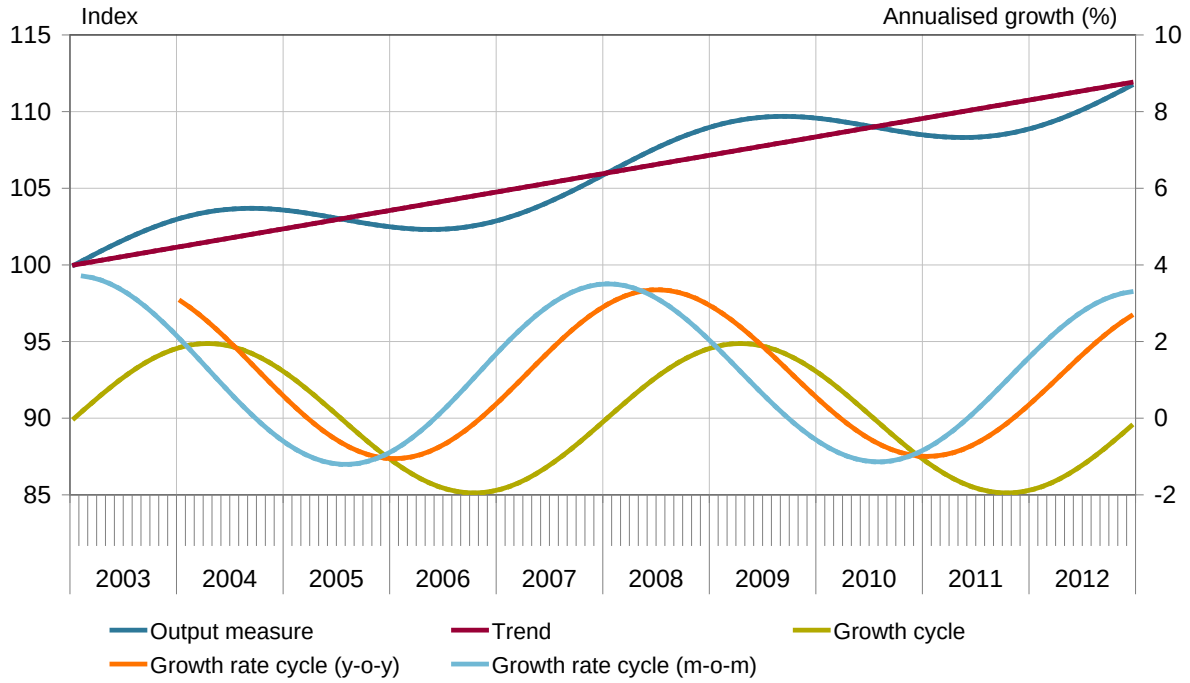
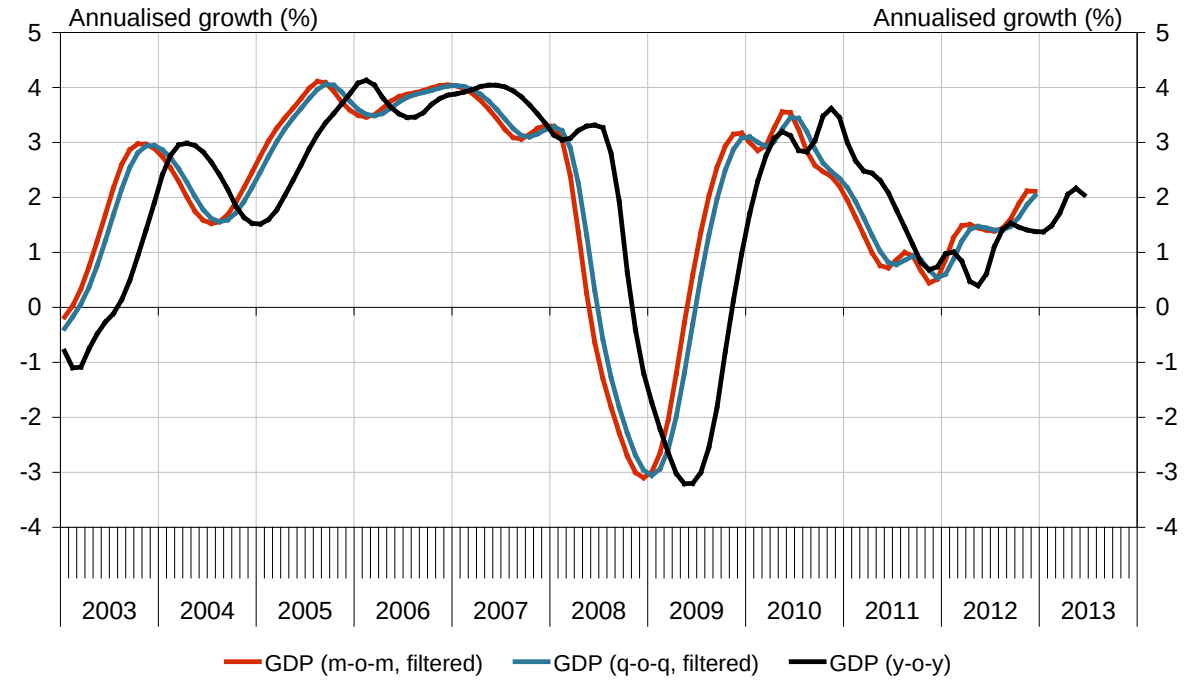
Figures

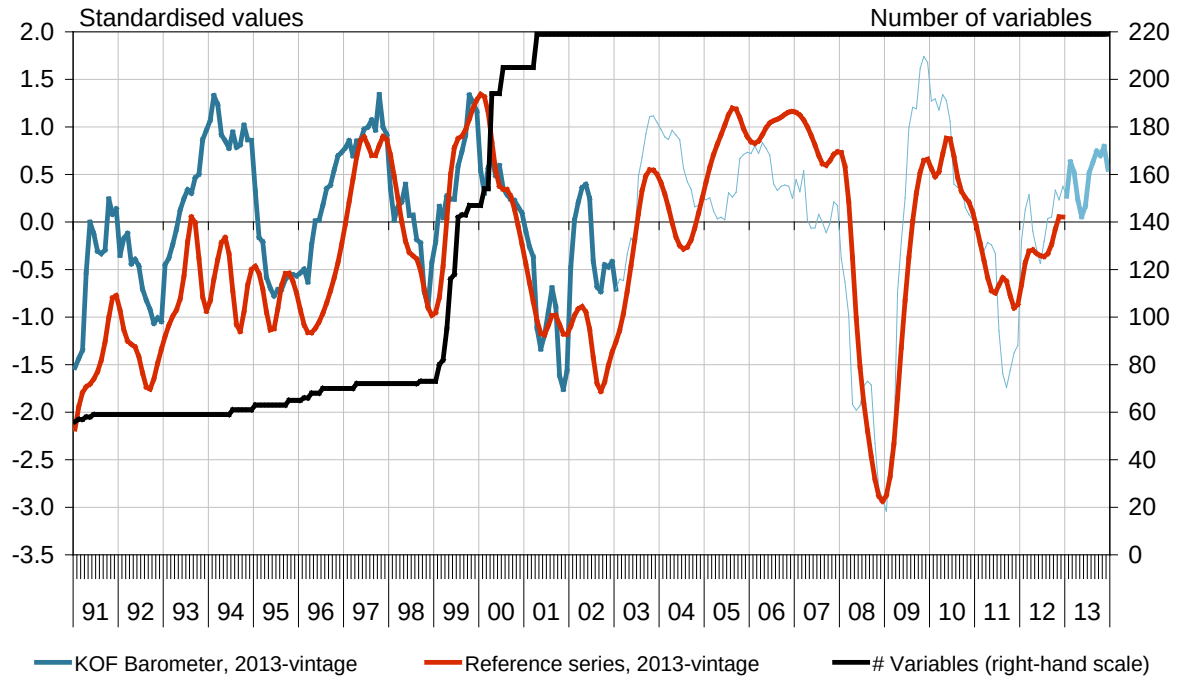
1: Concepts of business cycles



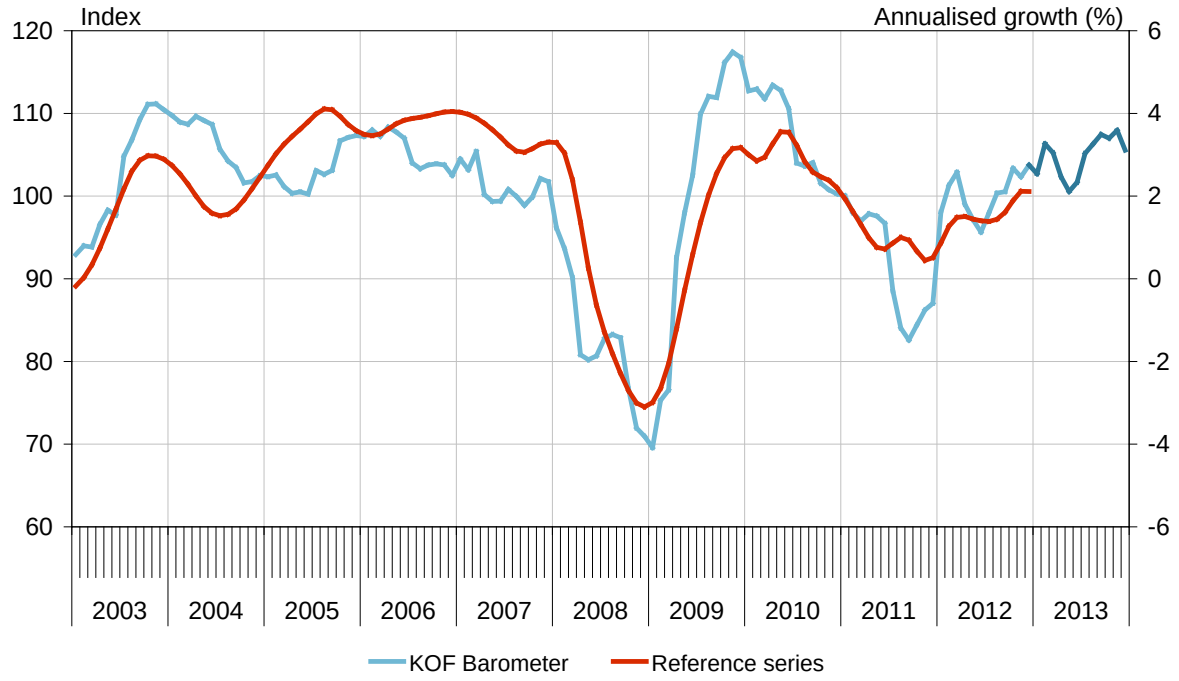
2: Potential reference series for the 2013-vintage of the KOF Economic Barometer



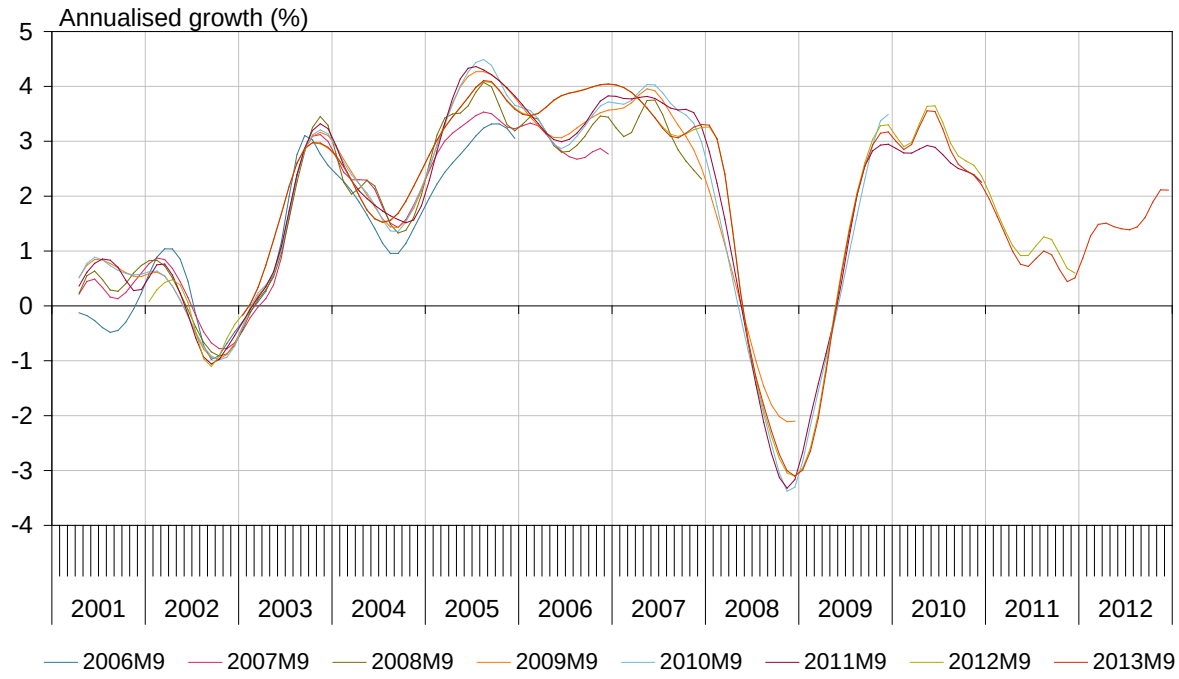
3: Extrapolating the KOF Economic Barometer backwards



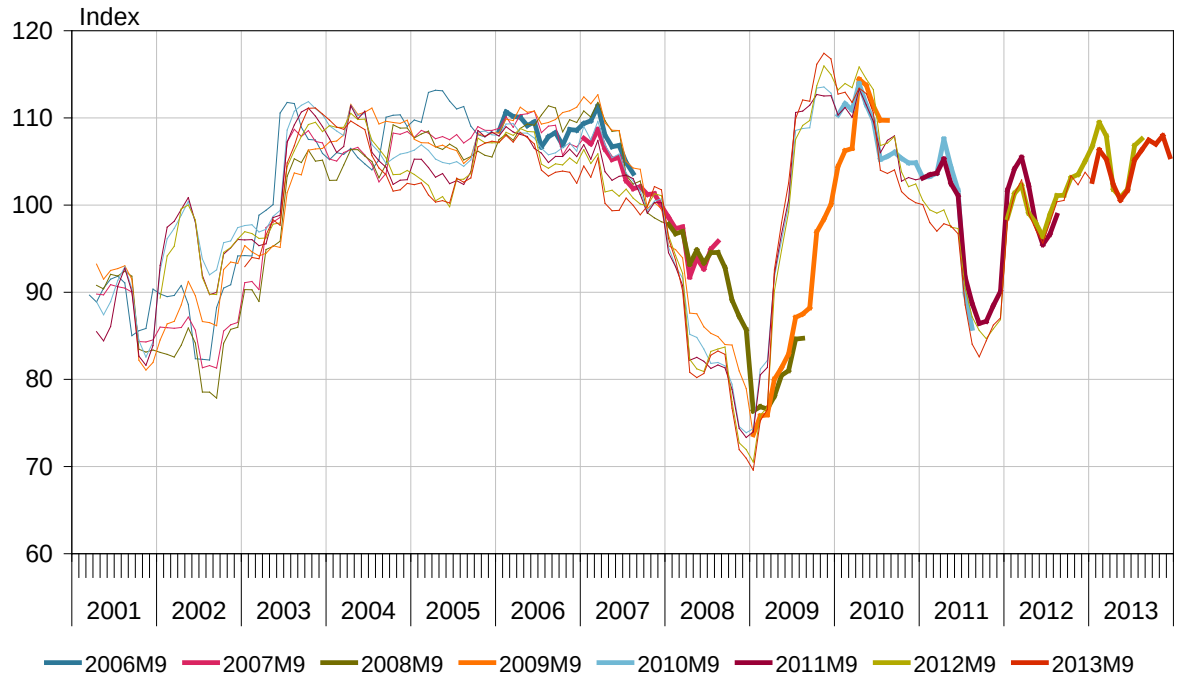
4: The 2013-vintage of the KOF Economic Barometer together with its reference series



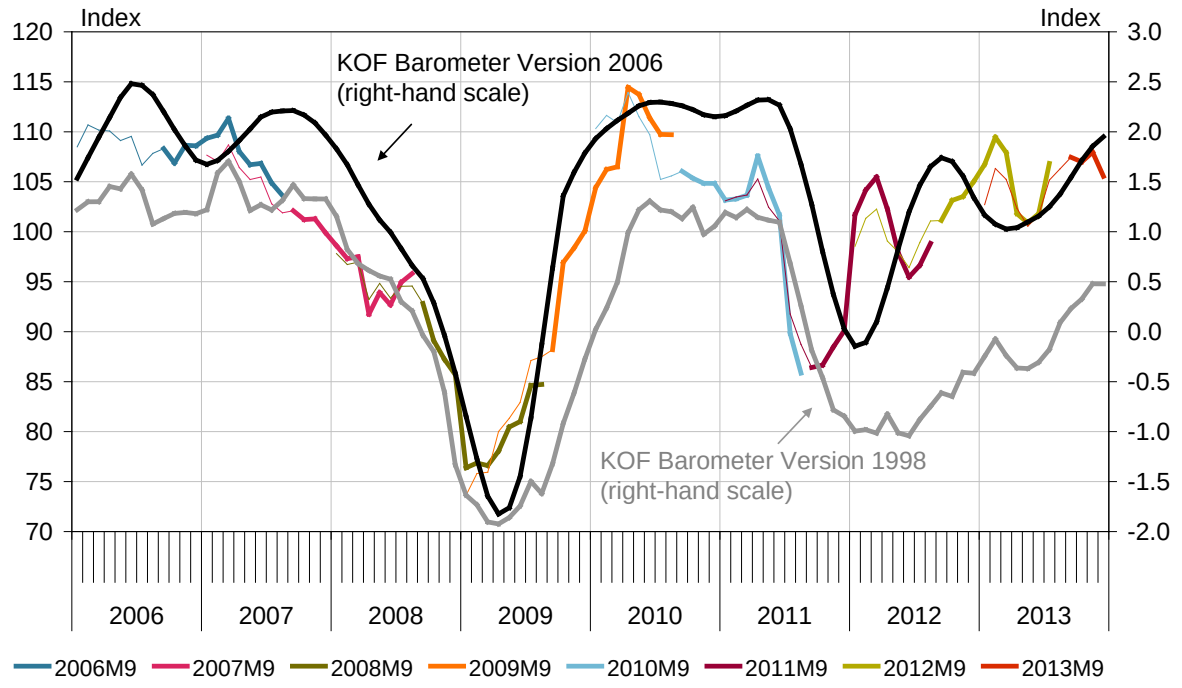
5: Different vintages of the monthly reference series used in the correlation analyses



6: Different vintages of the KOF Economic Barometer

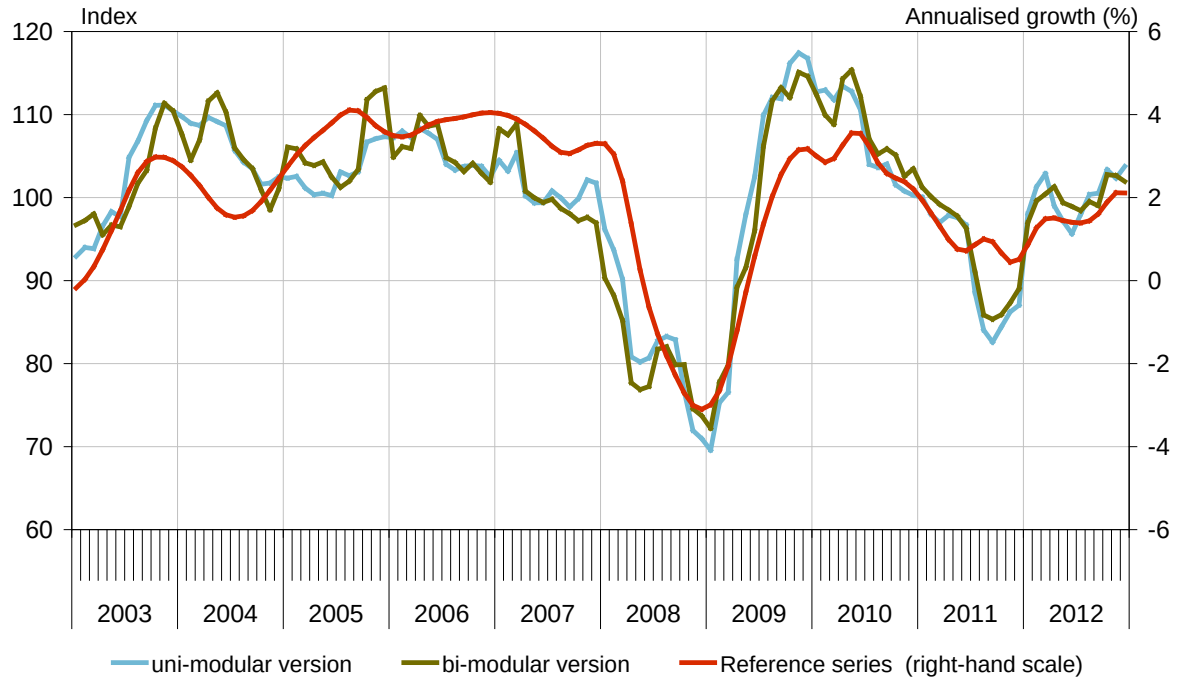


7: Out-of-sample values of KOF Economic Barometer vintages

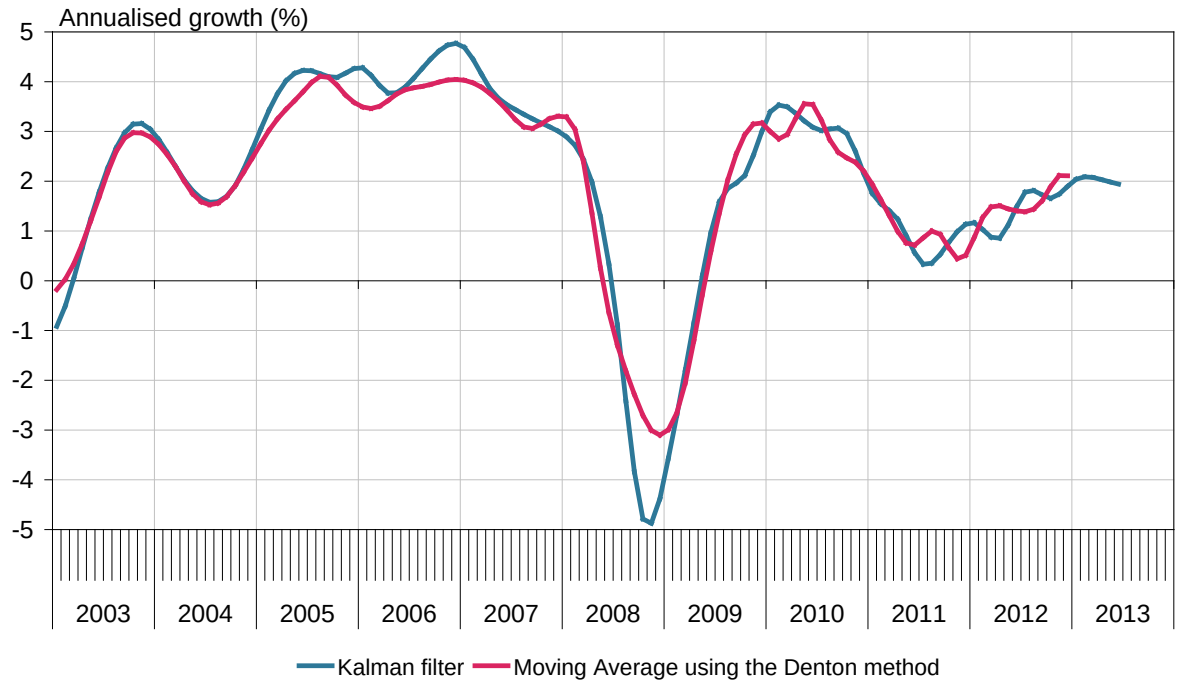


Notes: The data for Version 1998 are shown in real time. Please note that the Version 1998 is constructed to have a mean of zero and standard deviation of one for each underlying monthly vintage.

8: Comparing the 2013-vintage to a version using a bi-modular structure

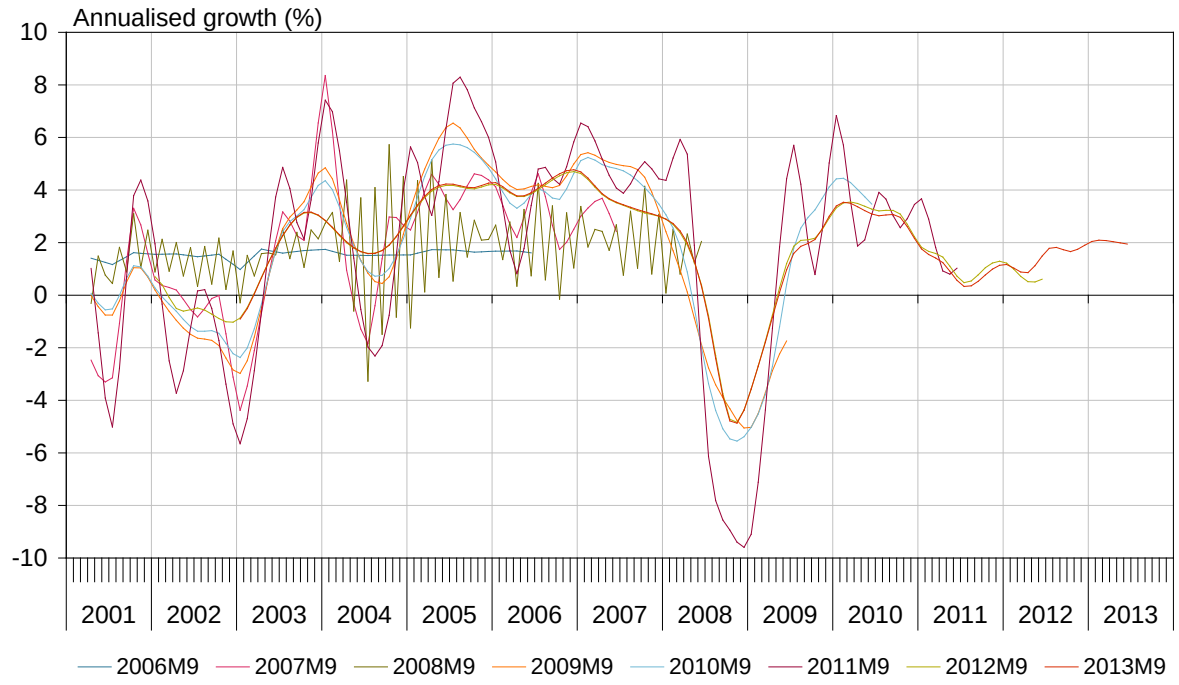


9: Reference series based upon a Kalman filter approach

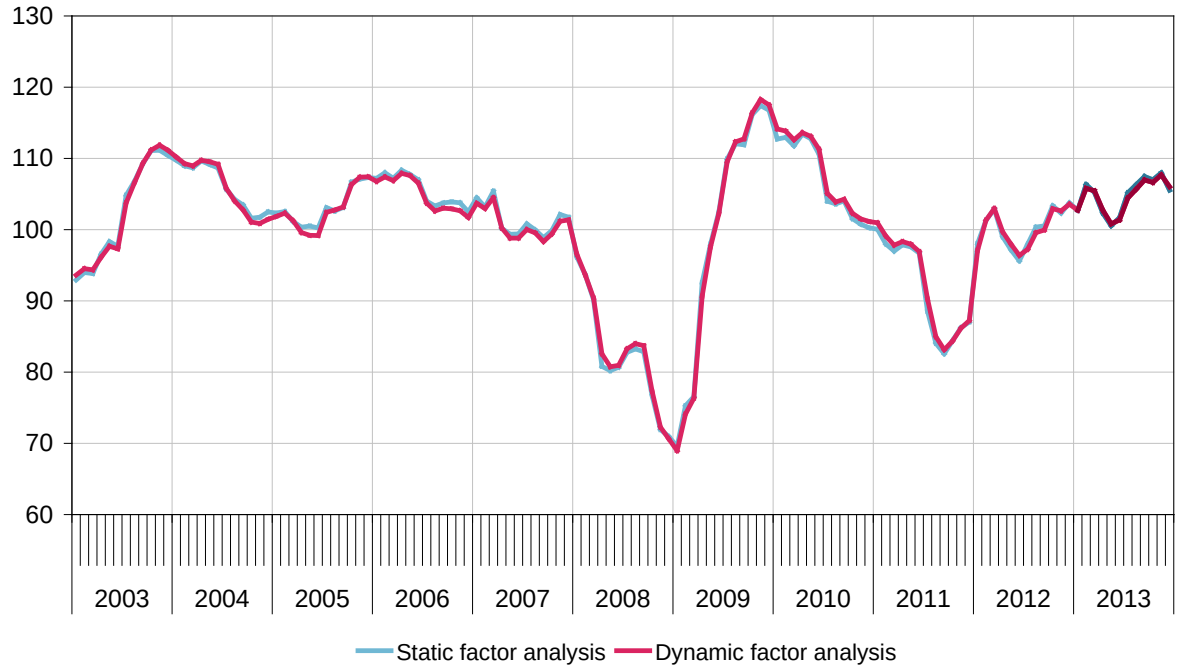


Notes: The red line is the 2013-vintage of the reference time series obtained by smoothing the month-over-month growth rates of interpolated GDP. The interpolation is done using the Denton Method.

10: Reference series based upon a Kalman filter approach: Historical vintages



11: Dynamic versus static factor analysis



Notes: The blue line is the 2013-vintage of the actual 2014 version of the KOF Economic Barometer as also shown in Figure 4. This is based on the static factor model as described in Section 3.2 and following Stock and Watson (2002b). The red line is an alternative version based on Giannone et al. (2008).

Tables

1: Variables used in the selection process

			2013-vintage	
Variable	Source	Sign	Transformation	Publ.lag
Banks: Net interest income, over the last 3 months	KOF (Switzerland)	+	B, D4Q	
Banks: Net fee and commission income, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Banks: Net trading income, over the last 3 months	KOF (Switzerland)	+	M, LVL	
Banks: Net interest income, over the next 3 months	KOF (Switzerland)	+	M, D4Q	
Banks: Net fee and commission income, over the next 3 months	KOF (Switzerland)	+	M, LVL	
Banks: Net trading income, over the next 3 months	KOF (Switzerland)	+	M, D1Q	
Banks: Securities transactions for clients, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Banks: Assets under management, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Banks: Authorized loans, over the last 3 months	KOF (Switzerland)	+	M, D1Q	
Banks: Refinancing at customers funds, over the last 3 months	KOF (Switzerland)	+	M, LVL	
Banks: Refinancing at other funds, over the last 3 months	KOF (Switzerland)	+	B, LVL	
Banks: Credit rating of domestic borrowers, over the last 3 months	KOF (Switzerland)	+	M, D1Q	
Banks: Credit rating of domestic private clients, over the last 3 months	KOF (Switzerland)	+		
Banks: Credit rating of domestic corporate clients, over the last 3 months	KOF (Switzerland)	+	B, D1Q	
Banks: Credit rating of domestic corporate SME clients, over the last 3 months	KOF (Switzerland)	+	P, LVL	
Banks: Credit rating of foreign borrowers, over the last 3 months	KOF (Switzerland)	+	P, LVL	
Banks: Loans to domestic borrowers, over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Banks: Loans to domestic private clients, over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Banks: Loans to domestic corporate clients, over the next 3 months	KOF (Switzerland)	+	E, LVL	
Banks: Loans to domestic corporate SME clients, over the next 3 months	KOF (Switzerland)	+		
Banks: Loans to foreign borrowers, over the next 3 months	KOF (Switzerland)	+	M, D1Q	
Banks: Business situation with domestic clients	KOF (Switzerland)	+	B, D3M	
Banks: Business situation with foreign clients	KOF (Switzerland)	+	E, D12M	
Banks: Overall business situation, over the next 6 months	KOF (Switzerland)	+	M, D12M	
Banks: Demand for services from domestic clients, over the last 3 months	KOF (Switzerland)	+	M, D12M	
Banks: Demand for services from domestic private clients, over the last 3 months	KOF (Switzerland)	+	M, LVL	
Banks: Demand for services from corporate clients, over the last 3 months	KOF (Switzerland)	+	M, D12M	
Banks: Demand for services from corporate SME clients, over the last 3 months	KOF (Switzerland)	+	B, D12M	
Banks: Demand for services from foreign clients, over the last 3 months	KOF (Switzerland)	+	M, D12M	
Banks: Demand for services from domestic clients, over the next 3 months	KOF (Switzerland)	+	E, LVL	
Banks: Demand for services from domestic private clients, over the next 3 months	KOF (Switzerland)	+	E, LVL	
Banks: Demand for services from domestic corporate clients, over the next 3 months	KOF (Switzerland)	+	E, D12M	
Banks: Demand for services from domestic corporate SME clients, over the next 3 months	KOF (Switzerland)	+		
Banks: Demand for services from foreign clients, over the next 3 months	KOF (Switzerland)	+	B, D3M	
Banks: Employment situation, over the last 3 months	KOF (Switzerland)	+	P, D12M	
Banks: Employment situation, over the next 3 months	KOF (Switzerland)	+		
Banks: Interest rate margins, over the next 3 months	KOF (Switzerland)	+	E, LVL	
Banks: Commision rates, over the next 3 months	Swiss National Bank (Switzerland)	+	E, D12M	
Money supply, M1	Swiss National Bank (Switzerland)	+		
Money supply, M2	Swiss National Bank (Switzerland)	+		
Money supply, M3	Swiss National Bank (Switzerland)	+		
Securities transactions	Swiss National Bank (Switzerland)	+	LOG,D3M	1
Swiss Performance Index (SPI)	Swiss National Bank (Switzerland)	+	LOG,D3M	1
Swiss Performance Index (SPI): Insurance sector	Swiss National Bank (Switzerland)	+		
Swiss Performance Index (SPI): Banking sector	Swiss National Bank (Switzerland)	+		
Nominal effective exchange rate of CHF vs 24 countries	Swiss National Bank (Switzerland)		LOG,D12M	1
Real effective exchange rate of CHF vs 24 countries	Swiss National Bank (Switzerland)			
Nominal effective exchange rate of CHF vs 16 European countries	Swiss National Bank (Switzerland)			
Real effective exchange rate of CHF vs 16 European countries	Swiss National Bank (Switzerland)			
Nominal effective exchange rate of CHF vs countries in euro area	Swiss National Bank (Switzerland)			
Real effective exchange rate of CHF vs countries in euro area	Swiss National Bank (Switzerland)			
Nominal three-month interest rate, Euro-Franc	Swiss National Bank (Switzerland)	-		
Long- and short-term interest rate spread (CHF)	SNB/Own calculations	+		
Short-term interest rate spread (USD-CHF)	SNB/Own calculations	+	D12M	1
Long-term interest rate spread (USD-CHF)	SNB/Datastream/Own calculations	+	D12M	1
Short-term interest rate spread (EURO-CHF)	SNB/Own calculations	+		
Long-term interest rate spread (EURO-CHF)	SNB/Datastream/Own calculations	+		
New registration of personal cars	SFSO (Switzerland)	+		
Vacancies	SECO (Switzerland)	+	LOG,D1M	2
Import of personal cars	Swiss Customs Administration (Switzerland)	+		
Retail trade: Expected turnover	KOF (Switzerland)	+	M, D3M	
Retail trade: Business situation, assessment	KOF (Switzerland)	+	M, D3M	
Retail trade: Client frequency, previous month over the same month last year	KOF (Switzerland)	+		
Retail trade: Inventories, assessment	KOF (Switzerland)	-		
Retail trade: Employment situation, assessment	KOF (Switzerland)	-	E, D3M	
Consumer survey: Job security	SECO (Switzerland)	+		
Consumer survey: Timing of large purchases	SECO (Switzerland)	+	D4Q	1
Consumer survey: Savings/Debts	SECO (Switzerland)	+		
Consumer survey: Household financial situation, ex post	SECO (Switzerland)	+	D1Q	1
Consumer survey: Household financial situation, ex ante	SECO (Switzerland)	+	D1Q	1
Consumer survey: Inflation, in the past	SECO (Switzerland)		LVL	1
Consumer survey: Inflation, expected	SECO (Switzerland)			
Consumer survey: Economic situation, ex post	SECO (Switzerland)	+	D1Q	1
Consumer survey: Economic situation, ex ante	SECO (Switzerland)	+	D1Q	1
Retail trade: Expected employment situation	KOF (Switzerland)	+		
Retail trade: Inventories, over the same month last year	KOF (Switzerland)		M, LVL	

Retail trade: Profit, over the last 3 months	KOF (Switzerland)	+	P, D1Q	
Retail trade: Expected purchases	KOF (Switzerland)	+		
Retail trade: Business situation, over the next 6 months	KOF (Switzerland)	+	B, D1Q	
Accomodation: Overnight stays (foreign guests), over the same quarter last year	KOF (Switzerland)	+		
Accomodation: Overnight stays (domestic guests), over the same quarter last year	KOF (Switzerland)	+		
Accomodation: Overnight stays (total), over the same quarter last year	KOF (Switzerland)	+		
Accomodation: Room occupancy rate, in %	KOF (Switzerland)	+		
Accomodation: Turnover, over the same quarter last year	KOF (Switzerland)	+		
Accomodation: Turnover, over the same quarter last year, in %	KOF (Switzerland)	+		
Accomodation: Bookings, over the same quarter last year	KOF (Switzerland)	+		
Accomodation: Employment situation, assessment	KOF (Switzerland)	-	E, D1Q	
Accomodation: Capacity, assessment	KOF (Switzerland)	-		
Accomodation: Profit, over the last 3 months	KOF (Switzerland)	+		
Accomodation: Overnight stays (foreign guests), over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Accomodation: Overnight stays (domestic guests), over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Accomodation: Overnight stays (total), over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Food and beverage services: Beverages sales, over the same quarter last year	KOF (Switzerland)	+		
Food and beverage services: Food sales, over the same quarter last year	KOF (Switzerland)	+		
Food and beverage services: Total sales, over the same quarter last year	KOF (Switzerland)	+		
Food and beverage services: Turnover, over the same quarter last year, in %	KOF (Switzerland)	+		
Food and beverage services: Turnover, over the same quarter last year	KOF (Switzerland)	+		
Food and beverage services: Employment situation, assessment	KOF (Switzerland)	-	E, D4Q	
Food and beverage services: Capacity, assessment	KOF (Switzerland)	-		
Food and beverage services: Profit, over the last 3 months	KOF (Switzerland)	+	P, D1Q	
Food and beverage services: Beverages sales, over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Food and beverage services: Food sales, over the next 3 months	KOF (Switzerland)	+	P, D1Q	
Food and beverage services: Total sales, over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Number of overnight stays in hotels	SFSO (Switzerland)	+	LOG,D1M	2
Food, beverages, tobacco: Orders, over the previous month	KOF (Switzerland)	+		
Food, beverages, tobacco: Orders, previous month over same month last year	KOF (Switzerland)	+		
Food, beverages, tobacco: Order books, over the previous month	KOF (Switzerland)	+	E, LVL	
Food, beverages, tobacco: Order books, assessment	KOF (Switzerland)	+	E, LVL	
Food, beverages, tobacco: Production, over the previous month	KOF (Switzerland)	+		
Food, beverages, tobacco: Production, over same month last year	KOF (Switzerland)	+		
Food, beverages, tobacco: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Food, beverages, tobacco: Intermediate products inventory, assessment	KOF (Switzerland)	-	B, D3M	
Food, beverages, tobacco: Finished products inventory, over the previous month	KOF (Switzerland)			
Food, beverages, tobacco: Finished products inventory, assessment	KOF (Switzerland)	-	M, LVL	
Food, beverages, tobacco: Employment situation, assessment	KOF (Switzerland)	-		
Food, beverages, tobacco: Business climate	KOF (Switzerland)	+		
Food, beverages, tobacco: Expected orders	KOF (Switzerland)	+		
Food, beverages, tobacco: Expected production	KOF (Switzerland)	+		
Food, beverages, tobacco: Expected intermediate products purchase	KOF (Switzerland)	+		
Food, beverages, tobacco: Expected employment situation	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Orders, over the previous month	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Orders, previous month over same month last year	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Order books, over the previous month	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Order books, assessment	KOF (Switzerland)	+	B, D3M	
Textile, clothing, leather, footwear: Production, over the previous month	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Production, over same month last year	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Textile, clothing, leather, footwear: Intermediate products inventory, assessment	KOF (Switzerland)	-		
Textile, clothing, leather, footwear: Finished products inventory, over the previous month	KOF (Switzerland)			
Textile, clothing, leather, footwear: Finished products inventory, assessment	KOF (Switzerland)	-		
Textile, clothing, leather, footwear: Employment situation, assessment	KOF (Switzerland)	-		
Textile, clothing, leather, footwear: Business climate	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Expected orders	KOF (Switzerland)	+	B, D3M	
Textile, clothing, leather, footwear: Expected production	KOF (Switzerland)	+	M, D3M	
Textile, clothing, leather, footwear: Expected intermediate products purchase	KOF (Switzerland)	+	M, D3M	
Textile, clothing, leather, footwear: Expected employment situation	KOF (Switzerland)	+		
Wood; other non-metals: Orders, over the previous month	KOF (Switzerland)	+	P, LVL	
Wood; other non-metals: Orders,previous month over same month last year	KOF (Switzerland)	+		
Wood; other non-metals: Order books, over the previous month	KOF (Switzerland)	+	P, LVL	
Wood; other non-metals: Order books, assessment	KOF (Switzerland)	+	P, D12M	
Wood; other non-metals: Production, over the previous month	KOF (Switzerland)	+		
Wood; other non-metals: Production, over same month last year	KOF (Switzerland)	+		
Wood; other non-metals: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Wood; other non-metals: Intermediate products inventory, assessment	KOF (Switzerland)	-	P, D12M	
Wood; other non-metals: Finished products inventory, over the previous month	KOF (Switzerland)		M, LVL	
Wood; other non-metals: Finished products inventory, assessment	KOF (Switzerland)	-	E, LVL	
Wood; other non-metals: Employment situation, assessment	KOF (Switzerland)	-		
Wood; other non-metals: Business climate	KOF (Switzerland)	+		
Wood; other non-metals: Expected orders	KOF (Switzerland)	+	M, D3M	
Wood; other non-metals: Expected production	KOF (Switzerland)	+	M, D3M	
Wood; other non-metals: Expected intermediate products purchase	KOF (Switzerland)	+	B, D12M	
Wood; other non-metals: Expected employment situation	KOF (Switzerland)	+		
Paper, printing, publishing: Orders, over the previous month	KOF (Switzerland)	+		
Paper, printing, publishing: Orders,previous month over same month last year	KOF (Switzerland)	+		
Paper, printing, publishing: Order books, over the previous month	KOF (Switzerland)	+	P, LVL	
Paper, printing, publishing: Order books, assessment	KOF (Switzerland)	+	P, D3M	

Paper, printing, publishing: Production, over the previous month	KOF (Switzerland)	+		
Paper, printing, publishing: Production, over same month last year	KOF (Switzerland)	+		
Paper, printing, publishing: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Paper, printing, publishing: Intermediate products inventory, assessment	KOF (Switzerland)	-		
Paper, printing, publishing: Finished products inventory, over the previous month	KOF (Switzerland)			
Paper, printing, publishing: Finished products inventory, assessment	KOF (Switzerland)	-		
Paper, printing, publishing: Employment situation, assessment	KOF (Switzerland)	-		
Paper, printing, publishing: Business climate	KOF (Switzerland)	+		
Paper, printing, publishing: Expected orders	KOF (Switzerland)	+	M, D3M	
Paper, printing, publishing: Expected production	KOF (Switzerland)	+	M, D3M	
Paper, printing, publishing: Expected intermediate products purchase	KOF (Switzerland)	+	M, D3M	
Paper, printing, publishing: Expected employment situation	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Orders, over the previous month	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Orders, previous month over same month last year	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Order books, over the previous month	KOF (Switzerland)	+	M, LVL	
Chemistry; petroleum processing; rubber: Order books, assessment	KOF (Switzerland)	+	B, D3M	
Chemistry; petroleum processing; rubber: Production, over the previous month	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Production, over same month last year	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Intermediate products inventory, over the previous month	KOF (Switzerland)		B, LVL	
Chemistry; petroleum processing; rubber: Intermediate products inventory, assessment	KOF (Switzerland)	-		
Chemistry; petroleum processing; rubber: Finished products inventory, over the previous month	KOF (Switzerland)			
Chemistry; petroleum processing; rubber: Finished products inventory, assessment	KOF (Switzerland)	-	B, D3M	
Chemistry; petroleum processing; rubber: Employment situation, assessment	KOF (Switzerland)	-		
Chemistry; petroleum processing; rubber: Business climate	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Expected orders	KOF (Switzerland)	+	M, D12M	
Chemistry; petroleum processing; rubber: Expected production	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Expected intermediate products purchase	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Expected employment situation	KOF (Switzerland)	+		
Metal industry: Orders, over the previous month	KOF (Switzerland)	+		
Metal industry: Orders,previous month over same month last year	KOF (Switzerland)	+		
Metal industry: Order books, over the previous month	KOF (Switzerland)	+		
Metal industry: Order books, assessment	KOF (Switzerland)	+		
Metal industry: Production, over the previous month	KOF (Switzerland)	+		
Metal industry: Production, over same month last year	KOF (Switzerland)	+		
Metal industry: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Metal industry: Intermediate products inventory, assessment	KOF (Switzerland)	-	B, D1M	
Metal industry: Finished products inventory, over the previous month	KOF (Switzerland)		P, LVL	
Metal industry: Finished products inventory, assessment	KOF (Switzerland)	-	M, D12M	
Metal industry: Employment situation, assessment	KOF (Switzerland)	-		
Metal industry: Business climate	KOF (Switzerland)	+		
Metal industry: Expected orders	KOF (Switzerland)	+	B, D3M	
Metal industry: Expected production	KOF (Switzerland)	+	B, D3M	
Metal industry: Expected intermediate products purchase	KOF (Switzerland)	+	B, D3M	
Metal industry: Expected employment situation	KOF (Switzerland)	+		
Machine construction, vehicle construction: Orders, over the previous month	KOF (Switzerland)	+		
Machine construction, vehicle construction: Orders,previous over same month last year	KOF (Switzerland)	+		
Machine construction, vehicle construction: Order books, over the previous month	KOF (Switzerland)	+		
Machine construction, vehicle construction: Order books, assessment	KOF (Switzerland)	+	P, D3M	
Machine construction, vehicle construction: Production, over the previous month	KOF (Switzerland)	+		
Machine construction, vehicle construction: Production, over same month last year	KOF (Switzerland)	+		
Machine construction, vehicle construction: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Machine construction, vehicle construction: Intermediate products inventory, assessment	KOF (Switzerland)	-		
Machine construction, vehicle construction: Finished products inventory, over the previous month	KOF (Switzerland)			
Machine construction, vehicle construction: Finished products inventory, assessment	KOF (Switzerland)	-	B, D3M	
Machine construction, vehicle construction: Employment situation, assessment	KOF (Switzerland)	-		
Machine construction, vehicle construction: Business climate	KOF (Switzerland)	+		
Machine construction, vehicle construction: Expected orders	KOF (Switzerland)	+	B, D3M	
Machine construction, vehicle construction: Expected production	KOF (Switzerland)	+	M, D3M	
Machine construction, vehicle construction: Expected intermediate products purchase	KOF (Switzerland)	+	B, D3M	
Machine construction, vehicle construction: Expected employment situation	KOF (Switzerland)	+		
Electrical, electronic equipment: Orders, over the previous month	KOF (Switzerland)	+		
Electrical, electronic equipment: Orders, previous month over same month last year	KOF (Switzerland)	+		
Electrical, electronic equipment: Order books, over the previous month	KOF (Switzerland)	+		
Electrical, electronic equipment: Order books, assessment	KOF (Switzerland)	+	P, D1M	
Electrical, electronic equipment: Production, over the previous month	KOF (Switzerland)	+		
Electrical, electronic equipment: Production, over same month last year	KOF (Switzerland)	+		
Electrical, electronic equipment: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Electrical, electronic equipment: Intermediate products inventory, assessment	KOF (Switzerland)	-	P, D1M	
Electrical, electronic equipment: Finished products inventory, over the previous month	KOF (Switzerland)			
Electrical, electronic equipment: Finished products inventory, assessment	KOF (Switzerland)	-		
Electrical, electronic equipment: Employment situation, assessment	KOF (Switzerland)	-		
Electrical, electronic equipment: Business climate	KOF (Switzerland)	+		
Electrical, electronic equipment: Expected orders	KOF (Switzerland)	+	M, D3M	
Electrical, electronic equipment: Expected production	KOF (Switzerland)	+	B, D3M	
Electrical, electronic equipment: Expected intermediate products purchase	KOF (Switzerland)	+	B, D3M	
Electrical, electronic equipment: Expected employment situation	KOF (Switzerland)	+		
Other industry: Orders, over the previous month	KOF (Switzerland)	+		
Other industry: Orders, previous month over same month last year	KOF (Switzerland)	+		
Other industry: Order books, over the previous month	KOF (Switzerland)	+		
Other industry: Order books, assessment	KOF (Switzerland)	+	P, D3M	

Other industry: Production, over the previous month	KOF (Switzerland)	+		
Other industry: Production, over same month last year	KOF (Switzerland)	+		
Other industry: Intermediate products inventory, over the previous month	KOF (Switzerland)			
Other industry: Intermediate products inventory, assessment	KOF (Switzerland)	-		
Other industry: Finished products inventory, over the previous month	KOF (Switzerland)			
Other industry: Finished products inventory, assessment	KOF (Switzerland)	-		
Other industry: Employment situation, assessment	KOF (Switzerland)	-		
Other industry: Business climate	KOF (Switzerland)	+		
Other industry: Expected orders	KOF (Switzerland)	+	M, D12M	
Other industry: Expected production	KOF (Switzerland)	+	B, D12M	
Other industry: Expected intermediate products purchase	KOF (Switzerland)	+	M, D12M	
Other industry: Expected employment situation	KOF (Switzerland)	+		
Food, beverages, tobacco: Production technical capacity, over the last 3 months	KOF (Switzerland)	+		
Food, beverages, tobacco: Production technical capacity, assessment	KOF (Switzerland)	-		
Food, beverages, tobacco: Capacity utilisation, in %	KOF (Switzerland)	+		
Food, beverages, tobacco: Sales prices, over the last 3 months	KOF (Switzerland)		B, LVL	
Food, beverages, tobacco: Profit, over the last 3 months	KOF (Switzerland)	+	E, LVL	
Food, beverages, tobacco: Production assured in months	KOF (Switzerland)	+		
Food, beverages, tobacco: Competition position domestically, over the last 3 months	KOF (Switzerland)	+	E, D4Q	
Food, beverages, tobacco: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Food, beverages, tobacco: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Food, beverages, tobacco: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Food, beverages, tobacco: Production impediments: Insufficient labor	KOF (Switzerland)	+	%, D4Q	
Food, beverages, tobacco: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Food, beverages, tobacco: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Food, beverages, tobacco: Production impediments: Other causes	KOF (Switzerland)			
Food, beverages, tobacco: Production impediments: none	KOF (Switzerland)	+		
Food, beverages, tobacco: Expected exports, over the next 3 months	KOF (Switzerland)	+	P, D4Q	
Food, beverages, tobacco: Expected purchasing prices, over the next 3 months	KOF (Switzerland)		B, D1Q	
Food, beverages, tobacco: Expected sales prices, over the next 3 months	KOF (Switzerland)		P, D1Q	
Food, beverages, tobacco: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Production technical capacity, over the last 3 months	KOF (Switzerland)	+	E, LVL	
Textile, clothing, leather, footwear: Production technical capacity, assessment	KOF (Switzerland)	-	M, D1Q	
Textile, clothing, leather, footwear: Capacity utilisation, in %	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Sales prices, over the last 3 months	KOF (Switzerland)		P, LVL	
Textile, clothing, leather, footwear: Profit, over the last 3 months	KOF (Switzerland)	+	P, D4Q	
Textile, clothing, leather, footwear: Production assured in months	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Competition position domestically, over the last 3 months	KOF (Switzerland)	+	E, D4Q	
Textile, clothing, leather, footwear: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	B, D4Q	
Textile, clothing, leather, footwear: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+	M, LVL	
Textile, clothing, leather, footwear: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Textile, clothing, leather, footwear: Production impediments: Insufficient labor	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Textile, clothing, leather, footwear: Production impediments: Other causes	KOF (Switzerland)			
Textile, clothing, leather, footwear: Production impediments: none	KOF (Switzerland)	+		
Textile, clothing, leather, footwear: Expected exports, over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Textile, clothing, leather, footwear: Expected purchasing prices, over the next 3 months	KOF (Switzerland)		E, LVL	
Textile, clothing, leather, footwear: Expected sales prices, over the next 3 months	KOF (Switzerland)		E, LVL	
Textile, clothing, leather, footwear: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Wood; other non-metals: Production technical capacity, over the last 3 months	KOF (Switzerland)	+	M, D1Q	
Wood; other non-metals: Production technical capacity, assessment	KOF (Switzerland)	-	E, D1Q	
Wood; other non-metals: Capacity utilisation, in %	KOF (Switzerland)	+	%, D1Q	
Wood; other non-metals: Sales prices, over the last 3 months	KOF (Switzerland)		M, D1Q	
Wood; other non-metals: Profit, over the last 3 months	KOF (Switzerland)	+	B, D4Q	
Wood; other non-metals: Production assured in months	KOF (Switzerland)	+		
Wood; other non-metals: Competition position domestically, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Wood; other non-metals: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	M, D1Q	
Wood; other non-metals: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+		
Wood; other non-metals: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Wood; other non-metals: Production impediments: Insufficient labor	KOF (Switzerland)	+		
Wood; other non-metals: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Wood; other non-metals: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Wood; other non-metals: Production impediments: Other causes	KOF (Switzerland)		%, D4Q	
Wood; other non-metals: Production impediments: none	KOF (Switzerland)	+		
Wood; other non-metals: Expected exports, over the next 3 months	KOF (Switzerland)	+	E, D4Q	
Wood; other non-metals: Expected purchasing prices, over the next 3 months	KOF (Switzerland)			
Wood; other non-metals: Expected sales prices, over the next 3 months	KOF (Switzerland)		B, D1Q	
Wood; other non-metals: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Paper, printing, publishing: Production technical capacity, over the last 3 months	KOF (Switzerland)	+	E, D4Q	
Paper, printing, publishing: Production technical capacity, assessment	KOF (Switzerland)	-	B, D1Q	
Paper, printing, publishing: Capacity utilisation, in %	KOF (Switzerland)	+		
Paper, printing, publishing: Sales prices, over the last 3 months	KOF (Switzerland)			
Paper, printing, publishing: Profit, over the last 3 months	KOF (Switzerland)	+		
Paper, printing, publishing: Production assured in months	KOF (Switzerland)	+		
Paper, printing, publishing: Competition position domestically, over the last 3 months	KOF (Switzerland)	+	P, D1Q	
Paper, printing, publishing: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	P, LVL	
Paper, printing, publishing: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+		
Paper, printing, publishing: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Paper, printing, publishing: Production impediments: Insufficient labor	KOF (Switzerland)	+		

Paper, printing, publishing: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Paper, printing, publishing: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Paper, printing, publishing: Production impediments: Other causes	KOF (Switzerland)			
Paper, printing, publishing: Production impediments: none	KOF (Switzerland)	+		
Paper, printing, publishing: Expected exports, over the next 3 months	KOF (Switzerland)	+		
Paper, printing, publishing: Expected purchasing prices, over the next 3 months	KOF (Switzerland)			
Paper, printing, publishing: Expected sales prices, over the next 3 months	KOF (Switzerland)			
Paper, printing, publishing: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Production technical capacity, over the last 3 months	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Production technical capacity, assessment	KOF (Switzerland)	-	M, D4Q	
Chemistry; petroleum processing; rubber: Capacity utilisation, in %	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Sales prices, over the last 3 months	KOF (Switzerland)			
Chemistry; petroleum processing; rubber: Profit, over the last 3 months	KOF (Switzerland)	+	P, D4Q	
Chemistry; petroleum processing; rubber: Production assured in months	KOF (Switzerland)	+	R, LVL	
Chemistry; petroleum processing; rubber: Competition position domestically, over the last 3 months	KOF (Switzerland)	+	B, D4Q	
Chemistry; petroleum processing; rubber: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Chemistry; petroleum processing; rubber: Production impediments: Insufficient labor	KOF (Switzerland)	+	%, D4Q	
Chemistry; petroleum processing; rubber: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Chemistry; petroleum processing; rubber: Production impediments: Other causes	KOF (Switzerland)			
Chemistry; petroleum processing; rubber: Production impediments: none	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Expected exports, over the next 3 months	KOF (Switzerland)	+		
Chemistry; petroleum processing; rubber: Expected purchasing prices, over the next 3 months	KOF (Switzerland)			
Chemistry; petroleum processing; rubber: Expected sales prices, over the next 3 months	KOF (Switzerland)			
Chemistry; petroleum processing; rubber: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Metal industry: Production technical capacity, over the last 3 months	KOF (Switzerland)	+		
Metal industry: Production technical capacity, assessment	KOF (Switzerland)	-	M, D1Q	
Metal industry: Capacity utilisation, in %	KOF (Switzerland)	+		
Metal industry: Sales prices, over the last 3 months	KOF (Switzerland)			
Metal industry: Profit, over the last 3 months	KOF (Switzerland)	+	P, D1Q	
Metal industry: Production assured in months	KOF (Switzerland)	+		
Metal industry: Competition position domestically, over the last 3 months	KOF (Switzerland)	+		
Metal industry: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Metal industry: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Metal industry: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Metal industry: Production impediments: Insufficient labor	KOF (Switzerland)	+	%, D1Q	
Metal industry: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Metal industry: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Metal industry: Production impediments: Other causes	KOF (Switzerland)			
Metal industry: Production impediments: none	KOF (Switzerland)	+		
Metal industry: Expected exports, over the next 3 months	KOF (Switzerland)	+	B, D1Q	
Metal industry: Expected purchasing prices, over the next 3 months	KOF (Switzerland)		M, D1Q	
Metal industry: Expected sales prices, over the next 3 months	KOF (Switzerland)		E, D4Q	
Metal industry: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Machine construction, vehicle construction: Production technical capacity, over the last 3 months	KOF (Switzerland)	+	P, D1Q	
Machine construction, vehicle construction: Production technical capacity, assessment	KOF (Switzerland)	-	M, D4Q	
Machine construction, vehicle construction: Capacity utilisation, in %	KOF (Switzerland)	+		
Machine construction, vehicle construction: Sales prices, over the last 3 months	KOF (Switzerland)		P, LVL	
Machine construction, vehicle construction: Profit, over the last 3 months	KOF (Switzerland)	+	P, D1Q	
Machine construction, vehicle construction: Production assured in months	KOF (Switzerland)	+		
Machine construction, vehicle construction: Competition position domestically, over the last 3 months	KOF (Switzerland)	+	B, D1Q	
Machine construction, vehicle construction: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	M, D4Q	
Machine construction, vehicle construction: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+	B, D4Q	
Machine construction, vehicle construction: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Machine construction, vehicle construction: Production impediments: Insufficient labor	KOF (Switzerland)	+		
Machine construction, vehicle construction: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+	%, D1Q	
Machine construction, vehicle construction: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Machine construction, vehicle construction: Production impediments: Other causes	KOF (Switzerland)			
Machine construction, vehicle construction: Production impediments: none	KOF (Switzerland)	+	%, D1Q	
Machine construction, vehicle construction: Expected exports, over the next 3 months	KOF (Switzerland)	+	M, D1Q	
Machine construction, vehicle construction: Expected purchasing prices, over the next 3 months	KOF (Switzerland)		M, D1Q	
Machine construction, vehicle construction: Expected sales prices, over the next 3 months	KOF (Switzerland)			
Machine construction, vehicle construction: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Electrical, electronic equipment: Production technical capacity, over the last 3 months	KOF (Switzerland)	+		
Electrical, electronic equipment: Production technical capacity, assessment	KOF (Switzerland)	-	M, D1Q	
Electrical, electronic equipment: Capacity utilisation, in %	KOF (Switzerland)	+		
Electrical, electronic equipment: Sales prices, over the last 3 months	KOF (Switzerland)		E, D4Q	
Electrical, electronic equipment: Profit, over the last 3 months	KOF (Switzerland)	+		
Electrical, electronic equipment: Production assured in months	KOF (Switzerland)	+		
Electrical, electronic equipment: Competition position domestically, over the last 3 months	KOF (Switzerland)	+		
Electrical, electronic equipment: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	B, D4Q	
Electrical, electronic equipment: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+	M, LVL	
Electrical, electronic equipment: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Electrical, electronic equipment: Production impediments: Insufficient labor	KOF (Switzerland)	+		
Electrical, electronic equipment: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Electrical, electronic equipment: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Electrical, electronic equipment: Production impediments: Other causes	KOF (Switzerland)			
Electrical, electronic equipment: Production impediments: none	KOF (Switzerland)	+		

Electrical, electronic equipment: Expected exports, over the next 3 months	KOF (Switzerland)	+	M, D1Q	
Electrical, electronic equipment: Expected purchasing prices, over the next 3 months	KOF (Switzerland)		B, D1Q	
Electrical, electronic equipment: Expected sales prices, over the next 3 months	KOF (Switzerland)		E, LVL	
Electrical, electronic equipment: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Other industry: Production technical capacity, over the last 3 months	KOF (Switzerland)	+		
Other industry: Production technical capacity, assessment	KOF (Switzerland)	-		
Other industry: Capacity utilisation, in %	KOF (Switzerland)	+		
Other industry: Sales prices, over the last 3 months	KOF (Switzerland)		E, LVL	
Other industry: Profit, over the last 3 months	KOF (Switzerland)	+		
Other industry: Production assured in months	KOF (Switzerland)	+		
Other industry: Competition position domestically, over the last 3 months	KOF (Switzerland)	+		
Other industry: Competition position in the EU, over the last 3 months	KOF (Switzerland)	+	B, D4Q	
Other industry: Competition position outside of the EU, over the last 3 months	KOF (Switzerland)	+	P, D4Q	
Other industry: Production impediments: Insufficient demand	KOF (Switzerland)	-		
Other industry: Production impediments: Shortage of labour force	KOF (Switzerland)	+		
Other industry: Production impediments: Insufficient technical capacity	KOF (Switzerland)	+		
Other industry: Production impediments: Financial restrictions	KOF (Switzerland)	-		
Other industry: Production impediments: Other causes	KOF (Switzerland)			
Other industry: Production impediments: none	KOF (Switzerland)	+		
Other industry: Expected exports, over the next 3 months	KOF (Switzerland)	+	P, D4Q	
Other industry: Expected purchasing prices, over the next 3 months	KOF (Switzerland)			
Other industry: Expected sales prices, over the next 3 months	KOF (Switzerland)			
Other industry: Expected business situation, over the next 6 months	KOF (Switzerland)	+		
Architects and engineers: Value of constructions, residential buildings	KOF (Switzerland)	+	P, D4Q	
Architects and engineers: Value of constructions, commercial construction	KOF (Switzerland)	+	B, D1Q	
Architects and engineers: Value of constructions, public construction	KOF (Switzerland)	+	B, D1Q	
Architects and engineers: Value of constructions, total	KOF (Switzerland)	+	P, D1Q	
Architects and engineers: Order books, over the last 3 months	KOF (Switzerland)	+	E, LVL	
Architects and engineers: Range of orders in hand, in months	KOF (Switzerland)	+		
Architects and engineers: Business situation, assessment	KOF (Switzerland)	+	P, D1M	
Architects and engineers: Business situation, over the next 6 months	KOF (Switzerland)	+	E, D12M	
Architects and engineers: Demand, over the next 3 months	KOF (Switzerland)	+	M, D3M	
Architects and engineers: Employment situation, over the next 3 months	KOF (Switzerland)	+	M, D12M	
Architects and engineers: Prices, over the next 3 months	KOF (Switzerland)		E, D12M	
Construction: Business situation, assessment	KOF (Switzerland)	+	E, D12M	
Construction: Demand, over the next 3 months	KOF (Switzerland)	+	B, D3M	
Construction: Order books	KOF (Switzerland)	+		
Construction: Production activity, over the last 3 months	KOF (Switzerland)	+	B, D12M	
Construction: Production impediments: none	KOF (Switzerland)	+		
Construction: Production impediments: Weather conditions	KOF (Switzerland)	-		
Construction: Production impediments: Shortage of labour force	KOF (Switzerland)	+		
Construction: Production impediments: Shortage of space and/or equipment	KOF (Switzerland)	+		
Construction: Employment situation, over the next 3 months	KOF (Switzerland)	+	M, D12M	
Construction: Prices, over the next 3 months	KOF (Switzerland)		B, D3M	
Construction: Production assured in months	KOF (Switzerland)	+		
Construction: Capacity utilisation, in %	KOF (Switzerland)	+		
Cement delivery, including imports	KOF (Switzerland)	+		
Baublatt indicator	KOF (Switzerland)	+		
CH MACROECONOMIC CLIMATE INDEX - LEADING INDEX SADJ	National Bureau of Statistics (China)	+	D3M	2
CH CONSUMER EXPECTATION INDEX NADJ	National Bureau of Statistics (China)	+	D1M	2
DE: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
ES: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D12M	1
GB: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
AT: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
BE: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
FR: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
IT: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D12M	1
NL: EU CONSUMER SURV. Consumer Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
AT: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
BE: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
DE: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D1M	1
GB: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
ES: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
FR: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D1M	1
IT: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D1M	1
NL: EU INDUSTRY SURV. Industrial Confidence Indicator	European Commission, DG ECFIN	+	D3M	1
JP CONS.CONFIDENCE INDEX-OVERALL LIVELIHOOD(EXCL.1 PERSON HH)	Cabinet Office (Japan)	+	D12M	1
JP REUTERS TANKAN: BUS.CNDTN-MFRS., 400 FIRMS, FCST. NADJ	Tankan (Japan)	+	D3M	
US UNIV OF MICHIGAN CONS.SENTIMENT: ECONOMIC OUTLOOK,12 MONTHS	University of Michagan (USA)	+	LVL	
US ISM MANUFACTURERS SVY RESULTS: PRODUCTION - NET NADJ	Institute for Supply Management (USA)	+		
AS WES: ECONOMIC SIT. NEXT 6 MONTHS - OVERALL ECONOMY, ASIA NADJ	ifo (Germany)	+	LVL	1
AS WES: ECONOMIC SITUATION - OVERALL ECONOMY, ASIA NADJ	ifo (Germany)	+		
C3 WES: ECONOMIC SIT.NEXT 6 MONTHS-OVERALL ECONOMY, OCEANIA NADJ	ifo (Germany)	+	D1Q	1
C3 WES: ECONOMIC SITUATION - OVERALL ECONOMY, OCEANIA NADJ	ifo (Germany)	+	D1Q	1
LM WES: ECONOMIC SIT.NEXT 6 MO-OVERALL ECONOMY,LATIN AMERICA	ifo (Germany)	+	D4Q	1
LM WES: ECONOMIC SITUATION - OVERALL ECONOMY, LATIN AMERICA NADJ	ifo (Germany)	+		
NA WES: ECONOMIC SIT.NEXT 6 MO-OVERALL ECONOMY,NORTH AMERICA	ifo (Germany)	+		
NA WES: ECONOMIC SITUATION - OVERALL ECONOMY, NORTH AMERICA NADJ	ifo (Germany)	+	D1Q	1
WE WES: ECONOMIC SIT.NEXT 6 MO-OVERALL ECONOMY,WESTERN EUROPE	ifo (Germany)	+	LVL	1
WE WES: ECONOMIC SITUATION- OVERALL ECONOMY, WESTERN EUROPE NADJ	ifo (Germany)	+		

Notes: The column "Sign" indicates the imposed sign restriction. The final columns headed "2013-vintage" show those variables and transformations that have been selected by the automated selection procedure in the September 2013 vintage. For the qualitative survey questions "P", "M" and "E" stand for the plus, minus and equal answers, respectively. In case we use the minus answers, the sign restriction is actually the opposite of what is listed. In case the equal answers are used, there is actually no sign restriction imposed. The "B" stands for the balances between plus and minus. "R" stands for answers formulated in terms of reach measured in months. "%" stands for answers formulated in percentages. "D1M" stands for the first monthly difference. "D3M" stands for the difference over a three-months period. "D12M" stands for the difference over a twelve-months period. "D1Q" and "D4Q" stand for the difference over one and four quarters, respectively. In case also "LOG" is mentioned, then the appropriate log difference is taken. "LVL" stands for the level. The final column reports the publication lag in months, if any.

2: In-sample correlation analyses across different vintages

Vintage	# Variables	Correl. with reference series Max	Lead	at lead=0	at lead=6	MCD
2006	233	0.89	1	0.88	0.64	3
2007	214	0.92	1	0.91	0.79	3
2008	202	0.90	2	0.87	0.81	3
2009	297	0.85	0	0.85	0.71	2
2010	224	0.84	1	0.83	0.65	2
2011	209	0.82	1	0.81	0.65	2
2012	227	0.81	1	0.81	0.57	1
2013	219	0.81	1	0.78	0.57	1

Notes: For the 2012 and 2013 vintages, the sample period covers 10 years ending in December before the year of the vintage label. The other vintages start in April 2001. The last column shows the Months-for-Cyclical-Dominance (MCD) measure.

3: Out-of-sample forecast accuracy of the KOF Economic Barometer

	Root Mean Squared Error (RMSE)							Mean Absolute Error (MAE)						
lead	0	1	2	3	4	5	6	0	1	2	3	4	5	6
	Reference series: month-over-month real GDP growth													
Benchmark: Barometer = 100	10.81	10.76	10.80	10.90	11.00	11.20	11.29	8.31	8.23	8.22	8.23	8.21	8.20	8.10
KOF Barometer - Version 2014	0.62	0.71	0.80	0.89	0.98	1.05	1.12	0.64	0.72	0.82	0.91	1.01	1.11	1.22
p-value	0.05	0.09	0.22	0.52	0.91	0.78	0.55	0.03	0.09	0.28	0.65	0.95	0.64	0.39
KOF Barometer - Version 2006	0.86	1.00	1.14	1.26	1.36	1.45	1.53	0.90	1.06	1.20	1.32	1.43	1.56	1.68
p-value	0.44	0.98	0.49	0.25	0.15	0.10	0.07	0.64	0.77	0.39	0.20	0.11	0.06	0.03
KOF Barometer - Version 1998	0.96	1.10	1.24	1.36	1.47	1.56	1.65	1.07	1.22	1.37	1.51	1.65	1.78	1.92
p-value	0.84	0.65	0.33	0.18	0.11	0.07	0.04	0.77	0.36	0.15	0.06	0.03	0.01	0.01
	Reference series: year-on-year real GDP growth													
Benchmark: Barometer = 100	13.60	13.54	13.44	13.28	13.05	12.89	12.81	10.59	10.49	10.40	10.28	10.10	9.99	9.93
KOF Barometer - Version 2014	0.59	0.54	0.52	0.51	0.53	0.58	0.65	0.64	0.59	0.57	0.56	0.57	0.60	0.67
p-value	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.04	0.02	0.02	0.01	0.01	0.01	0.02
KOF Barometer - Version 2006	0.41	0.37	0.38	0.45	0.55	0.67	0.81	0.41	0.38	0.41	0.47	0.58	0.70	0.83
p-value	0.03	0.03	0.02	0.02	0.03	0.06	0.21	0.01	0.01	0.01	0.01	0.03	0.10	0.38
KOF Barometer - Version 1998	0.39	0.36	0.38	0.45	0.56	0.7	0.84	0.42	0.4	0.44	0.5	0.61	0.73	0.86
p-value	0.03	0.03	0.03	0.03	0.05	0.13	0.42	0.01	0.01	0.01	0.03	0.07	0.21	0.55

Notes: The first row in each part shows the RMSE or MAE for the benchmark model in which the KOF Barometer is set to equal its long-run value. All series are normalised to have a mean of 100 and standard deviation of 10 during the in-sample period. All subsequent rows show ratios of the tested KOF Barometer relative to the benchmark model. The p-values are based on the Diebold-Mariano test in which the null hypothesis is that the benchmark and the tested model do not differ regarding forecast accuracy as measured by the RMSE or MAE. The sample January 2006 until December 2012 is used.

4: Out-of-sample forecast accuracy of the quarterly real GDP growth rates

	RMSE			MAE			CW
	AR	ARDL	Ratio	AR	ARDL	Ratio	p-value
				h=0			
KOF Barometer - Version 2014	0.38	0.33	0.86	0.31	0.28	0.90	0.00
KOF Barometer - Version 2006	0.38	0.32	0.83	0.31	0.26	0.84	0.01
KOF Barometer - Version 1998	0.38	0.35	0.91	0.31	0.27	0.87	0.00
				h=1			
KOF Barometer - Version 2014	0.42	0.41	0.95	0.33	0.32	0.97	0.07
KOF Barometer - Version 2006	0.42	0.42	1.00	0.33	0.35	1.07	0.06
KOF Barometer - Version 1998	0.42	0.42	0.99	0.33	0.34	1.02	0.01
				h=2			
KOF Barometer - Version 2014	0.43	0.40	0.94	0.32	0.29	0.89	0.00
KOF Barometer - Version 2006	0.43	0.47	1.09	0.32	0.37	1.15	0.15
KOF Barometer - Version 1998	0.43	0.48	1.12	0.32	0.36	1.13	0.09

Notes: CW - denotes p-values of the Clark and West (2007) test for comparing forecast accuracy of nested models. The null hypothesis is that of equal forecast accuracy.

5: Comparing the first principle components with higher-order ones

Vintage	2006	2007	2008	2009	2010	2011	2012	2013
Principal component	Eigenvalue							
1	57.98	60.58	60.30	82.05	49.77	47.71	53.43	51.73
2	23.42	17.81	14.78	24.12	16.93	15.07	16.02	13.32
3	13.36	11.18	10.46	13.31	8.88	8.17	9.82	8.92
Principal component	Eigenvalue ratio, ER(k)							
1	2.48	3.40	4.08	3.40	2.94	3.17	3.34	3.88
2	1.75	1.59	1.41	1.81	1.91	1.84	1.63	1.49
3	1.08	1.13	1.18	1.14	1.02	1.10	1.11	1.04
Principal component	Max. correlation with reference time series							
1	0.89	0.92	0.90	0.85	0.84	0.82	0.81	0.81
2	0.43	0.25	0.19	0.33	0.47	0.52	0.54	0.58
3	0.49	0.16	0.17	0.29	0.22	0.22	0.12	0.37
Principal component	Opt. lead(+)/lag(-) with reference time series							
1	1	1	2	0	1	1	1	1
2	7	-7	6	6	-7	-7	-7	-7
3	-7	1	0	3	-7	-7	7	6

Notes: All principal components were normalised to have a positive cross-correlation with the reference time series at the lead corresponding to the absolute maximum of the cross-correlation function in the range of 7 lagging to 7 leading months.

6: Out-of-sample forecast accuracy when taking the crisis out of the in-sample period

	Root Mean Squared Error (RMSE)							Mean Absolute Error (MAE)						
lead	0	1	2	3	4	5	6	0	1	2	3	4	5	6
	Reference series: month-over-month real GDP growth													
KOF Barometer - Version 2014	6.02	6.72	7.52	8.36	9.20	10.12	10.99	5.02	5.50	6.05	6.67	7.39	8.21	8.96
excluding 2008M4-2009M3	1.21	1.21	1.20	1.18	1.16	1.13	1.11	1.13	1.16	1.18	1.17	1.15	1.13	1.11
p-value	0.17	0.12	0.09	0.07	0.07	0.08	0.10	0.37	0.23	0.16	0.14	0.13	0.18	0.23
excluding 2008M4-2009M6	1.17	1.17	1.16	1.15	1.14	1.11	1.09	1.10	1.13	1.15	1.14	1.13	1.11	1.09
p-value	0.27	0.20	0.15	0.12	0.11	0.13	0.16	0.45	0.30	0.21	0.19	0.18	0.22	0.26
excluding 2008M7-2009M3	1.25	1.23	1.20	1.18	1.15	1.12	1.10	1.18	1.20	1.21	1.20	1.17	1.14	1.13
p-value	0.10	0.09	0.09	0.09	0.10	0.14	0.18	0.22	0.12	0.07	0.07	0.10	0.13	0.12
excluding 2008M7-2009M6	1.26	1.23	1.20	1.17	1.15	1.13	1.11	1.20	1.21	1.21	1.20	1.17	1.15	1.14
p-value	0.07	0.07	0.08	0.08	0.09	0.11	0.14	0.11	0.08	0.05	0.05	0.07	0.08	0.07
excluding 2008M10-2009M3	1.07	1.05	1.03	1.02	1.00	0.99	0.98	1.02	1.02	1.04	1.04	1.03	1.01	1.01
p-value	0.34	0.53	0.69	0.82	0.97	0.90	0.81	0.87	0.86	0.72	0.66	0.77	0.90	0.93
excluding 2008M10-2009M6	1.02	1.00	0.99	0.98	0.97	0.96	0.96	0.99	0.99	1.01	1.01	0.99	0.99	1.00
p-value	0.83	0.97	0.90	0.81	0.72	0.66	0.64	0.89	0.95	0.94	0.93	0.94	0.88	0.97

Notes: The first row in each part shows the RMSE or MAE for the benchmark model, i.e. the 2014-Version of the KOF Barometer. The reference series is normalised to have a mean of 100 and standard deviation of 10 during the in-sample period. All subsequent rows show the ratios of Versions of the KOF Barometer in which crisis observations were removed relative to the benchmark model. The p-values are based on the Diebold-Mariano test in which the null hypothesis is that the benchmark and the tested model do not differ regarding forecast accuracy as measured by the RMSE or MAE. The sample period used for comparison cover January 2009 until December 2012.