

Allowing composite indicators to learn

An application to the KOF Economic Barometer

Klaus Abberger, Michael Graff, Boriss Siliverstovs and Jan-Egbert Sturm

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Introduction

- Many composite leading indicators exist around the world
 - OECD – Composite Leading Indicators for 47 countries/regions
 - The Conference Board – Leading Economic Indices for 13 countries
 - CEPR/Banca d'Italia – EUROCOIN
 - Many others – mostly at the national level
- Commonalities
 - Reference series needed
 - Selection of variables needed
 - Aggregation method needed
- Relationships and data availability changes over time
 - Once in a while an overhaul is needed
 - This is done at an ad hoc basis and is often time consuming

Construction of the 2014 version

- Objectives
 - No longer use a filter for smoothing by broadening the set of underlying time series
 - Define a standardized procedure to select variables
 - Automate and regularly apply the variable selection procedure
- Three production stages
 - Preparation phase (done once)
 - Choose business cycle concept, define reference series, and define automated selection procedure
 - Variable selection procedure (repeated annually)
 - Pre-select the pool of potential variables
 - Apply the automated selection procedure
 - Calculate the weights using principle component analysis
 - Construction of the leading indicator (repeated monthly)
 - Construct the monthly indicator using the extracted weights

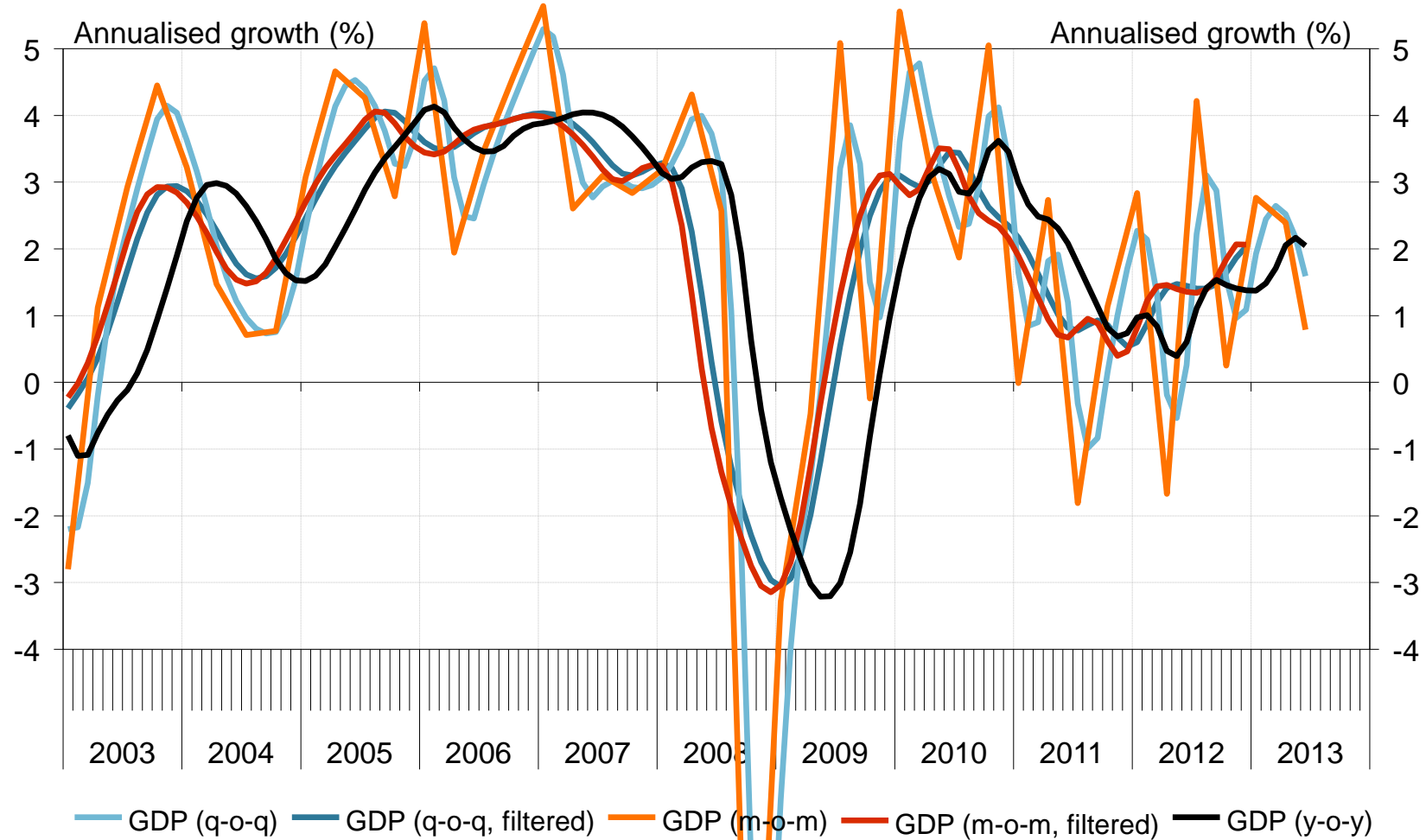
Supervised principal components analysis (SPCA)

- Essentially we apply the aggregation procedure based on SPCA
 - see Bair and Tibshirani (2004), Bair et al. (2006) and Boivin and Ng (2006)
- Rather than extracting common factors from all variables at hand, we specifically focus on a small subset of pre-selected indicators, from which we extract a common component, that are relevant for our reference time series
- We apply a so-called hard thresholding by relying on estimated cross-correlations and retaining only those variables for which a lead, sign and significance of cross-correlations with the target time series exceed the pre-defined threshold

Reference series

- The KOF Barometer is an indicator published monthly
 - The reference series ideally also has a monthly frequency
- Three-steps procedure:
 - Interpolation of s.a. real GDP level using the Denton additive method
 - Calculation of m-o-m growth rates
 - Smoothened using a symmetric 13-months moving average
- Alternative one-step procedure:
 - Kalman filter and smoother as suggested in Mariano and Murasawa (2003)
 - Correlation within 2013 vintage equals 0.976
 - For several earlier GDP vintages we encountered convergence problems of the non-linear numeric optimisation algorithm used in the Kalman filter approach

Potential reference series



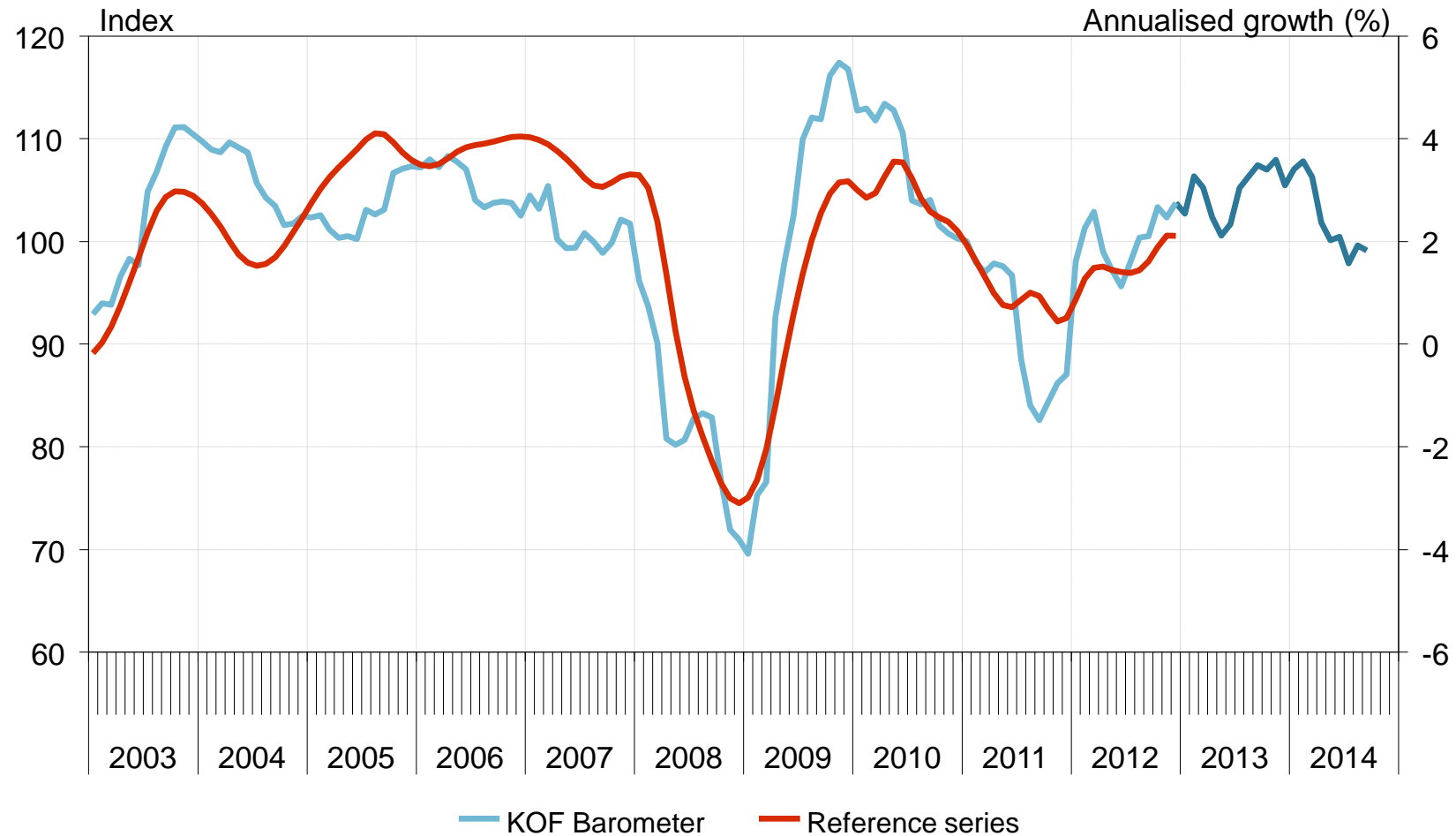
Pre-selection of potential variables (2013 vintage of the 2014 Version)

- International variables: currently 32 variables
 - Concentrate on the 11 most important trading partners
 - 1 Business tendency & 1 consumer survey question per country
 - Ifo World Economic Survey, assessment and expectations for 5 regions
- National variables: currently 444 variables
 - KOF Business Tendency Surveys (411)
 - SECO Consumer Survey (9)
 - BFS, SECO, OZD, SNB (24)
- For each of these variables we determine all
 - sensible transformation (level, log level, quarterly difference, monthly difference, annual difference, balance, positive, negative) (4356)
 - theoretically expected sign of the correlation with the reference series
- Except for year-over-year differences, X12-ARIMA is used to seasonally adjust all variables and their transformations

Automated selection procedure

- A variable has valid observations throughout the defined (10-year) observation window used in the cross-correlation analysis.
- The sign of the cross-correlation complies with the exogenously imposed sign restriction.
- Only those variables are retained, for which the maximum (absolute) cross-correlation is found at the lead range specified between 0 and 6 months.
- The computed cross-correlation surpasses a defined threshold.
- Of those transformations that survive, we take the one that optimizes:
 - $\max U = |r^{\max}| \times \sqrt{h^{\max} + 1}$
- Finally, the variance of these variables is collapsed into a composite indicator as the first principal component.
 - This first principal component is standardised to have a mean of 100 and standard deviation of 10 during the observation window.
 - Dynamic factor analysis approach of Giannone et al. (2008) results in basically the same results
 - Using the 2013 vintage, the correlation equals 0.998

Reference series and KOF Barometer



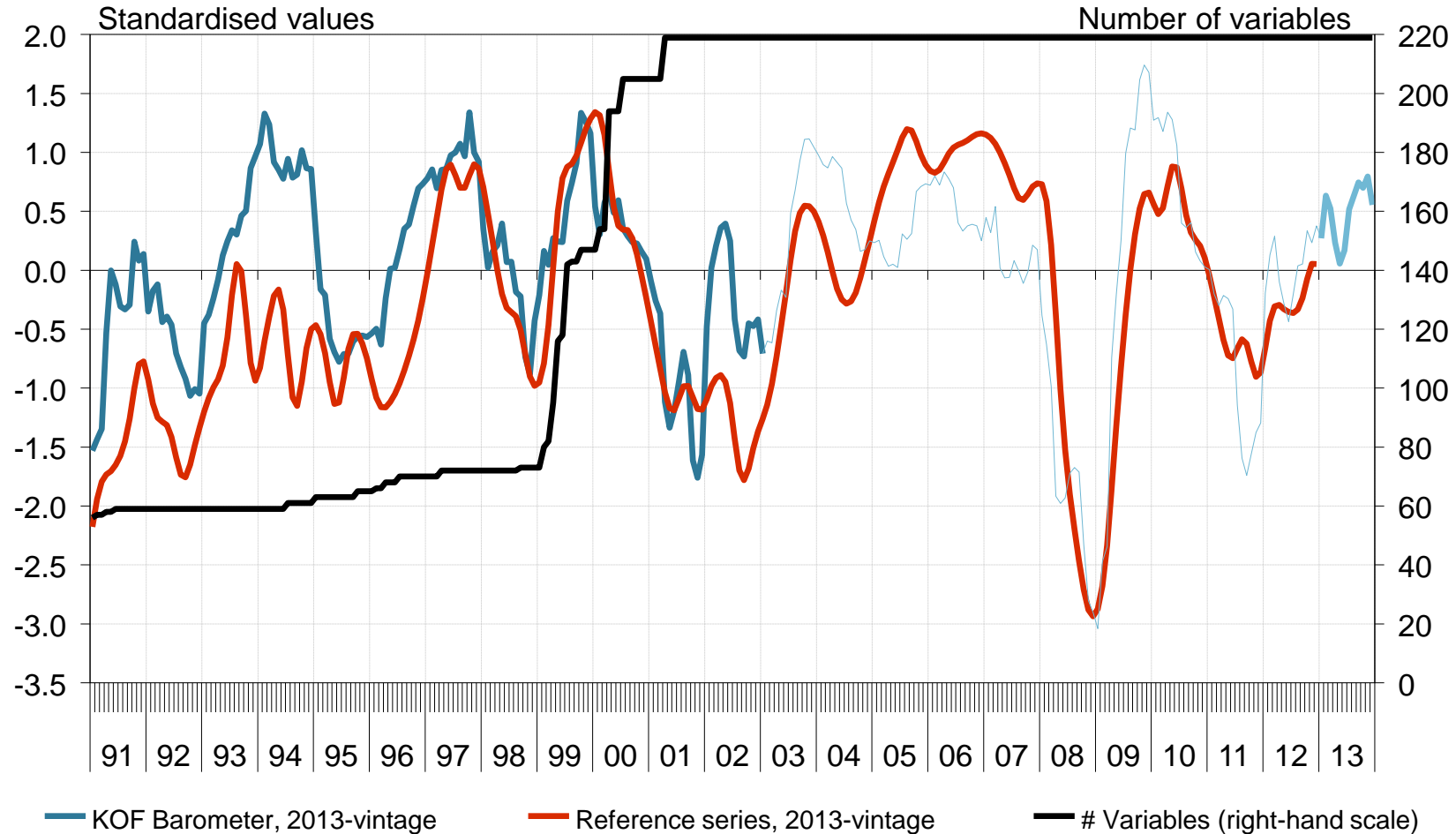
Out of sample production

- Except for year-over-year differences, the seasonal factors are subtracted from all variables and their transformations.
 - The seasonal factors are kept constant until the next vintage 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 the standardised variables with 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.

The construction of new KOF Barometer values before the start of the reference period

- The variable selection procedure is based upon a 10-years window
- To extrapolate a KOF Barometer vintage backwards, the problem of missing data is encountered
 - Both level and variance of the KOF Barometer are distorted
- To deal with this, the Stock and Watson (2002) Expectation Maximisation procedure is applied
 - Missing observations are estimated based on the first principal component
 - A new first principal component is estimated using these estimates
 - This procedure is repeated until it convergences
- (The same procedure is used in real-time when data are missing – this removes a potential bias)

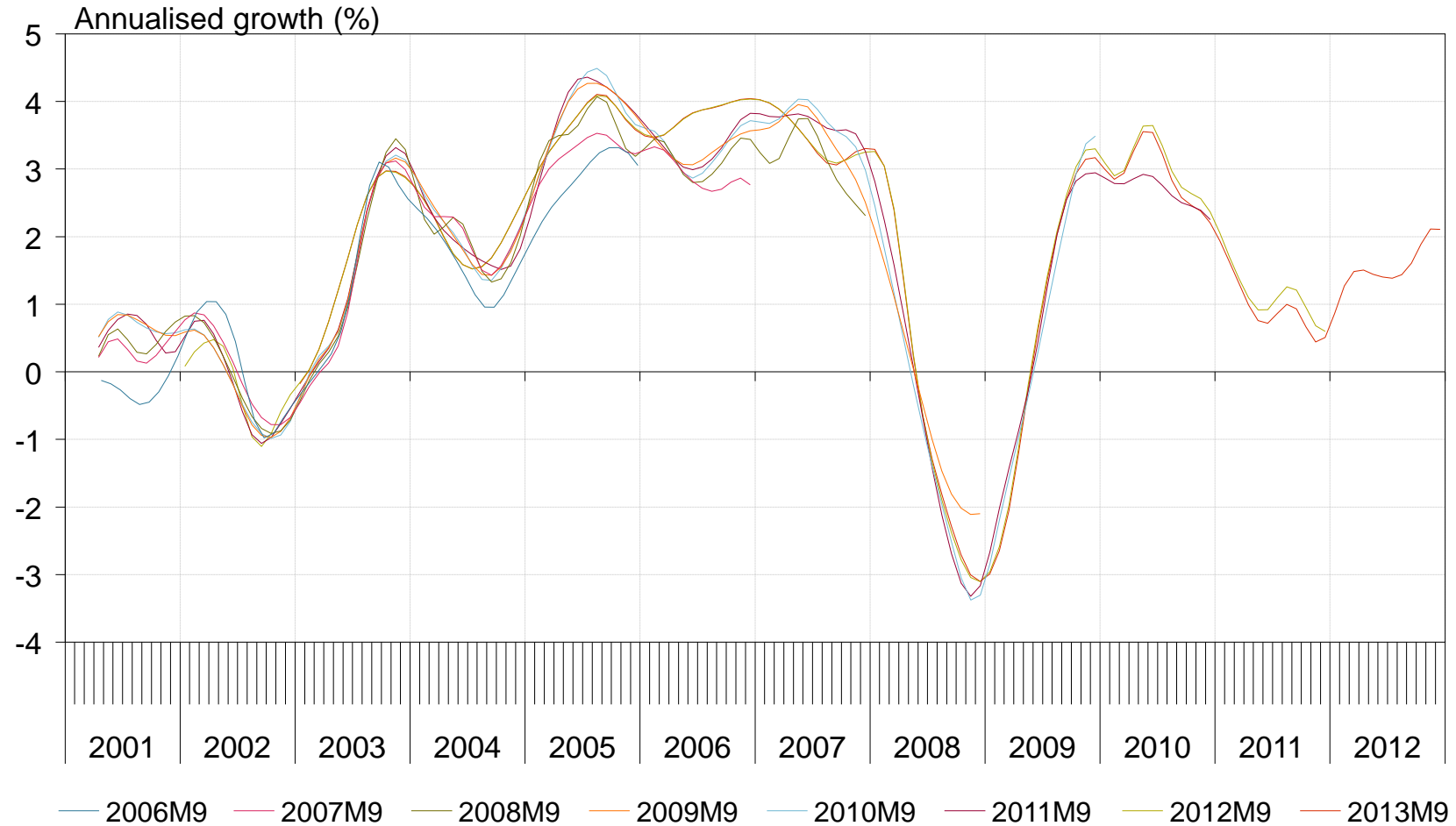
Backward extrapolation of the current KOF Barometer



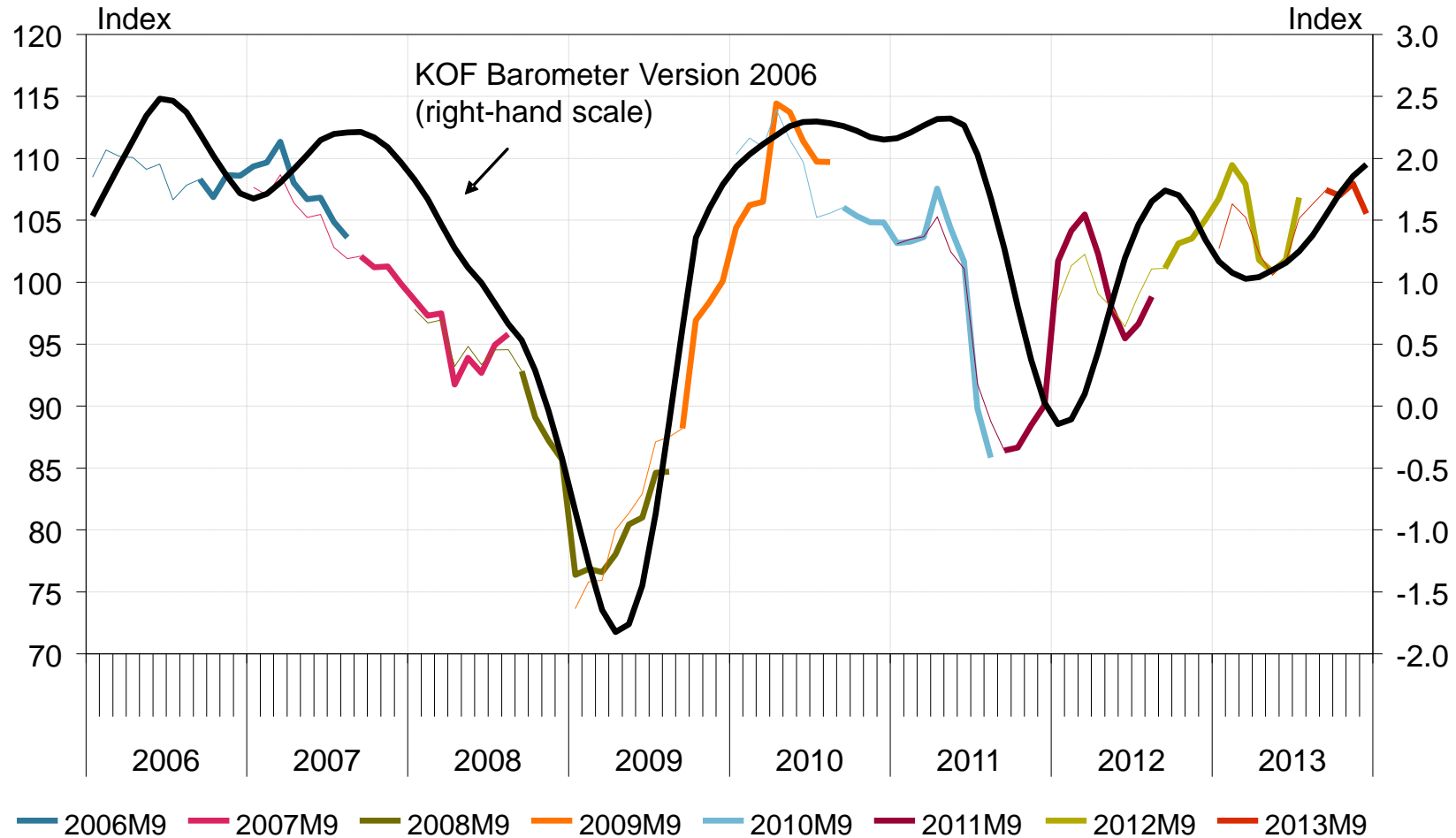
Yearly updates in September

- Swiss quarterly SNA is published by SECO
- Swiss annual SNA is published by SFSO
 - Every summer a new vintage is released
 - This vintage contains the first release of previous year's growth by the SFSO
- The subsequent quarterly release of SECO incorporates this annual information

Different vintages of the reference series



Pseudo real-time vintages of different versions of the KOF Barometer



Reasons for revisions between vintages

1. The 10-year reference window is shifted by one year.
 2. Existing GDP data might be revised.
 3. New variables might become available and some might no longer be published.
- Consequently, the set of variables selected and their loading coefficients might change from one vintage to another.
 - That is, we allow the composite indicator to learn using a largely automatized procedure

In-sample correlations across different vintages

Vintage	# Variables	Correl. with reference series				MCD
		Max	Lead	at lead=0	at lead=6	
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.

Out-of-sample forecast accuracy, m-o-m GDP

lead	Root Mean Squared Error (RMSE)							Mean Absolute Error (MAE)						
	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

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.

Out-of-sample forecast accuracy, y-o-y GDP

lead	Root Mean Squared Error (RMSE)							Mean Absolute Error (MAE)						
	0	1	2	3	4	5	6	0	1	2	3	4	5	6
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.

Conclusions

- Composite leading indicator for the Swiss growth rate cycle
- Principle building blocks
 - Identification of theoretically valid variables with empirically established leads to the reference series
 - Aggregation of these variables into a composite indicator.
- After the release of the annual SNA the KOF Barometer will be updated
 - Reflecting one additional year of information
 - Reflecting revisions in the reference series
 - Reflecting changes in the set of available variables

Comparing the 2006 and 2014 Versions

Version 2006

- Reference series:
 - y-o-y GDP growth
- Variable selection procedure
 - Cross-correlation analysis
 - Expert knowledge
 - Limited # var. selected
 - No updating procedure
- Construction process
 - Principal component analysis
 - Filter to smooth indicator
 - The selected filter assures that only revisions in the underlying variables cause revisions in the KOF Barometer

Version 2014

- Reference series:
 - smoothed m-o-m GDP growth
- Variable selection procedure
 - Cross-correlation analysis
 - Automated selection process
 - Large # var. selected
 - Updated yearly
- Construction process
 - Principal component analysis
 - No filtering
 - Only data revisions in the underlying variables cause revisions in the KOF Barometer (within a vintage)

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