The Use of the Sentiment Economic Indicator for GDP Short-term Forecasting: Evidence from EU Economies

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Abstract

The paper presents a quantitative analysis of the possibilities of Sentiment Economic Indicator based on the joint harmonized EU programme of business and consumer surveys to forecast quarterly GDP growths as a result of the publication lag of the data on GDP. We construct ARMAX models in some cases augmented by the GARCH models to capture the relationship between quarterly changes in GDP and the Sentiment Economic Indicator. The models show some forecasting power of the indicator for approximately half the sample. We show that only for some of the models the forecasting power of the ARMAX / GARCH models actually beats that of a simple ARMA model. We also show that the turbulences in 2007–2008 had a detrimental impact on the relationship between the Indicator and GDP. With the use of the results of rolling forecasts we run a panel regression to test whether or not the forecast errors are dependent on the magnitude of the quarterly changes in GDP. In the applied sample we have found out that the forecasting errors are not dependent on this factor.

Keywords	***JEL code***
Business cycle, forecasting error analysis, short-term GDP forecasting, sentiment economic indicator	*C22, E32, E37*

INTRODUCTION

The paper follows up on the discussion on short-term GDP forecasting, which, as we show shortly, has seen several contributions from the point of view of the Czech economy in the last few years.

Typically, the analyses focus on employing time series of data from the real economy or business and consumer surveys to construct composite indicators, which might hopefully possess the ability to forecast GDP or output gap from a short-term perspective. The issues related to the construction of composite

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leading indicators were discussed by Czesaný and Jeřábková (2009a) with the application in Czesaný and Jeřábková (2009b) where GDP is taken as a reference series to capture the cyclical behavior of the economy. Pošta and Valenta (2011) introduced the practice of how composite leading indicators are constructed at the Ministry of Finance where only data from business survey are used. As opposed to Czesaný and Jeřábková (2009b) output gap is used as a reference series. Both papers share a common feature: they do not use the indicators for quantitative output gap forecasting. Svatoň (2011) constructs several composite leading indicators based on data both on real and financial economy and confidence survey. He performs both qualitative and quantitative analysis. Arnoštová et al. (2011) also present a quantitative analysis in an attempt to assess forecasting capacity of several econometric models using especially data on real and financial economy. Benda and Růžička (2007) develop short-term forcasting methods based on the leading indicator approach. They use a set of econometric models (PCA, SURE) that provide estimates of GDP growth for the Czech economy for a co-incident quarter and a few quarters ahead. Their tests show relatively accurate forecasts of GDP fluctuations in the short run. Angelini et al (2008) exploit timely monthly releases of sentiment indicators to compute early estimates of current quarter GDP in the euro area. They also show that survey data and other soft informations are valuable for now-casting GDP.

Adamovicz and Walczyk (2011) examine business cycle in a new EU member states by analysing gross value added and economic sentiment indicator. They observe progressive synchonization of cyclical fluctuations between old and new EU member states. Only higher intensity of cyclical changes has been observed in new EU member.

Gelper and Croux (2009) compare the ESI (further info below) with more sophisticated aggregation schemes that are based on two statistical methods – dynamic factor analysis and partial least squares. The partial least squares method outperforms the other methods, but the ad hoc way of construction ESI can be fully competitive with statistical principles.

Giannone, Reichlin and Simoneli (2009) show that aggregate surveys can produce an accurate early estimate of GDP.

In this paper we focus on the relationship between confidence indicators published by the authorities (the indicators used in the paper will be specified below) and quarterly changes in GDP. The goal of the paper is not a construction of leading indicators in the right sense of the word but rather the examination of the possible use of the fact that the indicators for a given period of time are published sooner than national account data for the same period. It follows that such a publication lag of national accounts behind confidence indicators might be used for forecasting purposes; in this case for a backward forecast – backward in the sense that it is the past which is forecasted, yet unpublished though. We use confidence indicators published at the EU level, therefore, we extend the analysis to basically all EU economies (exceptions due to insufficient data are mentioned below).

We show that in approaximately half the sample it is possible to build a simple model that gives statistically relevant results; i.e. is statistically significant, shows significant forecasting power and stability over time. After the models are built and their forecasting power examined, we investigate the sensitivity of forecasting errors to the magnitude of quarterly changes in GDP. In other words, we examine to which degree the forecasting power of the models is influenced by the instability of the dependent variable. A panel is set up and by means of regression we show that in the sample considered in the paper the sensitivity of forecasting errors to quarterly changes in GDP is statistically insignificant. However, we also estimate the models only up to 2006 and show the forecasting power of the models was higher in most cases.

The paper is divided into three parts: first, the econometrical model and data and its properties are discussed, second, we present the results in the form of the estimated models and their characteristics and also the results of the sensitivity test. Finally, we conclude the key findings.

1 METHODOLOGY AND DATA

1.1 Methodology

To assess the forecasting capacity of the sentiment indicators, simple models are constructed. Each model uses as a starting point a regression between quarterly changes in GDP and the sentiment indicator. As is shown below in the results of the paper, in most cases the diagnostics render the results of such regression tests irrelevant as high autocorrelation between residuals and remaining heteroskedasticity in the residuals are present. As a first step we impose ARMA structure on the original regression model, i.e.:

$$GDP_t = \alpha + \beta IND_t + \varepsilon_t\,, \tag{1}$$

$$\varepsilon_t = \rho\varepsilon_{t-1} + \eta_t + \theta\eta_{t-1}, \tag{2}$$

where *GDP* denotes quarterly changes in GDP, α is an intercept, β is a regression coefficient, *IND* denotes sentiment indicator, ε is the residuals of the regression equation and η is the residuals of the ARMA equation, ρ and θ are coefficients of the ARMA equation. The additional ARMA structure is presented as ARMA (1,1) in (2) as no higher lags were used (see below).

As one can see below some models with the structure described by (1) and (2) still showed remaining heteroskedasticity in the residuals. Therefore we used ARCH / GARCH model:

$$h_t = \gamma + \delta_1\varepsilon_{t-1}^2 + \delta_2 h_{t-1}\,, \tag{3}$$

where h is the variance of the residuals from (1), γ is a constant and $\delta_{1,2}$ are estimated coefficients of the GARCH equation. In most cases the problem with remaining heteroskedasticity is solved by the simple ARCH / GARCH model.

To assess the relation between forecasting errors and magnitude of quarterly changes in GDP we run a panel regression estimated by the two-stage least squares as a special case of instrumental variables regression. We give additional information on this part of analysis below.

1.2 Data

We use Economic Sentiment Indicator (ESI) published by the European Commission as a composite confidence indicator. ESI consists of six particular confidence indicators where each of them is composed of three questions. The result is calculated as a simple arithmetic average of the seasonally adjusted balances to specific questions. European Commission manual (2007) informs that business and consumer surveys provide monthly judgements and anticipations concerning diverse facets of economic activity in the different sectors of the economy. Each sector has explicit weight for ESI final compilation: industry (40% weight), services (30%), construction (20%) and retail trade (5%), as well as consumers (5%). The indicators are further standardized according to their mean level and volatility before aggregation. The process of ESI compilation is further described in the mentioned manual. ESI is available on monthly basis so we create simple quarterly average in order to compare it with quarterly GDP. We consider this way as more accurate than decomposition of quarterly GDP to monthly basis through quadratic polynom or any other mathematical method. ESI series are seasonally adjusted by Danties alghoritm described in the European Commission manual (2007). Quarterly seasonally adjusted GDP series are taken directly from Eurostat.

We use as long time series of ESI and GDP as available. For Belgium, Denmark, Germany, France, Italy, Finland, Netherlands and United Kingdom the data are accessible since 1991Q1. For European Union (27 member states), Bulgaria, Czech Republic, Estonia, Spain, Latvia, Lithuania, Luxembourg, Hungary, Austria, Poland, Portugal, Slovenia, Slovak Republic and Sweden the sample starts between 1993Q1 and 1997Q1. And for Greece and Romania the data are available since 2001Q1. The sample ends in 2011Q3 for all. We do not include Malta and Cyprus in the sample as the series available for these two economies are too short. Ireland is excluded as the indicator is not published for this economy at all.

Table 1 Crosscorrelogram between ESI and quarterly GDP growth

Lag / Economy	AT	BE	BG	CZ	DE	DK	EE	EL	ES	EU
0	0.5050	0.2762	0.2705	0.6561	0.4594	0.3531	0.5288	0.5696	0.8970	0.7346
1	0.2931	0.1240	0.1343	0.4409	0.2485	0.1999	0.3987	0.5304	0.8555	0.4644
2	0.1066	–0.0105	0.0568	0.2012	0.0534	0.0709	0.1900	0.4783	0.7634	0.1836
3	–0.0126	–0.0931	–0.0572	0.0348	–0.0884	–0.0493	0.0361	0.3889	0.6534	–0.0051
4	–0.1276	–0.1568	–0.0383	–0.0426	–0.1827	–0.0833	–0.0869	0.3165	0.5355	–0.1221
5	–0.2552	–0.2771	–0.1038	–0.0837	–0.2176	–0.1671	–0.1157	0.3432	0.4299	–0.1972
6	–0.3517	–0.3169	–0.0703	–0.0843	–0.2153	–0.0055	–0.1428	0.3006	0.3500	–0.2232
7	–0.3787	–0.3018	–0.1125	–0.0765	–0.2012	–0.0955	–0.2479	0.2178	0.2976	–0.2068
8	–0.3309	–0.2691	–0.1306	–0.0603	–0.1325	–0.1035	–0.2937	0.1383	0.2527	–0.1746
9	–0.2553	–0.1946	–0.0990	–0.0328	–0.0918	–0.1293	–0.2688	0.0334	0.2307	–0.1431
10	–0.1965	–0.1293	–0.1243	–0.0193	–0.0714	–0.1407	–0.2151	0.0177	0.1977	–0.0977
Lag / Economy	**FI**	**FR**	**HU**	**IT**	**LT**	**LU**	**LV**	**NL**	**PL**	**PT**
0	0.6063	0.5652	0.7475	0.5141	0.4763	0.2841	0.5067	0.5766	0.3009	0.5727
1	0.4124	0.3100	0.5507	0.3154	0.3289	0.1945	0.4235	0.3776	0.2011	0.3984
2	0.2335	0.0662	0.3862	0.0876	0.1396	0.1204	0.2854	0.1803	0.1276	0.2991
3	0.0768	–0.0889	0.2605	–0.0557	0.0218	–0.0074	0.1551	0.0542	0.1424	0.2100
4	0.0066	–0.161	0.1935	–0.1490	–0.1101	0.0082	0.1041	–0.0152	0.0366	0.1590
5	–0.0514	–0.2005	0.2095	–0.2137	–0.2237	0.0033	–0.0636	–0.1029	–0.0555	0.1077
6	–0.1592	–0.2411	0.2145	–0.1904	–0.2303	0.0265	–0.1190	–0.1395	–0.0321	0.1590
7	–0.1082	–0.2363	0.254	–0.1655	–0.2002	0.0533	–0.1735	–0.1715	0.0982	0.1734
8	–0.0890	–0.2204	0.2187	–0.1333	–0.2307	–0.0002	–0.1787	–0.2076	–0.0245	0.1476
9	–0.0901	–0.1621	0.1721	–0.0865	–0.2474	0.0633	–0.1761	–0.2142	–0.0284	0.1433
10	–0.0539	–0.1201	0.0963	–0.0856	–0.1914	–0.0052	–0.1733	–0.2017	–0.0273	0.0976
Lag / Economy	**RO**	**SE**	**SI**	**SK**	**UK**					
0	0.6906	0.4646	0.4230	0.4839	0.6015					
1	0.5165	0.2724	0.1913	0.3656	0.4106					
2	0.3287	0.0455	0.0162	0.1368	0.2158					
3	0.2385	–0.1668	0.0261	0.0807	0.0516					
4	0.1283	–0.3114	–0.0604	0.0658	–0.0498					
5	0.0656	–0.3904	–0.1179	0.0603	–0.1389					
6	–0.0226	–0.3791	–0.1470	–0.0711	–0.1505					
7	–0.1079	–0.3242	–0.1303	–0.0343	–0.0950					
8	–0.1390	–0.2465	–0.0835	–0.0202	–0.0418					
9	–0.1532	–0.2254	–0.1067	–0.0467	–0.0073					
10	–0.0945	–0.1986	–0.1391	0.0014	0.0525					

Notes: AT – Austria, BE – Belgium, BG – Bulgaria, CZ – Czech Republic, DE – Germany, DK – Denmark, EE – Estonia, EL – Greece, ES – Spain, EU – EU27, FI – Finland, FR – France, HU – Hungary, IT – Italy, LT – Lithuania, LU – Luxembourg, LV – Latvia, NL – Netherlands, PL – Poland, PT – Portugal, RO – Romania, SE – Sweden, SI – Slovenia, SK – Slovak Republic, UK – United Kingdom.
Source: Own construction

Table 1 shows crosscorrelogram between ESI and quarterly GDP growth. The goal is to capture correlation of lagging values of ESI and quarterly GDP growth. The correlation between the first lagged value of ESI and quarterly GDP growth is in most countries weaker than correlations at zero lag. Only in case of Spain there is a significant correlation at the first lag. Correlation on further lags generally decline steeply. This implies that the ESI should not be considered as a leading indicator with respect to the reference series, but just for publication lead estimation. Simply we try to estimate last unpublished quarterly GDP due to three month lead of ESI against the release of GDP figures. For instance at the end of March we are able to estimate the first quarter of the respective year.

Table 2 Descriptive statistics for quarterly changes in GDP and ESI

Economy	**AT**		**BE**		**BG**		**CZ**		**DE**	
Variable	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**
Mean	0.50334	99.38849	0.60626	99.85992	1.0932	101.0267	0.6606	99.97846	0.32185	99.64008
St. dev.	0.174	9.44644	1.44761	9.90138	2.62675	8.62944	0.92579	10.27073	0.86046	9.45436
JB	3.81443	5.73540*	7968.853***	6.48908***	243.0699***	2.28921	65.93284***	6.31443**	193.0991***	4.40877
ADF	–4.54643***	–5.17664***	–7.60870***	–4.70014***	–9.80467***	–2.54299	–3.27821**	–2.72152*	–6.65010***	–4.75715***
Economy	**DK**		**EE**		**EL**		**ES**		**EU**	
Variable	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**
Mean	0.39822	100.1151	1.24972	101.9961	0.46612	96.3625	0.63788	101.725	0.46342	101.775
St. dev.	1.27505	10.30605	2.32503	9.08649	1.24811	14.27416	0.60867	9.11274	0.59362	9.12546
JB	0.51448	10.09949***	108.3591***	11.96403	1.17308	4.08061	48.64879	16.08724***	430.9949***	35.83318***
ADF	–10.50847***	–3.49219**	–4.79861***	–2.62703*	–4.52401***	–2.93646	–2.69189*	–3.36834*	–3.28124**	–4.62151***
Economy	**FI**		**FR**		**HU**		**IT**		**LT**	
Variable	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**
Mean	0.57304	100.5909	0.39494	99.99127	0.53862	100.3776	0.22818	99.62302	1.29555	101.3358
St. dev.	1.27522	9.70815	0.49898	9.91404	0.86687	10.77312	0.67291	9.84491	2.52831	9.31165
JB	275.1786	7.55500**	71.18633***	4.47011	132.3869***	40.55382***	212.9857***	2.09329	770.3447***	6.26799**
ADF	–6.18702***	–5.20137***	–4.77740***	–4.35765***	–3.37641**	–3.04019**	–5.17599***	–3.72686***	–6.61743***	–2.85700*
Economy	**LU**		**LV**		**NL**		**PL**		**PT**	
Variable	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**
Mean	0.91797	100.9564	1.14458	101.5216	0.55382	99.74683	1.10456	99.02402	0.41026	99.05539
St. dev.	1.94012	9.82075	2.64071	9.07031	0.66733	9.99059	1.07451	9.72421	0.8619	10.62156
JB	15.69461***	1.7023	140.1597***	8.54669**	54.54470***	4.54595	200.5571***	2.23399	1.41433	2.96888
ADF	–9.76718***	–4.58983***	–3.18975**	–2.91196**	–5.30342***	–3.79204***	–8.99316***	–2.78849*	–6.15051***	–3.27243*
Economy	**RO**		**SE**		**SI**		**SK**		**UK**	
Variable	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**	**GDP**	**Indicator**
Mean	0.99218	100.4879	0.70053	102.7693	0.82641	99.7607	1.0147	100.3589	0.55143	100.219
St. dev.	1.23958	9.34202	0.93836	8.41717	1.32223	9.54855	1.96844	9.45547	0.68068	9.70783
JB	18.60828***	6.51712**	358.0559***	2.08377	308.6994***	14.84725***	251.2445***	25.59141***	148.3592***	27.39304***
ADF	–3.15157**	–3.39622*	–5.70936***	–5.76801***	–5.22250***	–3.61689***	–8.21872***	–3.02248**	–3.42824**	–3.996512***

Note: JB is Jarque-Bera statistic under the null of normal distribution. ADF is augmented Dickey-Fuller statistic under the null of unit root. (*, **, *** denote rejection of the null at 10%, 5% and 1% level of significance, respectively).
Source: Own construction

We are not able to run the analysis with flash estimates of GDP as that would require having the actual series of GDP for each flash available. However, the older "versions" of GDP series are not published by Eurostat or national statistical offices. It would not make sense to use flash estimates of GDP together with current GDP series.

Descriptive statistics for quarterly changes in GDP and ESI are reported in Table 2. It shows mean value, standard deviation, Jarque-Bera test of normality of the distribution and augmented Dickey-Fuller unit root test. The series may be considered stationary, which is important information for further analysis.

Table 3 Crosscorrelogram between ESI and quarterly GDP growth

Economy	AT	BE	BG	CZ	DE	DK	EE	EL	ES	EU
C	−1.26698 (0.8901)	−3.388918** (1.56185)	−6.41191** (2.52063)	−3.46152** (1.61983)	−2.50689*** (0.78382)	−4.23072*** (1.14555)	−12.38281*** (1.99813)	−4.90125*** (1.20542)	−5.46661*** (0.41003)	−2.24381* (1.20465)
Indicator	0.01776** (0.00891)	0.03997** (0.01555)	0.07386*** (0.02481)	0.04146*** (0.01504)	0.02910*** (0.00779)	0.04585*** (0.01131)	0.13299*** (0.02141)	0.05497*** (0.01224)	0.06006*** (0.00392)	0.02736** (0.01155)
AR(1)	0.30245** (0.12077)	x	x	0.76575*** (0.12762)	x	−0.25333** (0.10875)	0.23567 (0.14506)	x	0.23292 (0.14576)	0.35333 (0.22360)
MA(1)	0.93069*** (0.037661)	x	−0.37008*** (0.12437)	x	x	x	x	x	x	x
C	x	x	x	0.11292*** (0.02621)	0.31467*** (0.7300)	x	2.71110*** (0.17345)	x	0.05388*** (0.01634)	0.06746*** (0.13168)
ARCH(1)	x	x	x	0.69929*** (0.25594)	0.44078** (0.17394)	x	−0.03035*** (0.01070)	x	0.18619 (0.23694)	0.39433** (0.16531)
GARCH(1)	x	x	x	x	x	x	x	x	x	x
R–sq	0.7019	0.076297	0.187455	0.559372	0.185447	0.191255	0.32727	0.324395	0.81749	0.586497
F–stat	60.4349***	6.607926**	6.344299***	17.77289***	5.91936***	9.222893***	7.29703***	20.16652***	67.18626***	21.27542***
AIC	0.80661	3.534856	4.647843	1.547553	2.205431	3.182087	4.22863	2.956912	0.26	0.673153
JB	0.46563*	8605.571***	348.6318***	1.45999	0.58369	1.45968	223.1742***	5.32046*	1.50437	2.97913
ARCH LM	3.00906*	0.01267	0.8091	0.4812	0.57037	0.41473	0.10408	0.03499	0.15266	0.0065
Q–stat	0.2913	1.0428	0.1379	1.412	0.8286	0.005	0.2074	0.0176	0.227	0.9993
MRSE	0.34472	1.38279	2.34728	0.61405	0.77184	1.14461	1.90503	1.01416	0.25953	0.38167
TC	0.22434	0.60484	0.54656	0.28008	0.55697	0.5733	0.42583	0.46903	0.1497	0.27595
MRSE (ARMA)	0.34738	1.42915	2.51385	0.67443	0.81978	1.24519	2.05482	1.05621	0.31015	0.41984
TC (ARMA)	0.22659	0.64602	0.61331	0.32929	0.61662	0.69463	0.47660	0.51866	0.18132	0.30497
MRSE (2006)	0.29565	1.42915	1.94946	0.34886	0.63595	1.10807	1.69540	0.95395	0.26392	0.23811
TC (2006)	0.21487	0.64602	0.35778	0.16333	0.54908	0.50903	0.39923	0.39822	0.14169	0.17943

Note: Sample ends in 2011Q3 and starts according to the information given in part 2. Dependent variable: quarterly changes in GDP. Independent variable: sentiment indicator ESI (denoted as indicator). C denotes a constant in the regression or GARCH specification. AR(1) stands for autoregressive term with 1 lag. MA(1) stands for moving average term with 1 lag. ARCH(1) stands for squared residuals from the regression delayed by 1 lag. GARCH(1) stands for variance of the residuals from the regression delayed by 1 lag. Estimates of the coefficients with standard errors in parenthesis are given. R-sq denotes the coefficient of determination. F-stat is a statistic of an F-test under the null of slope coefficients equal to 0. AIC is the value of Akaike information criterion. JB is Jarque-Berra statistic for the residuals under the null of normal distribution. ARCH LM test is the Engle's LM statistic under the null of no remaining ARCH in the residuals. Q-stat is the Ljung-Box statistic under the null of no autocorrelation of the residuals. MRSE is a root mean square error. TC is Theil inequality coefficient. MRSE (ARMA) and TC(ARMA) give the statistics for simple ARMA models used as a baseline for comparison with the ARMAX models. MRSE (ARMA) and TC(ARMA) give the statistics for models estimated up to 2006Q4 and used for forecast the GDP up to 2006Q4. (*, **, *** denote rejection of the null at 10%, 5% and 1% level of significance, respectively).
Source: Own construction

2 RESULTS

First, we present the estimated models used for the fore-WWcasting exercise. Referring back to part 1 of the paper, a simple regression model with quarterly changes in GDP as the dependent and ESI as the independent variable was estimated for each economy. Based on the analysis of the residuals, ARMA structure was imposed or, further, ARCH / GARCH specification was used to meet the standard conditions for the behavior of the residuals. Tables 3 to 5 give the results.

The ARCH LM test and Q statistic are given for the first relevant lag of the residuals. We checked the remaining autocorrelation and ARCH up to 5 additional lags, but we do not report the results here.

We were able to use the basic regression model only in four cases: Belgium, Greece, Lithuania and Portugal. Even after the complete procedure we could still find some remaining ARCH in some cases: Austria, Hungary, Portugal (here applying ARMA or GARCH structure did not result in well-behaved residuals) and Romania. In some cases we did not obtain normal residuals.

Table 4 Model Output

Economy	FI	FR	HU	IT	LT	LU	LV	NL	PL	PT
C	−5.24922*** (1.04907)	−2.71905*** (0.68274)	−4.30388*** (0.81815)	−2.37217** (0.97666)	−11.6349*** (2.99716)	−5.79568*** (1.82260)	−19.9478*** (1.97156)	−3.68076*** (0.74801)	−2.04585** (0.85174)	−4.36442*** (0.85875)
Indicator	0.05884*** (0.01031)	0.03092*** (0.00677)	0.04859*** (0.008215)	0.02647*** (0.00979)	0.12771*** (0.02947)	0.06700*** (0.01805)	0.20281*** (0.02056)	0.04118*** (0.00761)	0.03193*** (0.00818)	0.04807*** (0.00860)
AR(1)	x	0.40409*** (0.10621)	0.39961*** (0.13618)	0.38126** (0.16468)	x	−0.31899*** (0.11749)	x	0.36097*** (0.10967)	x	x
MA(1)	x	x	x	x	x	x	x	x	x	x
C	0.57549*** (0.12119)	x	0.00223** (0.00098)	2.25415*** (0.08394)	x	x	2.66883*** (0.51945)	0.00546*** (0.00042)	1.69912*** (0.10234)	x
ARCH(1)	0.45276*** (0.15036)	x	−0.06372*** (0.00481)	x	x	x	0.53861* (0.27527)	−0.08649*** (0.01554)	0.30418*** (0.03772)	x
GARCH(1)	x	x	1.08570*** (0.00141)	−0.32734 (0.21368)	x	x	x	1.05616*** (0.01875)	−1.00808*** (0.01401)	x
R–sq	0.33151	0.451095	0.622797	0.341137	0.226841	0.202123	0.184983	0.379109	0.09025	0.32801
F–stat	12.89365***	32.05061***	18.49226***	7.766487***	18.77729***	7.853087***	4.690663***	9.158839***	1.512842	31.2395***
AIC	2.767692	0.911874	1.510904	1.580785	4.481044	4.013098	4.483328	1.386499	2.534005	2.188474
JB	3.99920	3.30805	2.35082	0.28319	607.131***	3.26329	19.1743***	2.27187	112.8966***	1.10558
ARCH LM	1.99664	0.09952	2.76048*	0.34943	0.14655	1.93726	0.95544	0.54316	0.26389	2.964639*
Q–stat	0.4784	0.7504	0.2766	0.0814	0.1507	0.0051	0.0778	0.0123	0.2871	0.3219
MRSE	1.03539	0.36787	0.52788	0.54165	2.20622	1.71851	2.36586	0.52270	1.01708	0.70117
TC	0.44817	0.31432	0.27472	0.45949	0.48104	0.50537	0.49119	0.34043	0.37836	0.44165
MRSE (ARMA)	1.14451	0.40666	0.45578	0.57669	2.45599	1.85853	2.40969	0.58248	1.02449	0.65853
TC (ARMA)	0.52646	0.36470	0.23144	0.51499	0.58079	0.58981	0.55162	0.39015	0.38179	0.42418
MRSE (2006)	0.77169	0.30652	0.33222	0.47206	1.85347	1.74527	1.89518	0.47530	1.09894	0.70613
TC (2006)	0.36692	0.26114	0.17146	0.43110	0.41892	0.44533	0.42364	0.30989	0.37916	0.41332

Note: Sample ends in 2011Q3 and starts according to the information given in part 2. Dependent variable: quarterly changes in GDP. Independent variable: sentiment indicator ESI (denoted as indicator). C denotes a constant in the regression or GARCH specification. AR(1) stands for autoregressive term with 1 lag. MA(1) stands for moving average term with 1 lag. ARCH(1) stands for squared residuals from the regression delayed by 1 lag. GARCH(1) stands for variance of the residuals from the regression delayed by 1 lag. Estimates of the coefficients with standard errors in parenthesis are given. R-sq denotes the coefficient of determination. F-stat is a statistic of an F-test under the null of slope coefficients equal to 0. AIC is the value of Akaike information criterion. JB is Jarque-Berra statistic for the residuals under the null of normal distribution. ARCH LM test is the Engle's LM statistic under the null of no remaining ARCH in the residuals. Q-stat is the Ljung-Box statistic under the null of no autocorrelation of the residuals. MRSE is a root mean square error. TC is Theil inequality coefficient. MRSE (ARMA) and TC(ARMA) give the statistics for simple ARMA models used as a baseline for comparison with the ARMAX models. MRSE (ARMA) and TC(ARMA) give the statistics for models estimated up to 2006Q4 and used for forecast the GDP up to 2006Q4. (*, **, *** denote rejection of the null at 10%, 5% and 1% level of significance, respectively).
Source: Own construction

Table 5 Model Output

Economy	RO	SE	SI	SK	UK
C	−7.42885*** (2.73306)	−3.55915*** (1.12650)	−7.69975*** (1.63584)	−8.58374*** (1.13051)	−2.02008** (0.98265)
Indicator	0.08364*** (0.02404)	0.04284*** (0.01076)	0.08333*** (0.01659)	0.095521*** (0.01120)	0.02668*** (0.00961)
AR(1)	0.47689*** (0.16605)	x	0.25803* (0.13192)	x	x
MA(1)	x	x	x	-0.56334*** (0.11203)	0.48370*** (0.09113)
C	x	0.06518 (0.08144)	0.17703*** (0.06470)	x	0.11180*** (0.03871)
ARCH(1)	x	0.31997 (0.22946)	0.13463 (0.09410)	x	0.444902* (0.22837)
GARCH(1)	x	0.65991*** (0.25148)	0.64937*** (0.07686)	x	x
R-sq	0.586361	0.180101	0.210332	0.413086	0.526823
F-stat	27.6426***	3.789179***	3.142988**	19.35522***	21.43243***
AIC	2.584985	2.436198	3.08135	3.745541	1.203095
JB	1.31397	35.9437***	32.44813***	51.08552***	1.64484
ARCH LM	4.86597**	0.37678	0.78657	0.294868	0.00026
Q-stat	0.0131	0.003	0.3694	0.0063	0.5124
MRSE	0.82047	0.84391	1.17479	1.49497	0.46536
TC	0.27219	0.40372	0.4417	0.3998	0.28917
MRSE (ARMA)	0.87125	0.86054	1.21811	1.95140	0.43776
TC (ARMA)	0.30006	0.43898	0.47911	0.60626	0.26745
MRSE (2006)	0.59859	0.56677	0.85604	0.96861	0.33376
TC (2006)	0.19022	0.31682	0.33418	0.27179	0.21502

Note: Sample ends in 2011Q3 and starts according to the information given in part 2. Dependent variable: quarterly changes in GDP. Independent variable: sentiment indicator ESI (denoted as indicator). C denotes a constant in the regression or GARCH specification. AR(1) stands for autoregressive term with 1 lag. MA(1) stands for moving average term with 1 lag. ARCH(1) stands for squared residuals from the regression delayed by 1 lag. GARCH(1) stands for variance of the residuals from the regression delayed by 1 lag. Estimates of the coefficients with standard errors in parenthesis are given. R-sq denotes the coefficient of determination. F-stat is a statistic of an F-test under the null of slope coefficients equal to 0. AIC is the value of Akaike information criterion. JB is Jarque-Berra statistic for the residuals under the null of normal distribution. ARCH LM test is the Engle's LM statistic under the null of no remaining ARCH in the residuals. Q-stat is the Ljung-Box statistic under the null of no autocorrelation of the residuals. MRSE is a root mean square error. TC is Theil inequality coefficient. MRSE (ARMA) and TC(ARMA) give the statistics for simple ARMA models used as a baseline for comparison with the ARMAX models. MRSE (ARMA) and TC(ARMA) give the statistics for models estimated up to 2006Q4 and used for forecast the GDP up to 2006Q4. (*, **, *** denote rejection of the null at 10%, 5% and 1% level of significance, respectively).
Source: Own construction

If we take as an arbitrary benchmark value of the coefficient of determination 50%, we see that 7 models meet such a condition: Austria, Czech Republic, Spain, EU27, Hungary, Romania and United Kingdom. However, taking the coefficient of determination as a sole measure of fit is very misleading as it provides no information on the fit in levels. When taking as an arbitrary benchmark value of Theil inequality coefficient 0.4 (which normalizes root mean square error by the sum of the roots of the mean squared values of forecast and actual values of the variable), we obtain 11 satisfactory models: Austria, Czech Republic, Spain, EU27, France, Hungary, Netherlands, Poland, Romania, Slovak Republic and United Kingdom.

In the Annex we present graphical output for the whole sample of economies which compares the actuals with the forecast.

In the next step of the analysis we estimated simple ARMA models for each economy up to 2011Q2 and used it for forecast up to 2011Q3. This serves as a baseline forecast to which the forecast from the ARMAX / GARCH models may be compared.

From Tables 3 to 5 one can see that only in three cases does the simple ARMA model produces better results than the ARMAX / GARCH model. On the other hand, it should be noted that the increase in forecasting power due to ARMAX / GARCH (as compared with simple ARMA) is rather negligible in many cases.

We further estimated the ARMAX / GARCH models only up to 2006Q4 to exclude the effect of the turbulences between 2007 and 2008. Then we used the estimates to produce forecasts up to 2006Q4. The results in the form of MRSE and Theil coefficients are presented in Tables 3 to 5. We stress that the models are not directly comparable in some cases as the ARMA (GARCH) structure needed to be altered for the significantly shorter data sample. We do not present the exact specifications of the "2006" models in the paper. It should be noted that in many cases the model produces much better results than the original one. Thus the turbulences between 2007 and 2008 seem to have a rather strong negative impact on the relationship between ESI and GDP.

To evaluate the models further, we ran a panel regression between the forecast errors and absolute values of quarterly changes in GDP to check the sensitivity of the forecasts to the speed with which the dependent variable changes.

We ran a rolling forecast from 2009Q1 to 2011Q3 to obtain the forecast errors, e.g. by forecast for 2009Q1 we mean that the model was estimated up to 2008Q4 (which means that data for the sentiment indicator, ESI, were available for 2009Q1 at that time) and based on the estimation we forecast the GDP growth for 2009Q1. By comparing the forecast for the particular quarter with the actual quarterly growth of GDP in that quarter, we obtained the forecast errors.

To run such an exercise, it is crucial to set the starting quarter of the rolling procedure. We start the forecast in 2009Q1 as most estimated models as presented in Tables 3 to 5 exhibited significant stability back to that period. By choosing 2009Q1 as a starting point for the exercise, we cut the cross-sample down to 20 economies, i.e. we leave out Greece, Latvia, Poland, Sweden and Slovenia whose models were highly unstable. Next we cut the cross-sample down even more by taking account of the fit of the forecasts, i.e. we apply the arbitrary rule used above – Theil inequality coefficient lower than 0.4. The resulting sample consists of 10 economies: Austria, Czech Republic, Spain, EU27, France, Hungary, Netherlands, Romania, Slovak Republic and United Kingdom.

Table 6 Panel regression

	Panel 1	Panel 2
C	0,46423*** (0,14920)	0,42434*** (0,15102)
GDP	0,16311 (0,18672)	-0,00890 (0,14983)
AR(1)	0,31879*** (0,06170)	0,54590*** (0,08474)
R-sq	0,43	0,56
F-stat	5,85	10,24
DW	2,02	2,05
JB	3411,722***	1601,068***

Note: Sample runs from 2009Q1 to 2011Q3 and across 20 economies in Panel 1 and 10 economies in Panel 2 as described above. Dependent variable: forecast errors based on the rolling forecasts. Independent variable: absolute value of quarterly changes in GDP. Other notation corresponds to that used earlier. (*, **, *** denote rejection of the null at 10%, 5% and 1% level of significance, respectively).
Source: Own construction

Table 6 gives the results of the panel regression. Two-stage least squares were used to obtain the estimates, with a constant and lagged values of independent variable as instruments. Autoregressive term was used to obtain serially uncorrelated residuals. In both cases the forecast errors come out as independent of the absolute value of quarterly changes in GDP.

CONCLUSION

The assessment of the so-called soft indicators as sentiment and confidence survey indicators has become increasingly popular in recent years. This paper presents one of many ways how confidence indicators might be useful for forecasting development of GDP. We used Economic Sentiment Indicator built and published by the European Commission.

First, we constructed a regression model augmented by the ARMA and ARCH / GARCH structure in some cases to capture the relationship between quarterly changes in GDP and ESI. It turned out that the regression models had some forecasting power in roughly half the sample. This showed that universal use of the data cannot be expected.

To assess the forecasting power in more detail we created simple ARMA models for each case and used to produce GDP forecasts. The quality of these forecasts was compared to the quality of the ARMAX forecasts (were ESI is used). In most cases the ARMAX forecasts beat the underlying ARMA forecasts although the difference in quality is rather negligible in many cases.

To capture the effect of the turbulences, which roughly took place between 2007 and 2008, on the forecasting power of the model, we estimated the original (ARMAX) model only up to the fourth quarter of 2006. Then we compared the quality of the forecasts of such a model with that of the original version, which was used for the whole sample. It was shown that the forecasting capacity of the ARMAX / GARCH model was negatively influenced by the turbulences.

Finally, we ran a rolling forecast exercise from 2009Q1 to 2011Q3 and compared the forecast with the actual measured quarterly GDP growth. The sample was divided into two groups according to the stability of the models and Theil inequality coefficient. The first group included 20 countries and the second had 10 members. We conducted a panel regression test between the forecast errors and quarterly GDP changes in absolute value to check the sensitivity of the errors on the variability of the forecasted series. In both cases the forecast errors came out as independent of the absolute values of quarterly changes in GDP. Therefore, it seems that the relationship between ESI and GDP may be exploited in relatively peaceful times while the relationship may be quite distorted when an economy is hit by unexpected shocks.

References

ANGELINI, E., CAMBA-MÉNDEZ, G., GIANNONE, D., RÜNSTLER, G., REICHLIN, L. *Short-term Forecasts of Economic Activity in the Euro Area* [online]. Frankfurt am Main: European Central Bank, 2008. [cit. 5.3.2012]. <http://www.ecb.int/pub/pdf/scpwps/ecbwp949.pdf>.

ADAMOVICZ, E., WALCZYK, K. *Cyclical Fluctuations of Business Activity in the New EU Countries* [online]. Warsaw: Warsaw School of Economics – Research Institute for Economic Development, 2011. [cit. 5.3.2012]. <https://www.ciret.org/files/workshops/moscow/papers/Walczyk_Konrad.pdf>.

ARNOŠTOVÁ, K., HAVRLANT, D., RŮŽIČKA, L., TÓTH, P. Short-Term Forecasting of Czech Quarterly GDP Using Monthly Indicators. In *Finance a Úvěr – Czech Journal of Economics and Finance,* 2011, 6, pp. 566–583.

BENDA, V., RŮŽIČKA, L. *Short-term Forecasting Methods Based on the LEI Approach:* The Case of the Czech Republic [online]. Prague: Czech National Bank, 2007. [cit. 5.3.2012]. <http://www.cnb.cz/miranda2/export/sites/www.cnb.cz/en/research/research_publications/irpn/download/rpn_1_2007.pdf>.

CZESANÝ, S., JEŘÁBKOVÁ, Z. Metoda konstrukce kompozitních indikátorů hospodářského cyklu pro českou ekonomiku (The Method of Construction of Composite Business Cycle Indicators for the Czech Economy). In *Statistika*, 2009, 1, pp. 21–31.

CZESANÝ, S., JEŘÁBKOVÁ, Z. Kompozitní indikátory hospodářského cyklu české ekonomiky (Composite Indicators of the Economic Cycle of the Czech Economy). In *Statistika*. 2009, 3, pp. 256–274.

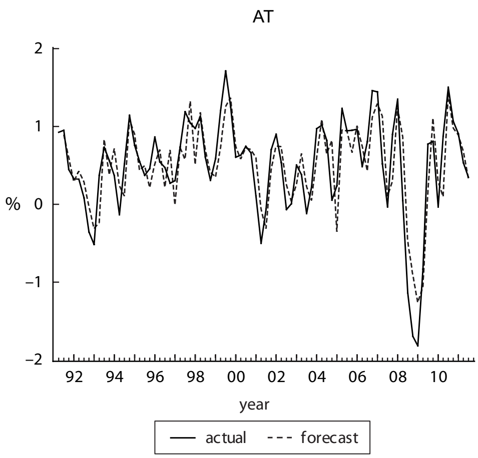
EC. *A User Manual to the Joint Harmonised EU Programme of Business and Consumer Surveys* [online]. Brussels: European Commission, Directorate for Economic and Financial Affairs, 2007. [cit. 5.3.2012]. <http://ec.europa.eu/economy_finance/db_indicators/surveys/documents/userguide_en.pdf>

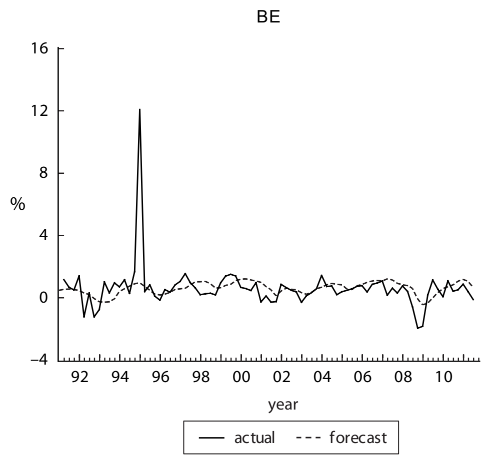
GELPER, S., CROUX, C. *On the Construction of the European Economic Sentiment Indicator* [online]. Leuven: Katholieke Universiteit Leuven, 2010. [cit. 5.3.2012]. <http://www.econ.kuleuven.be/public/ndbaf40/esi.pdf>.

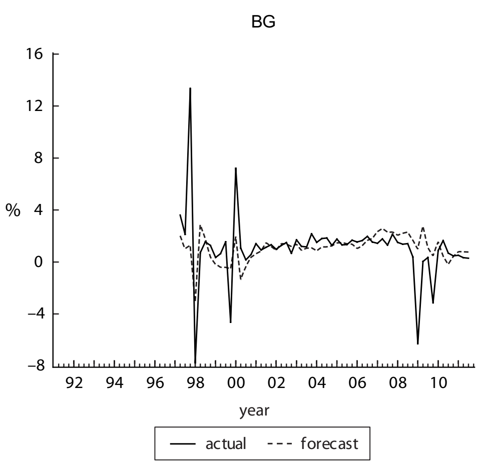
GIANNONE, D., REICHLIN, L, SIMONELLI, S. Nowcasting Euro Area Economic Activity in Real-Time: The Role of Confidence Indicator. *National Institute Economic Review,* 2009, 210, pp. 90–97.
POŠTA, V., VALENTA, V. Composite Leading Indicators Based on Business Survey: Case of the Czech Economy. In *Statistika, Economy and Statistics Journal,* 2011, 1, pp. 12–18.
SVATOŇ, P. *Composite Leading Indicators: A Contribution to the Analysis of the Czech Business Cycle* [online]. Prague: Ministry of Finance of the Czech Republic, 2011. <http://www.mfcr.cz/cps/rde/xbcr/mfcr/VS_COMPOSITE_LEADING_INDICATORS-082011.pdf>.

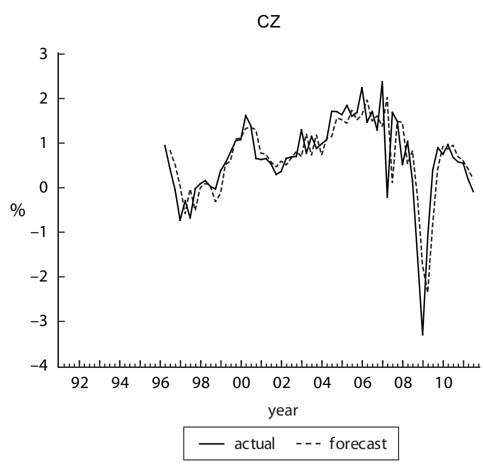
ANNEX

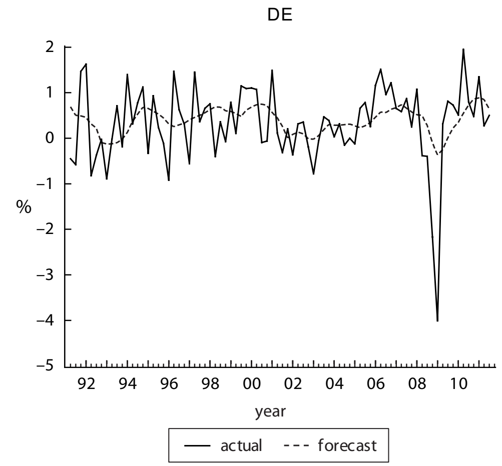
Figures 1 to 25 Actual quarterly changes in GDP vs forecast based on estimation up to 2011Q2 and forecast up to 2011Q3







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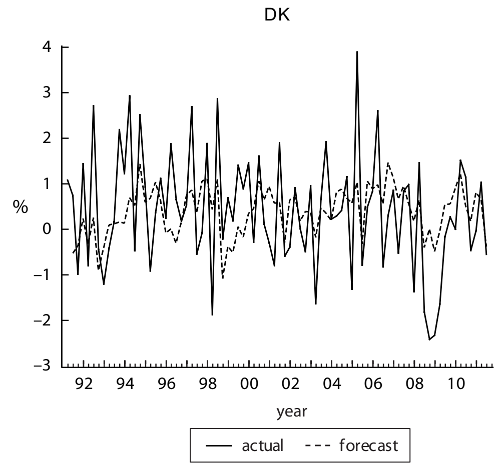
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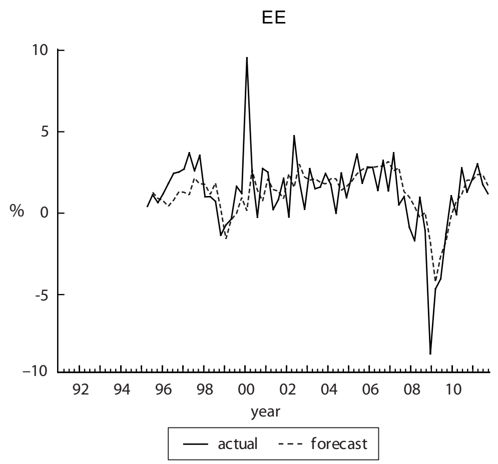
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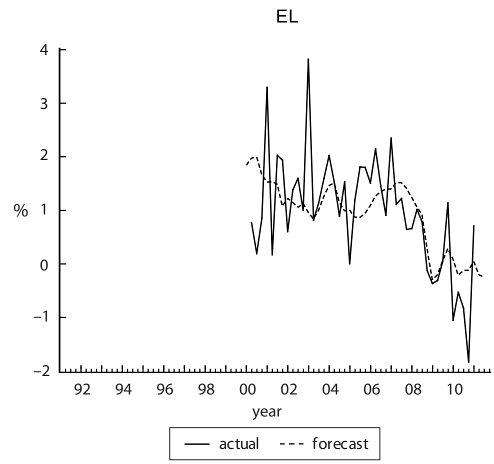
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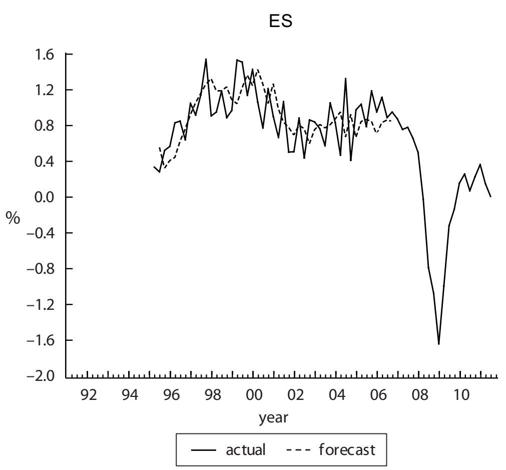
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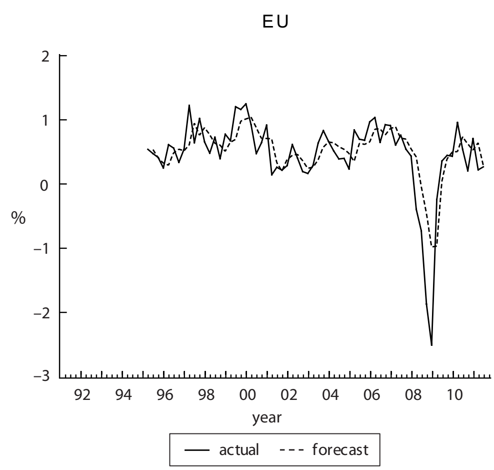
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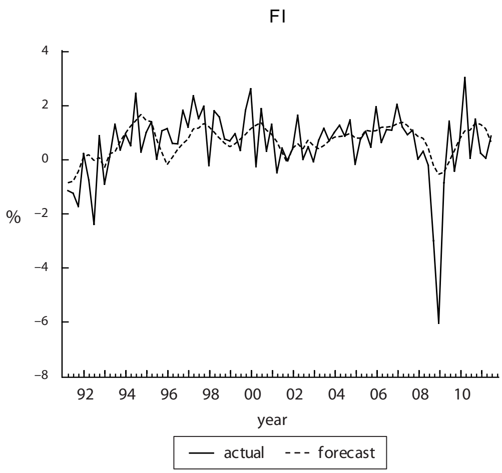
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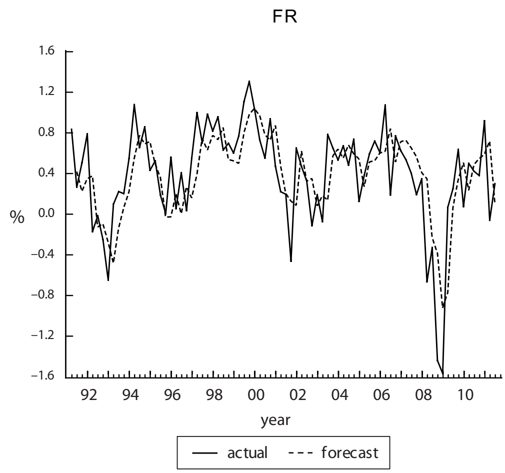
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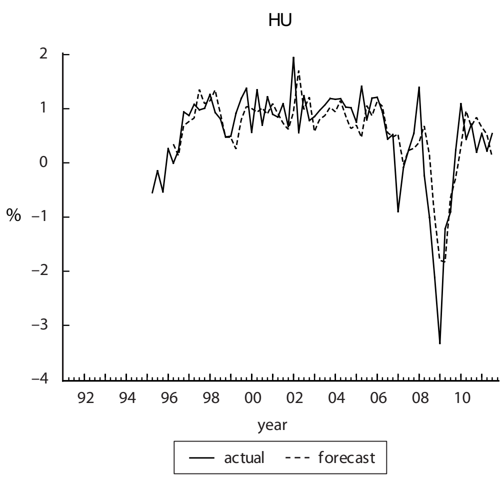
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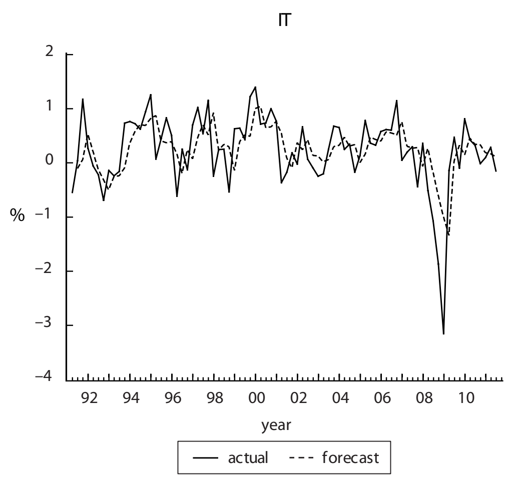
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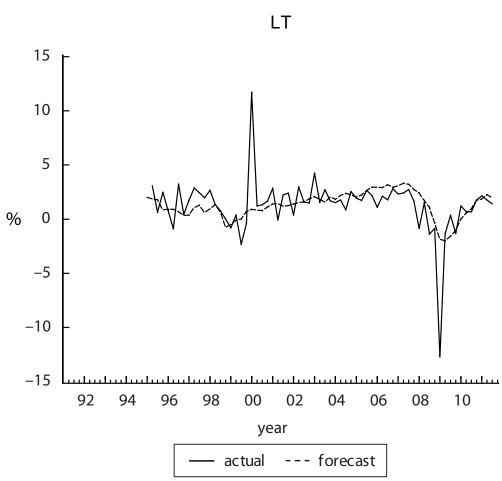
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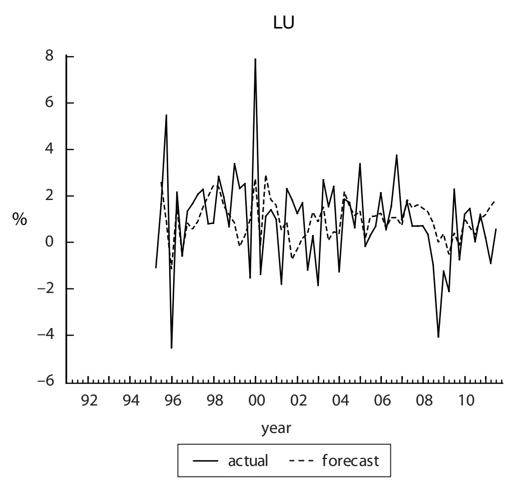
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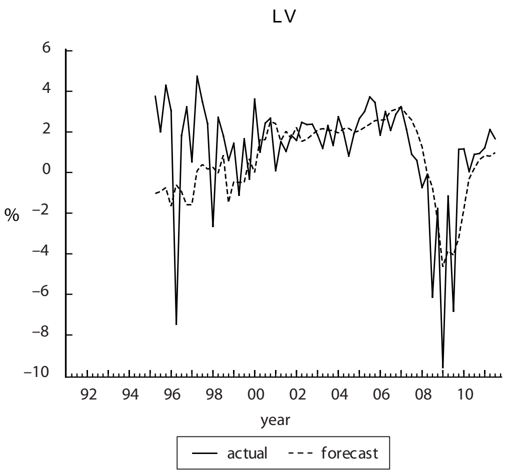
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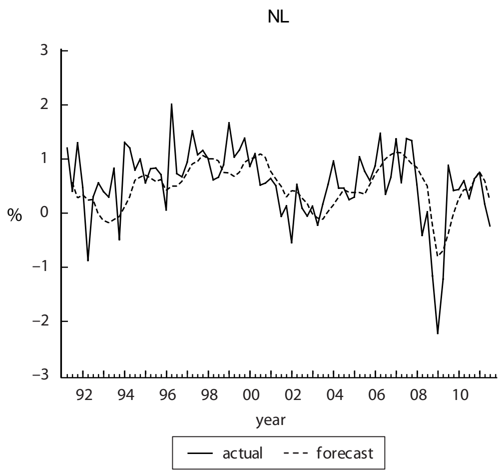
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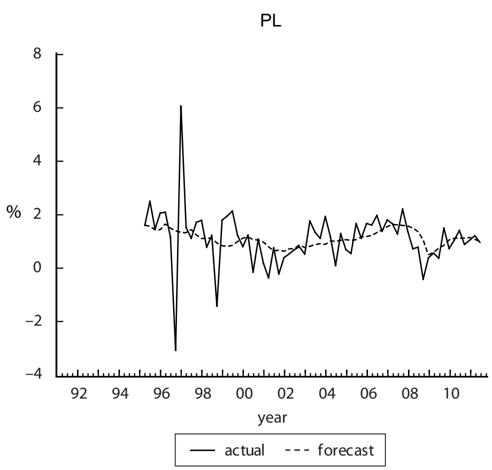
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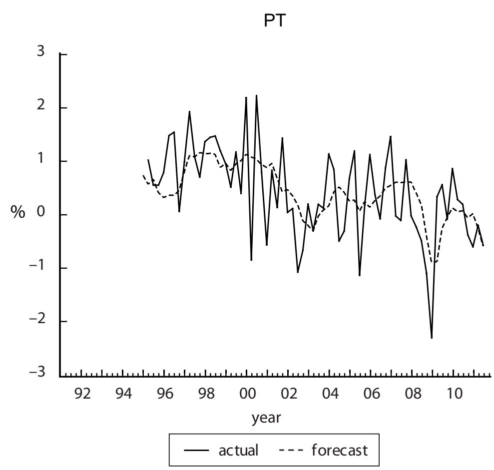
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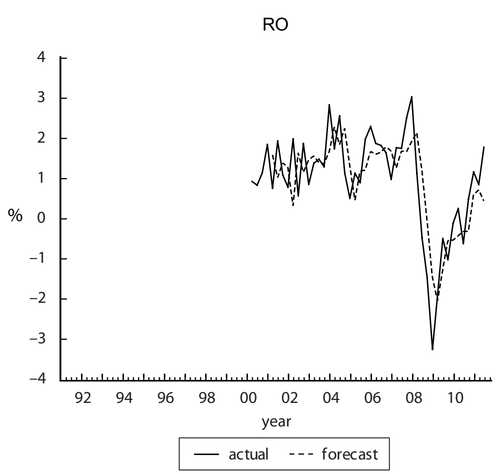
forecast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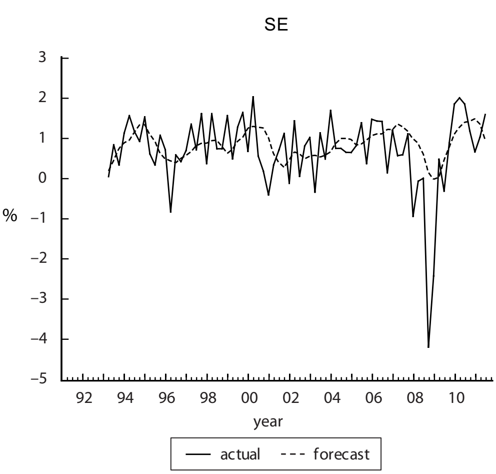
92 94 96 98 00 02 04 06 08 10
year
actual
forecast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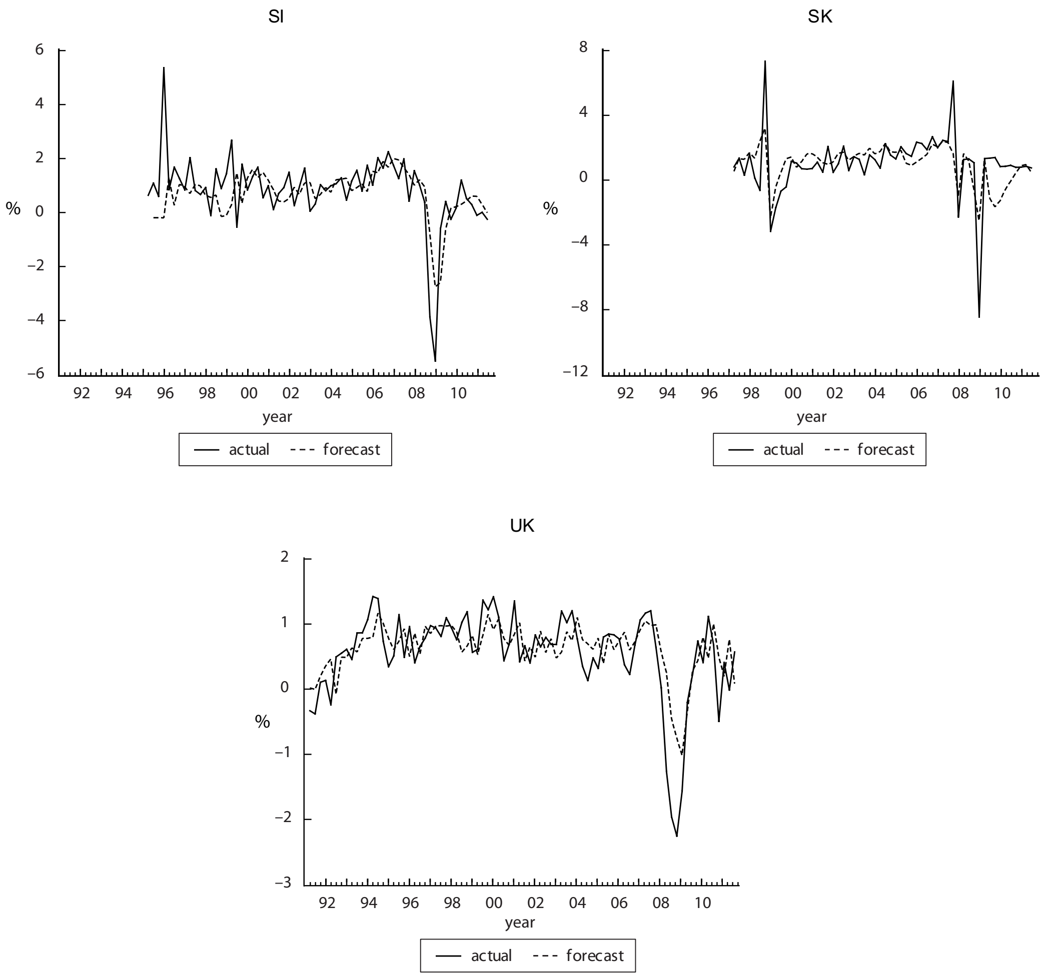
year
actual
forecast



Source: Own construction