

Nowcasting: Trust the Purchasing Managers' Index or wait for the flash GDP estimate?

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Abstract

This study shows for the first time that euro area real GDP nowcasts using the PMI survey can be more accurate than Eurostat's flash GDP estimate for extended periods of time in predicting the final GDP release. The nowcast performance of the PMI composite output index, measured as well as linked to GDP in different ways, is examined in detail for the years 2003-2010. PMI-based nowcasts of quarterly real GDP growth have outperformed the flash real GDP estimate in particular over the years 2003-2007, but even in a few cases on average over 2003-2010. Simple PMI-based rules-of-thumb for nowcasting quarter-on-quarter real GDP growth can also be derived at the country level. In contrast to the euro area, the PMI rules do generally not outperform the flash GDP estimate at the country level, with the main exception of the pre-crisis years in Germany due to a comparatively poor performance of the German flash GDP estimate. These findings imply that a close look at the PMI surveys is valuable for a reliable and early assessment of the current state of the euro area economy.

Keywords: Nowcasting; Survey indicators; Monthly tracer of GDP; Real-time analysis

JEL classification: E32; E37

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1. Introduction

Timely and accurate signals about the current state of the economy are essential for statisticians and analysts. In this context survey indicators are closely monitored as they can provide up-to-date and often unique monthly signals of current economic developments. This paper focuses on the nowcasting performance of the Purchasing Managers' Index (PMI) survey for the euro area, because the PMI has the advantage compared to other survey indicators of a theoretical no-change threshold of 50 and they are the most closely monitored business surveys in the world. For evidence on the usefulness of the PMI outside the euro area see, among others, Harris (1991), Koenig (2002), Peláez (2003), Rossiter (2010) and Lahiri and Monokroussos (2011). Notwithstanding the exclusive focus on the PMI, surveys released by the European Commission (EC) are of course also potentially useful for nowcasting euro area real GDP, but their interpretation is less straightforward than that of the PMI and they are typically designed to match year-on-year growth rates. Studies on the usefulness of EC surveys are for instance Gelper and Croux (2010), who analyse the economic sentiment index and Raffinot (2007) who prefers, among a wide set of survey indicators, industrial production trend observed in recent months together with the general economic situation over the last twelve months for the construction of a monthly tracer of euro area real GDP. Besides the focus on the PMI, this study defines nowcasting in a narrow way as predicting current quarter-on-quarter growth in real GDP. Bańbura et al. (2010) provide a more general description of the nowcasting process for euro area real GDP.

The main contribution of this paper is that it compares the accuracy of PMI-based nowcast of current quarter-on-quarter euro area real GDP growth with that of the flash GDP estimate. The nowcast performance of the PMI composite output index, measured as well as linked to GDP in three different ways, is examined in detail for the years 2003-2010. The surprising conclusion is that there are extended periods of time where PMI-based GDP nowcasts turn out to be more in line with the latest official GDP estimates than the first official or flash GDP estimate. PMI-based nowcasts of quarterly real GDP growth have outperformed the flash real GDP estimate in particular over the years 2003-2007, but even in a few cases on average over 2003-2010. Regarding timeliness two months of the current quarter appears to be generally sufficient, which is 2½ months before the flash GDP estimate. This finding implies that statisticians and analysts may not have to wait for the flash GDP estimate for a reliable assessment of the current state of the euro area economy, but can closely monitor the earlier available nowcasts based on the PMI surveys. Applying the same methodology to the four largest euro area countries shows that identical rules can not be statistically rejected for three out of the four largest euro area countries. For Spain there are difficulties in that quarterly real GDP growth is not stationary over the sample considered and that a PMI construction output index is not available. In contrast to the euro area, the PMI rules do generally not outperform the flash GDP estimate at the country level, with the main exception of the pre-crisis years in Germany due to a comparatively poor performance of the German flash GDP estimate.

The remainder of this paper introduces rules-of-thumb to nowcast euro area real GDP based on the PMI composite output index. Section 3 presents the nowcast performance of the rules-of-thumb and

compares it with that of the flash GDP estimate. Section 4 provides results for the four largest euro area countries. Section 5 concludes.

2. Rules-of-thumb

Starting point to derive the rules-of-thumb is a regression model that regresses the quarter-on-quarter real GDP growth, y , on the level of the PMI composite output index, CO .

$$y_t = \alpha + \beta CO_t + \varepsilon_t \quad (1)$$

The composite output index consists of the manufacturing output index and the services business activity index and 50 is subtracted from the indices so that the constant can be expected to be zero. The question asked to survey respondents in the Manufacturing PMI surveys is “*has your output (in units) risen, fallen or remained unchanged on that of one month ago*”. For the services sector the corresponding output question is about business activity. The net balance of survey responses is converted into a diffusion index which is then seasonally adjusted. It therefore appears most appropriate to compare the PMI data against month-on-month changes in official data. Here the focus is on quarterly real GDP, implying that the monthly PMI data has to be transformed into quarterly series. This paper analyses besides a simply quarterly average of the monthly observations also a theoretical correct weighted average, which makes use of five monthly PMI's, with a weighting of 1 2 3 2 1 for the second and third month of the previous quarter, respectively, for the first, second, and third month of the current quarter, because the PMI refers to month-on-month instead of quarter-on-quarter changes.¹

A serious drawback of the PMI composite output index is that it does not capture developments in the construction sector. Therefore an extended version of Eq. (1) is estimated by adding the level of and change in the PMI construction output index to the model. Another additional regressor is the change in the composite output index. The changes in the indices are considered as it is a priori unclear whether the level or the change is more relevant. The extended model read as follows.

$$y_t = \alpha + \beta_1 CO_t + \beta_2 \Delta CO_t + \gamma_1 CS_t + \gamma_2 \Delta CS_t + \varepsilon_t \quad (2)$$

Table 1 presents the estimation results of Eq. (1) and (2) and Wald test statistics in order to test whether certain restrictions to the coefficients has to be statistically rejected or not. In addition the adjusted R-squared, standard error of regression and some residual statistics (Durbin Watson and Ljung-Box statistics) are reported. The R-squared varies for the total sample between 0.64 and 0.80. The R-squared is consistently lower for the theoretical correct PMI average than for the quarterly average. The coefficient restrictions can in all cases, except one, not statistically rejected and the model residuals behave correctly, excluding one case. Four rules-of-thumb are derived from these simplifying equations.

1. 10% rule: current quarter-on-quarter real GDP growth equals 10% of the PMI composite output index from which 50 is subtracted.

¹ In addition, one could apply a theoretical weighted average of a logistic transformation of the PMI diffusion indices (see Vermeulen (2011) for a more extended elaboration on this issue), because the values of diffusion indices can only vary between -100 and 100. The Appendix reports the nowcasts outcomes based on such a logistic transformation as the nowcast performance does not improve compared to those based on averages.

2. 10%+ rule: current quarter-on-quarter real GDP growth equals 10% of the PMI composite output index plus 5% of the change in the PMI construction output index. The latter part does take into account developments in the construction sector.

3. Asymmetric rule: the 10% rule holds only as the PMI composite output index is positive, but a stronger impact of 15% applies for negative PMIs, i.e. below 50.

4. Asymmetric+ rule: the 10%+ rule is applied as the PMI composite output index is positive and 15% of the level of the composite output index is taken for negative PMIs. The impact of the change in the construction output index is always 5%.

The reason why the 10%(+) rule breaks down for negative PMIs could be that respondents are reluctant to report declining output or business activity following a period of expansion. For example, Massy and Wu (2005) show in a series of experiments that people tend to underreact in unstable environments with precise signals (i.e. turning points) and overreact to stable environments with noisy signals (i.e. trending developments). Purchasing managers tend to hang to their view of a stable environment too long and miss the important things that happen when an environment becomes more unstable (a recession starts) and underreact to such developments.

Table 1 Estimation results to derive rules-of-thumb

	Constant	CO level	CO change	CS level	CS change	Wald test ¹⁾	Adj.R ²	DW	Q(1)/Q(4)	Sample
<i>10% rule</i>										
Quarterly average	-0.030 (0.107)	0.117 *** (0.020)				0.336	0.735	1.65	0.205	1998Q3-2011Q1
Theoretical average	-0.006 (0.127)	0.112 *** (0.023)				0.509	0.335	1.46	0.549	1998Q4-2011Q1
							0.640	1.46	0.052	
							0.395		0.235	
<i>10%+ rule</i>										
Quarterly average	0.109 (0.114)	0.085 *** (0.022)	0.037 ** (0.017)	0.024 (0.014)	0.030 ** (0.012)	0.553	0.801	1.45	0.126	2000Q2-2011Q1
		0.104 *** (0.013)			0.051 *** (0.016)	0.937	0.293	1.30	0.288	2000Q2-2011Q1
Theoretical average	0.140 (0.105)	0.079 *** (0.018)	0.074 ** (0.029)	0.023 (0.016)	0.035 ** (0.014)	0.042 **	0.798	1.76	0.038 **	2000Q3-2011Q1
		0.101 *** (0.011)			0.072 ** (0.029)	0.716	0.295	1.52	0.275	2000Q3-2011Q1
							0.771	1.76	0.557	
							0.316		0.609	
							0.740	1.52	0.178	
							0.336		0.555	
<i>Asymmetric rule</i>										
Quarterly average		0.162 *** (0.025)				0.657	0.744	1.55	0.955	CO < 0
Theoretical average		0.150 *** (0.044)				0.996	0.510	1.58	0.903	CO < 0
							0.545	1.58	0.409	
							0.681		0.447	
<i>Asymmetric+ rule</i>										
Quarterly average		0.142 *** (0.016)			0.087 (0.042)	0.591	0.818	1.66	0.787	CO < 0
Theoretical average		0.125 *** (0.026)			0.133 (0.060)	0.394	0.431	1.69	0.993	CO < 0
							0.751	1.69	0.993	
							0.504		0.962	

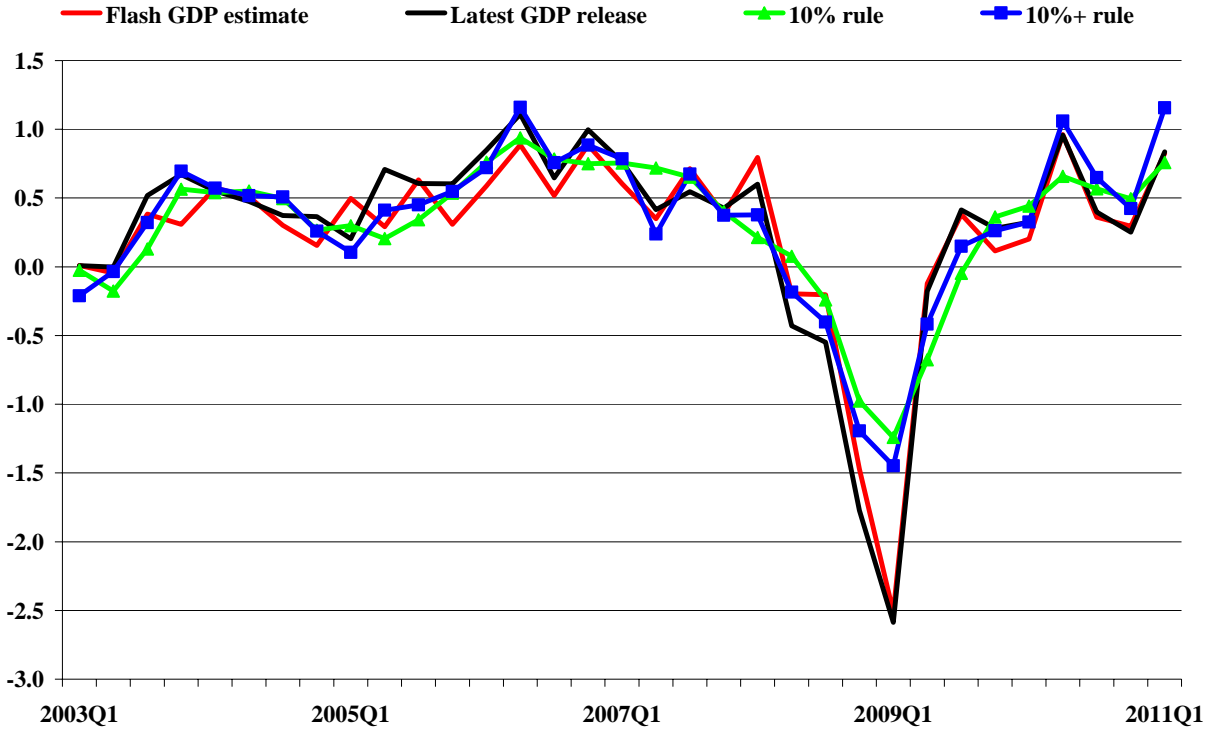
Sources: Eurostat, Markit, author calculations. Notes: CO denotes PMI composite output index, CS PMI construction output index. DW denotes Durbin-Watson statistic and Q(1) and Q(4) the Ljung Box Q-statistic at order 1 and 4, respectively. Newey-west corrected standard errors are reported in parentheses. Below the adjusted R-squared is the standard error of regression reported. ** and *** denote significant at the 5%, respectively, 1% confidence level.

¹⁾ F-statistic. 10% rule: constant=0, composite output coefficient=0.1; 10%+ rule: assuming the constant =0, first case change in the composite output coefficient=0, construction output coefficient=0, second case composite output coefficient=0.1, change in the construction output coefficient=0.05; asymmetric rule: assuming the constant=0, composite output coefficient=0.15; asymmetric+ rule: assuming constant=0, composite output coefficient=0.15, change in the construction output coefficient=0.05.

Figure 1 plots the real GDP outcomes based on the 10% rule and 10%+ rule using the quarterly average together with the first official also known as flash real GDP estimate retrieved from the euro area real-time data base (for an in-depth presentation of this data base see Giannone et al., 2010) and the final real GDP release using Eurostat’s second GDP release for 2011Q1. It shows that all outcomes are close to each other over the period 2003Q1-2011Q1, except during the bottom of the latest crisis where the PMI-based outcomes were substantially higher than the flash GDP estimate and final GDP release.

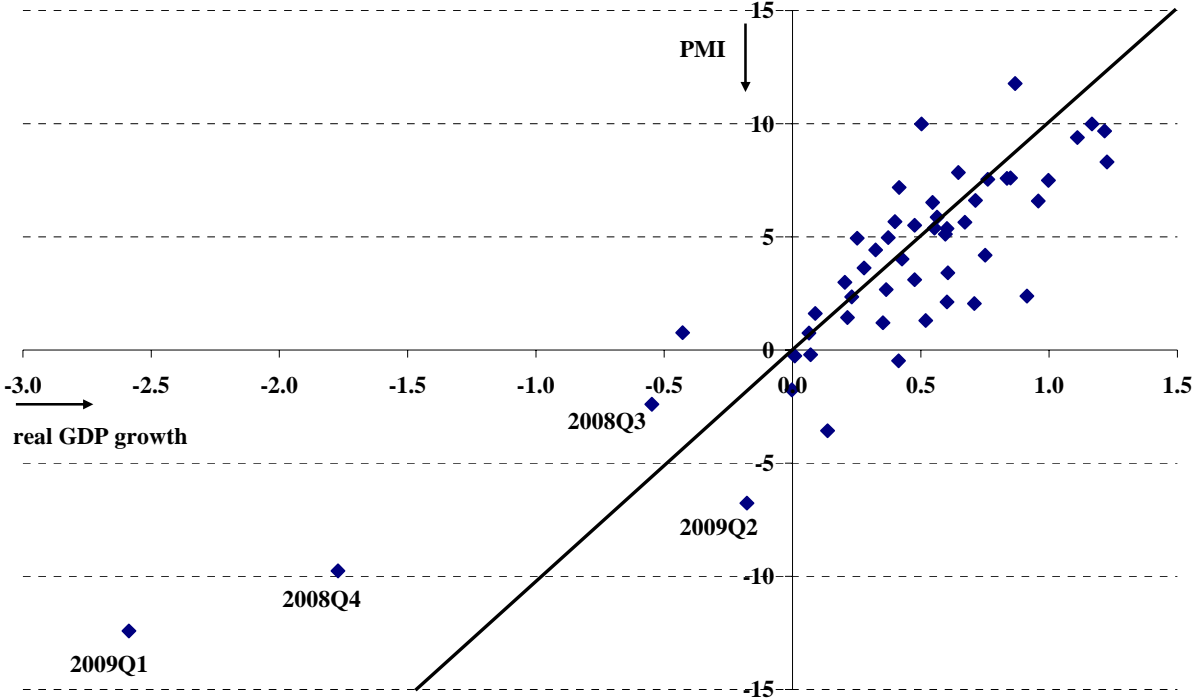
Figures 2 and 3 shows a scatter diagram of the quarter-on-quarter real GDP growth using the final GDP release together with the PMI composite output index using the quarterly average (10% rule), respectively, the quarterly average of the PMI composite output adjusted for the change in the construction output index (10%+ rule). It illustrates the need for an asymmetric rule, because a “45 degree” relation between the PMI composite output (adjusted for the change in the construction output index) and real GDP is visible for positive values of the PMI composite output index, but not for negative values, in particular for the extreme negative values in 2008Q4 and 2009Q1. It appears that the PMI’s did not capture the sharp output falls in both quarters.

Figure 1 10% rule and 10%+ rule based on the PMI quarterly average, flash GDP estimate and final quarter-on-quarter real GDP growth (2003Q1-2011Q1)



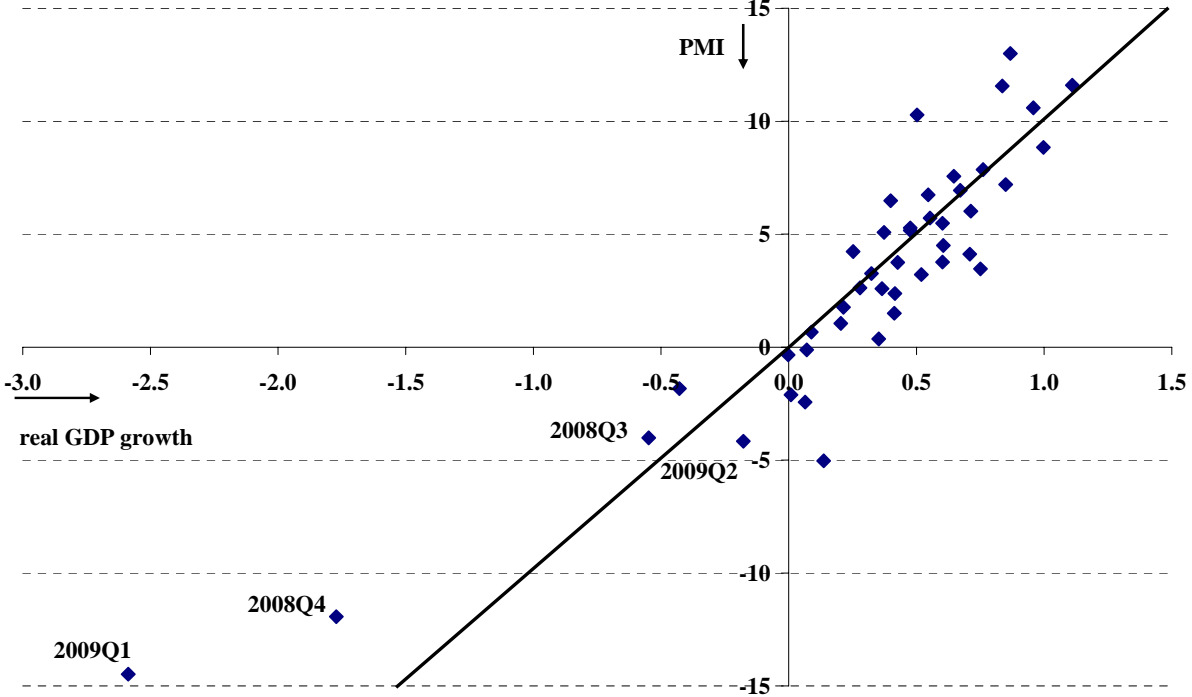
Sources: Euro area real-time data base, Eurostat, Markit, author calculations.

Figure 2 Scatter diagram of quarterly average PMI composite output index and final quarter-on-quarter real GDP growth (1998Q3-2011Q1)



Sources: Euro area real-time data base, Eurostat, Markit, author calculations.

Figure 3 Scatter diagram of quarterly average PMI composite output index adjusted for the change in the construction output index and final quarter-on-quarter real GDP growth (2000Q2-2011Q1)



Sources: Euro area real-time data base, Eurostat, Markit, author calculations.

3. Nowcasting performance for the euro area

This section reports the performance of the four PMI-based rules-of-thumb in nowcasting current quarter-on-quarter euro area real GDP growth for the years 2003-2010 and compares it with the flash real GDP estimate. The second estimate for 2011Q1 is used as a benchmark for the final GDP data. The nowcast errors for the more recent years should be interpreted with more caution than for the earlier years, because the numbers for the recent years could still be revised.

Tables 2 and 3 reports the mean absolute nowcast errors for the quarter-on-quarter real GDP growth rates as well as root mean squared errors, averaged over the respective calendar year and over the years 2003-2006 up to 2003-2010. Table 2 is based on the quarterly average and Table 3 on the theoretical correct average. The rule-of-thumb results for the 1, 2 and 3 months of available PMIs are respectively 3½, 2½ and 1½ month earlier available than the flash GDP estimate. Three conclusions emerge from both tables.

- As expected the root mean squared error (RMSE) and mean absolute error (MAE) decrease the more information becomes available during the quarter. The lowest errors are recorded based on the full information set of three months. This notwithstanding, rules-of-thumb using the first two months of the current quarter provide nowcasts for real GDP almost as accurate as those based on all three months of the quarter. These real GDP nowcasts are 2½ months earlier available than the flash GDP estimate.

- The PMI-based real GDP nowcasts become generally more accurate the more detailed the rule is. Put differently, the 10%+ rule generally outperforms the 10% rule and the asymmetric and asymmetric+ rules typically outperform the 10% rule and 10%+ rule, respectively.

- The nowcasts derived from the PMI-based rules-of-thumb are in many, but not all, cases as accurate as the flash GDP estimate.

Table 2 Quarter-on-quarter real GDP growth nowcast errors of PMI-based rules-of-thumb and flash GDP: quarterly average (percentage points; second release for 2011Q1 as final GDP)

Period	10% rule			10%+ rule			asymmetric rule			asymmetric+ rule			Flash GDP
	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	3 months & 1½ month
<i>Mean absolute error</i>													
2003	0.23	0.19	0.18	0.19	0.14	0.12	0.27	0.24	0.22	0.24	0.18	0.16	0.14
2004	0.08	0.09	0.08	0.15	0.12	0.08	0.08	0.09	0.08	0.15	0.12	0.08	0.08
2005	0.27	0.27	0.23	0.20	0.18	0.15	0.27	0.27	0.23	0.20	0.18	0.15	0.26
2006	0.22	0.19	0.16	0.20	0.14	0.10	0.22	0.19	0.16	0.20	0.14	0.10	0.18
2007	0.13	0.12	0.11	0.25	0.18	0.10	0.13	0.12	0.11	0.25	0.18	0.10	0.11
2008	0.63	0.55	0.50	0.46	0.33	0.30	0.41	0.29	0.25	0.37	0.19	0.22	0.27
2009	0.72	0.62	0.60	0.50	0.40	0.41	0.54	0.38	0.35	0.33	0.16	0.18	0.08
2010	0.17	0.19	0.21	0.17	0.21	0.13	0.17	0.19	0.21	0.17	0.21	0.13	0.05
2003-2006	0.20	0.19	0.16	0.19	0.14	0.11	0.21	0.20	0.17	0.20	0.16	0.12	0.16
2003-2007	0.19	0.17	0.15	0.20	0.15	0.11	0.20	0.18	0.16	0.21	0.16	0.12	0.15
2003-2008	0.26	0.24	0.21	0.24	0.18	0.14	0.23	0.20	0.17	0.24	0.17	0.13	0.17
2003-2009	0.33	0.29	0.27	0.28	0.21	0.18	0.28	0.22	0.20	0.25	0.16	0.14	0.16
2003-2010	0.31	0.28	0.26	0.27	0.21	0.17	0.26	0.22	0.20	0.24	0.17	0.14	0.15
<i>Root mean squared error</i>													
2003	0.29	0.25	0.22	0.26	0.19	0.15	0.33	0.30	0.26	0.28	0.21	0.18	0.19
2004	0.12	0.11	0.09	0.19	0.14	0.09	0.12	0.11	0.09	0.19	0.14	0.09	0.11
2005	0.32	0.31	0.29	0.27	0.23	0.18	0.32	0.31	0.29	0.27	0.23	0.18	0.29
2006	0.23	0.20	0.17	0.22	0.16	0.11	0.23	0.20	0.17	0.22	0.16	0.11	0.19
2007	0.17	0.17	0.16	0.28	0.20	0.11	0.17	0.17	0.16	0.28	0.20	0.11	0.12
2008	0.70	0.59	0.53	0.58	0.41	0.34	0.48	0.35	0.32	0.38	0.22	0.23	0.27
2009	0.87	0.77	0.75	0.62	0.54	0.60	0.65	0.44	0.42	0.42	0.19	0.24	0.10
2010	0.19	0.21	0.22	0.21	0.22	0.16	0.19	0.21	0.22	0.21	0.22	0.16	0.07
2003-2006	0.25	0.23	0.21	0.24	0.18	0.13	0.26	0.24	0.22	0.24	0.19	0.14	0.21
2003-2007	0.24	0.22	0.20	0.25	0.19	0.13	0.25	0.23	0.21	0.25	0.19	0.14	0.19
2003-2008	0.36	0.31	0.28	0.33	0.24	0.18	0.30	0.25	0.23	0.28	0.20	0.16	0.21
2003-2009	0.47	0.41	0.39	0.38	0.30	0.28	0.37	0.29	0.27	0.30	0.20	0.17	0.20
2003-2010	0.44	0.39	0.37	0.36	0.29	0.27	0.35	0.28	0.26	0.29	0.20	0.17	0.19

Sources: Euro area real-time data base, Eurostat, Markit, author calculations.

Table 3 Quarter-on-quarter real GDP growth nowcast errors of PMI-based rules-of-thumb and flash GDP: theoretical correct average (percentage points; second release for 2011Q1 as final GDP)

Period	10% rule			10%+ rule			asymmetric rule			asymmetric+ rule			Flash GDP
	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	3 months & 1½ month
<i>Mean absolute error</i>													
2003	0.10	0.08	0.08	0.15	0.16	0.15	0.11	0.09	0.08	0.16	0.15	0.15	0.14
2004	0.07	0.06	0.06	0.07	0.06	0.05	0.07	0.06	0.06	0.07	0.06	0.05	0.08
2005	0.16	0.17	0.16	0.16	0.17	0.17	0.16	0.17	0.16	0.16	0.17	0.17	0.26
2006	0.14	0.15	0.15	0.15	0.13	0.12	0.14	0.15	0.15	0.15	0.13	0.12	0.18
2007	0.16	0.15	0.15	0.19	0.15	0.15	0.16	0.15	0.15	0.19	0.15	0.15	0.11
2008	0.33	0.35	0.35	0.32	0.32	0.32	0.23	0.32	0.31	0.28	0.36	0.36	0.27
2009	0.52	0.51	0.51	0.36	0.41	0.42	0.41	0.40	0.40	0.30	0.30	0.33	0.08
2010	0.26	0.28	0.29	0.24	0.23	0.24	0.26	0.28	0.29	0.24	0.23	0.24	0.05
2003-2006	0.12	0.11	0.11	0.13	0.13	0.12	0.12	0.12	0.11	0.14	0.13	0.12	0.16
2003-2007	0.12	0.12	0.12	0.15	0.13	0.13	0.12	0.12	0.12	0.15	0.13	0.13	0.15
2003-2008	0.16	0.16	0.16	0.17	0.16	0.16	0.14	0.15	0.15	0.17	0.17	0.17	0.17
2003-2009	0.21	0.21	0.21	0.20	0.20	0.20	0.18	0.19	0.19	0.19	0.19	0.19	0.16
2003-2010	0.22	0.22	0.22	0.21	0.20	0.20	0.19	0.20	0.20	0.19	0.19	0.20	0.15
<i>Root mean squared error</i>													
2003	0.10	0.09	0.10	0.23	0.22	0.21	0.11	0.10	0.10	0.23	0.22	0.21	0.19
2004	0.07	0.06	0.06	0.08	0.07	0.06	0.07	0.06	0.06	0.08	0.07	0.06	0.11
2005	0.23	0.23	0.23	0.26	0.24	0.22	0.23	0.23	0.23	0.26	0.24	0.22	0.29
2006	0.17	0.18	0.18	0.17	0.15	0.14	0.17	0.18	0.18	0.17	0.15	0.14	0.19
2007	0.20	0.19	0.18	0.19	0.16	0.16	0.20	0.19	0.18	0.19	0.16	0.16	0.12
2008	0.39	0.38	0.39	0.34	0.33	0.34	0.27	0.35	0.35	0.32	0.42	0.42	0.27
2009	0.80	0.84	0.85	0.62	0.69	0.71	0.58	0.62	0.63	0.39	0.47	0.49	0.10
2010	0.30	0.31	0.32	0.27	0.28	0.27	0.30	0.31	0.32	0.27	0.28	0.27	0.07
2003-2006	0.16	0.16	0.15	0.20	0.18	0.17	0.16	0.16	0.15	0.20	0.18	0.17	0.21
2003-2007	0.16	0.16	0.16	0.19	0.18	0.17	0.17	0.16	0.16	0.20	0.18	0.17	0.19
2003-2008	0.22	0.21	0.22	0.22	0.21	0.21	0.19	0.21	0.21	0.22	0.24	0.23	0.21
2003-2009	0.36	0.38	0.38	0.31	0.33	0.33	0.28	0.30	0.30	0.25	0.28	0.28	0.20
2003-2010	0.36	0.37	0.37	0.31	0.32	0.32	0.28	0.30	0.31	0.25	0.28	0.28	0.19

Sources: Euro area real-time data base, Eurostat, Markit, author calculations.

Table 4 summarises the nowcasting performance of the four rules based on a quarterly average and theoretical correct weighted average of the PMI survey series with those of the flash real GDP estimate produced by Eurostat since 2003 using all three months of the quarter for the PMI series.

Two conclusions emerge from the table regarding the performance of the PMI versus the flash GDP estimate.

- The flash GDP estimate is in two calendar years (2009 and 2010) more in line with the final GDP estimate than any PMI-based rule. This notwithstanding, the conclusion – if the events of 2009-2010 are anything to go by – is that one can trust the flash GDP estimate more than PMI-based nowcasts during “abnormal” times.

- Among the various PMI-based rules, the quarterly average which also takes into account the change in the construction output index and distinguishes between positive and negative PMI’s performs the best. This rule has consistently outperformed the flash GDP estimate on average for the years 2003-2006 up to 2003-2010. Up to 2007/08 most PMI-based rules, excluding those based on a logistic transformation, have been more reliable about the final GDP estimate than the flash GDP estimate. This tentative finding based on a short sample suggests that one should trust the nowcasts based on an average of the PMI during “normal” times as there appears to be no value added in waiting for the flash GDP estimate. In particular trustworthy at “normal” times appears to be the 10% rule based on the theoretical correct average and the 10%+ rule based on the quarterly average.

Table 4 Overview quarter-on-quarter real GDP growth nowcast errors of PMI-based rules using the three months of the quarter and of flash GDP

(percentage points; second release for 2011Q1 as final GDP)

Period	10% rule		10%+ rule		asymmetric		asymmetric+		Flash GDP
	QA	TA	QA	TA	QA	TA	QA	TA	
<i>Mean absolute error</i>									
2003	0.18	0.08	0.12	0.15	0.22	0.08	0.16	0.15	0.14
2004	0.08	0.06	0.08	0.05	0.08	0.06	0.08	0.05	0.08
2005	0.23	0.16	0.15	0.17	0.23	0.16	0.15	0.17	0.26
2006	0.16	0.15	0.10	0.12	0.16	0.15	0.10	0.12	0.18
2007	0.11	0.15	0.10	0.15	0.11	0.15	0.10	0.15	0.11
2008	0.50	0.35	0.30	0.32	0.25	0.31	0.22	0.36	0.27
2009	0.60	0.51	0.41	0.42	0.35	0.40	0.18	0.33	0.08
2010	0.21	0.29	0.13	0.24	0.21	0.29	0.13	0.24	0.05
2003-2006	0.16	0.11	0.11	0.12	0.17	0.11	0.12	0.12	0.16
2003-2007	0.15	0.12	0.11	0.13	0.16	0.12	0.12	0.13	0.15
2003-2008	0.21	0.16	0.14	0.16	0.17	0.15	0.13	0.17	0.17
2003-2009	0.27	0.21	0.18	0.20	0.20	0.19	0.14	0.19	0.16
2003-2010	0.26	0.22	0.17	0.20	0.20	0.20	0.14	0.20	0.15
<i>Root mean squared error</i>									
2003	0.22	0.10	0.15	0.21	0.26	0.10	0.18	0.21	0.19
2004	0.09	0.06	0.09	0.06	0.09	0.06	0.09	0.06	0.11
2005	0.29	0.23	0.18	0.22	0.29	0.23	0.18	0.22	0.29
2006	0.17	0.18	0.11	0.14	0.17	0.18	0.11	0.14	0.19
2007	0.16	0.18	0.11	0.16	0.16	0.18	0.11	0.16	0.12
2008	0.53	0.39	0.34	0.34	0.32	0.35	0.23	0.42	0.27
2009	0.75	0.85	0.60	0.71	0.42	0.63	0.24	0.49	0.10
2010	0.22	0.32	0.16	0.27	0.22	0.32	0.16	0.27	0.07
2003-2006	0.21	0.15	0.13	0.17	0.22	0.15	0.14	0.17	0.21
2003-2007	0.20	0.16	0.13	0.17	0.21	0.16	0.14	0.17	0.19
2003-2008	0.28	0.22	0.18	0.21	0.23	0.21	0.16	0.23	0.21
2003-2009	0.39	0.38	0.28	0.33	0.27	0.30	0.17	0.28	0.20
2003-2010	0.37	0.37	0.27	0.32	0.26	0.31	0.17	0.28	0.19

Sources: Euro area real-time data base, Eurostat, Markit, author calculations.

Notes: QA = quarterly average ; TA = theoretical correct average.

Bold and shaded numbers denote lowest error among the respective row, respectively, lower error than the flash GDP estimate, i.e. PMI-rule outperforming the flash GDP estimate.

4. Country results

This section examines whether the earlier derived PMI-based rules-of-thumb for nowcasting quarter-on-quarter real GDP growth for the euro area can also be derived at the country level. Estimations of the earlier introduced equations for the four largest euro area countries show that identical rules can not be statistically rejected for three out of the four largest euro area countries. For Spain it is problematic that quarterly real GDP growth is not stationary over the sample considered and that a PMI construction output index is not available. The latter is particularly important, because the construction sector has played a crucial role in the Spanish economy in recent years. For Spain the 10%+ rule is therefore adjusted by taking the previous q-o-q real GDP growth into account instead of the change in the construction output index.

Tables 5-8 show the nowcasting performance of the PMI rules-of thumb for the four largest euro area countries using the quarterly average. Similar results are derived by taking the theoretically correct average. The asymmetric rules assume a 10% or 10%+ rule only when the PMI composite output index is positive, but a stronger impact of 15% for negative PMIs at the euro area level. The latter implies that the

asymmetric rules are only applied for the quarters with a negative PMI composite output index at the euro area level (2003Q2 and 2008Q3-2009Q3) and are thus not “fine tuned” at the country level.

The nowcast performance of the PMI rules-of-thumb at the country level is generally worse than the flash GDP estimate, which is in contrast to the euro area finding. For Italy there is no single case where the PMI-based rules outperform the flash GDP estimate, whereas for Germany PMIs have outperformed the flash GDP estimates over the pre-crisis years. The latter is, however, more due to the comparatively low accuracy of the German flash GDP estimate than to a good absolute performance of the PMI rules-of-thumb.

Table 5 Quarter-on-quarter real GDP growth nowcast errors of PMI-based rules-of-thumb using quarterly average and flash GDP estimate: Germany (percentage points, second release for 2011Q1 as final GDP data)

Period	10% rule			10%+ rule			asymmetric rule			asymmetric+ rule			Flash GDP
	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	3 & 1½ month
<i>Mean absolute error</i>													
2003	0.32	0.29	0.25	0.25	0.12	0.10	0.38	0.36	0.32	0.31	0.19	0.16	0.24
2004	0.43	0.37	0.34	0.43	0.36	0.34	0.43	0.37	0.34	0.43	0.36	0.34	0.31
2005	0.31	0.30	0.29	0.25	0.15	0.20	0.31	0.30	0.29	0.25	0.15	0.20	0.52
2006	0.34	0.34	0.30	0.38	0.29	0.21	0.34	0.34	0.30	0.38	0.29	0.21	0.42
2007	0.31	0.28	0.26	0.44	0.38	0.26	0.31	0.28	0.26	0.44	0.38	0.26	0.12
2008	1.07	0.96	0.89	0.94	0.75	0.72	0.92	0.72	0.63	0.78	0.52	0.46	0.18
2009	1.29	1.14	1.12	1.06	0.96	1.01	1.05	0.82	0.80	0.82	0.64	0.70	0.21
2010	0.40	0.45	0.50	0.41	0.45	0.40	0.40	0.45	0.50	0.41	0.45	0.40	0.13
2003-2006	0.35	0.33	0.30	0.33	0.23	0.21	0.36	0.34	0.31	0.34	0.25	0.23	0.37
2003-2007	0.34	0.32	0.29	0.35	0.26	0.22	0.35	0.33	0.30	0.36	0.27	0.23	0.32
2003-2008	0.46	0.42	0.39	0.45	0.34	0.30	0.45	0.40	0.36	0.43	0.31	0.27	0.30
2003-2009	0.58	0.53	0.49	0.54	0.43	0.40	0.53	0.46	0.42	0.49	0.36	0.33	0.29
2003-2010	0.56	0.52	0.49	0.52	0.43	0.40	0.52	0.46	0.43	0.48	0.37	0.34	0.27
<i>Root mean squared error</i>													
2003	0.39	0.35	0.30	0.35	0.18	0.11	0.45	0.43	0.38	0.37	0.23	0.19	0.26
2004	0.47	0.43	0.39	0.50	0.44	0.39	0.47	0.43	0.39	0.50	0.44	0.39	0.31
2005	0.34	0.33	0.31	0.29	0.17	0.23	0.34	0.33	0.31	0.29	0.17	0.23	0.63
2006	0.46	0.44	0.38	0.47	0.36	0.25	0.46	0.44	0.38	0.47	0.36	0.25	0.45
2007	0.40	0.37	0.36	0.55	0.46	0.32	0.40	0.37	0.36	0.55	0.46	0.32	0.14
2008	1.13	1.00	0.94	1.01	0.79	0.77	0.94	0.78	0.71	0.80	0.53	0.52	0.22
2009	1.54	1.42	1.42	1.23	1.20	1.30	1.27	1.07	1.07	0.95	0.82	0.95	0.27
2010	0.60	0.69	0.73	0.45	0.50	0.49	0.60	0.69	0.73	0.45	0.50	0.49	0.18
2003-2006	0.42	0.39	0.35	0.41	0.31	0.26	0.43	0.41	0.37	0.42	0.32	0.27	0.44
2003-2007	0.41	0.39	0.35	0.44	0.34	0.28	0.43	0.40	0.37	0.45	0.35	0.28	0.40
2003-2008	0.59	0.54	0.50	0.58	0.45	0.40	0.55	0.49	0.44	0.52	0.39	0.33	0.37
2003-2009	0.80	0.73	0.71	0.71	0.62	0.62	0.70	0.60	0.58	0.60	0.47	0.48	0.36
2003-2010	0.78	0.73	0.71	0.68	0.60	0.60	0.69	0.62	0.60	0.59	0.48	0.48	0.34

Sources: Eurostat, Markit, OECD real-time data base, author calculations.

Note: Bold and shaded numbers denote lowest error among the respective row, respectively, lower error than the flash GDP estimate, i.e. PMI-rule outperforming the flash GDP estimate.

Table 6 Quarter-on-quarter real GDP growth nowcast errors of PMI-based rules-of-thumb using quarterly average and flash GDP estimate: Spain (percentage points, second release for 2011Q1 as final GDP data)

Period	10% rule			10%+ rule			asymmetric rule			asymmetric+ rule			Flash GDP
	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	3 & 1½ month
<i>Mean absolute error</i>													
2003	0.63	0.60	0.56	0.35	0.34	0.33	0.71	0.62	0.56	0.46	0.37	0.33	0.17
2004	0.33	0.37	0.38	0.26	0.27	0.27	0.33	0.37	0.38	0.26	0.27	0.27	0.26
2005	0.66	0.66	0.68	0.25	0.25	0.25	0.66	0.66	0.68	0.25	0.25	0.25	0.06
2006	0.37	0.35	0.32	0.14	0.14	0.12	0.37	0.35	0.32	0.14	0.14	0.12	0.13
2007	0.24	0.27	0.31	0.14	0.13	0.13	0.24	0.27	0.31	0.14	0.13	0.13	0.16
2008	0.67	0.68	0.80	0.20	0.20	0.22	1.18	1.24	1.35	0.84	0.90	0.95	0.27
2009	0.21	0.19	0.18	0.43	0.42	0.42	0.53	0.44	0.38	1.24	1.13	1.04	0.09
2010	0.26	0.24	0.18	0.24	0.23	0.21	0.26	0.24	0.18	0.24	0.23	0.21	0.05
2003-2006	0.50	0.49	0.49	0.25	0.25	0.24	0.52	0.50	0.49	0.28	0.26	0.24	0.16
2003-2007	0.45	0.45	0.45	0.23	0.22	0.22	0.46	0.45	0.45	0.25	0.23	0.22	0.16
2003-2008	0.48	0.49	0.51	0.22	0.22	0.22	0.58	0.59	0.60	0.35	0.34	0.34	0.18
2003-2009	0.44	0.45	0.46	0.25	0.25	0.25	0.57	0.56	0.57	0.48	0.46	0.44	0.16
2003-2010	0.42	0.42	0.43	0.25	0.25	0.24	0.53	0.52	0.52	0.45	0.43	0.41	0.15
<i>Root mean squared error</i>													
2003	0.65	0.63	0.60	0.40	0.40	0.40	0.76	0.66	0.61	0.54	0.44	0.40	0.23
2004	0.39	0.42	0.45	0.33	0.34	0.35	0.39	0.42	0.45	0.33	0.34	0.35	0.33
2005	0.67	0.67	0.68	0.26	0.26	0.26	0.67	0.67	0.68	0.26	0.26	0.26	0.07
2006	0.43	0.40	0.36	0.17	0.16	0.15	0.43	0.40	0.36	0.17	0.16	0.15	0.15
2007	0.27	0.31	0.34	0.16	0.15	0.15	0.27	0.31	0.34	0.16	0.15	0.15	0.16
2008	0.68	0.72	0.83	0.27	0.28	0.27	1.27	1.41	1.48	1.19	1.36	1.39	0.32
2009	0.28	0.23	0.20	0.50	0.48	0.47	0.79	0.68	0.58	1.44	1.32	1.20	0.16
2010	0.29	0.27	0.22	0.24	0.24	0.22	0.29	0.27	0.22	0.24	0.24	0.22	0.07
2003-2006	0.55	0.54	0.54	0.30	0.30	0.31	0.58	0.55	0.54	0.35	0.32	0.31	0.22
2003-2007	0.51	0.51	0.51	0.28	0.28	0.28	0.54	0.51	0.51	0.32	0.29	0.28	0.21
2003-2008	0.54	0.55	0.57	0.28	0.28	0.28	0.71	0.74	0.76	0.57	0.62	0.62	0.23
2003-2009	0.51	0.51	0.54	0.32	0.32	0.31	0.72	0.73	0.74	0.76	0.76	0.73	0.22
2003-2010	0.49	0.49	0.51	0.31	0.31	0.30	0.69	0.69	0.69	0.71	0.71	0.69	0.21

Sources: Eurostat, Markit, OECD real-time data base, author calculations.

Note: Bold and shaded numbers denote lowest error among the respective row, respectively, lower error than the flash GDP estimate, i.e. PMI-rule outperforming the flash GDP estimate. 10%+ rule for Spain takes previous real GDP growth into account instead of change in the PMI construction output index.

Table 7 Quarter-on-quarter real GDP growth nowcast errors of PMI-based rules-of-thumb using quarterly average and flash GDP estimate: France (percentage points, second release for 2011Q1 as final GDP data)

Period	10% rule			10%+ rule			asymmetric rule			asymmetric+ rule			Flash GDP
	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	3 & 1½ month
<i>Mean absolute error</i>													
2003	0.26	0.25	0.18	0.22	0.19	0.20	0.24	0.25	0.22	0.20	0.15	0.16	0.25
2004	0.22	0.17	0.15	0.38	0.31	0.23	0.22	0.17	0.15	0.38	0.31	0.23	0.21
2005	0.22	0.23	0.21	0.30	0.30	0.29	0.22	0.23	0.21	0.30	0.30	0.29	0.20
2006	0.35	0.31	0.29	0.41	0.35	0.31	0.35	0.31	0.29	0.41	0.35	0.31	0.11
2007	0.22	0.25	0.26	0.29	0.20	0.17	0.22	0.25	0.26	0.29	0.20	0.17	0.20
2008	0.54	0.49	0.42	0.64	0.60	0.39	0.52	0.44	0.41	0.64	0.56	0.48	0.35
2009	0.50	0.39	0.34	0.27	0.07	0.14	0.41	0.33	0.27	0.31	0.26	0.29	0.16
2010	0.45	0.44	0.42	0.58	0.60	0.56	0.45	0.44	0.42	0.58	0.60	0.56	0.05
2003-2006	0.26	0.24	0.21	0.33	0.29	0.26	0.26	0.24	0.22	0.32	0.28	0.25	0.19
2003-2007	0.25	0.24	0.22	0.32	0.27	0.24	0.25	0.24	0.23	0.32	0.26	0.23	0.19
2003-2008	0.30	0.28	0.25	0.37	0.33	0.26	0.29	0.28	0.26	0.37	0.31	0.27	0.22
2003-2009	0.33	0.30	0.27	0.36	0.29	0.25	0.31	0.28	0.26	0.36	0.31	0.28	0.21
2003-2010	0.35	0.32	0.29	0.39	0.33	0.29	0.33	0.30	0.28	0.39	0.34	0.31	0.19
<i>Root mean squared error</i>													
2003	0.37	0.35	0.29	0.26	0.21	0.21	0.37	0.35	0.30	0.25	0.19	0.18	0.28
2004	0.24	0.21	0.19	0.40	0.33	0.27	0.24	0.21	0.19	0.40	0.33	0.27	0.26
2005	0.26	0.28	0.25	0.31	0.34	0.35	0.26	0.28	0.25	0.31	0.34	0.35	0.26
2006	0.45	0.44	0.43	0.49	0.48	0.44	0.45	0.44	0.43	0.49	0.48	0.44	0.14
2007	0.26	0.30	0.31	0.31	0.22	0.23	0.26	0.30	0.31	0.31	0.22	0.23	0.21
2008	0.67	0.60	0.51	0.65	0.60	0.41	0.58	0.52	0.47	0.70	0.65	0.51	0.36
2009	0.53	0.40	0.36	0.27	0.09	0.16	0.49	0.35	0.27	0.34	0.39	0.38	0.21
2010	0.48	0.46	0.44	0.65	0.65	0.63	0.48	0.46	0.44	0.65	0.65	0.63	0.07
2003-2006	0.34	0.33	0.30	0.38	0.35	0.33	0.34	0.33	0.31	0.38	0.35	0.32	0.24
2003-2007	0.33	0.32	0.30	0.37	0.33	0.31	0.33	0.32	0.31	0.36	0.33	0.31	0.23
2003-2008	0.40	0.38	0.35	0.43	0.39	0.33	0.38	0.36	0.34	0.44	0.40	0.35	0.26
2003-2009	0.42	0.39	0.35	0.41	0.36	0.31	0.40	0.36	0.33	0.42	0.40	0.35	0.25
2003-2010	0.43	0.40	0.36	0.45	0.41	0.37	0.41	0.38	0.35	0.46	0.44	0.40	0.24

Sources: Eurostat, Markit, OECD real-time data base, author calculations.

Note: Bold and shaded numbers denote lowest error among the respective row, respectively, lower error than the flash GDP estimate, i.e. PMI-rule outperforming the flash GDP estimate.

Table 8 Quarter-on-quarter real GDP growth nowcast errors of PMI-based rules-of-thumb using quarterly average and flash GDP estimate: Italy (percentage points, second release for 2011Q1 as final GDP data)

Period	10% rule			10%+ rule			asymmetric rule			asymmetric+ rule			Flash GDP
	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	3 & 1½ month
<i>Mean absolute error</i>													
2003	0.35	0.36	0.33	0.33	0.33	0.32	0.29	0.32	0.29	0.27	0.28	0.28	0.25
2004	0.27	0.24	0.23	0.32	0.25	0.20	0.27	0.24	0.23	0.32	0.25	0.20	0.12
2005	0.27	0.31	0.30	0.31	0.34	0.29	0.27	0.31	0.30	0.31	0.34	0.29	0.22
2006	0.34	0.32	0.32	0.55	0.44	0.39	0.34	0.32	0.32	0.55	0.44	0.39	0.09
2007	0.53	0.52	0.48	0.59	0.46	0.38	0.53	0.52	0.48	0.59	0.46	0.38	0.06
2008	0.76	0.70	0.67	0.72	0.60	0.57	0.53	0.41	0.39	0.49	0.44	0.49	0.30
2009	0.86	0.78	0.77	0.70	0.61	0.63	0.70	0.60	0.60	0.55	0.44	0.45	0.28
2010	0.16	0.18	0.15	0.23	0.27	0.24	0.16	0.18	0.15	0.23	0.27	0.24	0.12
2003-2006	0.31	0.31	0.29	0.38	0.34	0.30	0.29	0.30	0.28	0.36	0.33	0.29	0.17
2003-2007	0.35	0.35	0.33	0.42	0.36	0.32	0.34	0.34	0.32	0.41	0.35	0.31	0.15
2003-2008	0.42	0.41	0.39	0.47	0.40	0.36	0.37	0.35	0.33	0.42	0.37	0.34	0.17
2003-2009	0.48	0.46	0.44	0.50	0.43	0.40	0.42	0.39	0.37	0.44	0.38	0.35	0.19
2003-2010	0.44	0.43	0.41	0.47	0.41	0.38	0.39	0.36	0.34	0.41	0.36	0.34	0.18
<i>Root mean squared error</i>													
2003	0.42	0.40	0.36	0.36	0.34	0.32	0.38	0.36	0.32	0.30	0.29	0.28	0.27
2004	0.32	0.26	0.24	0.33	0.27	0.24	0.32	0.26	0.24	0.33	0.27	0.24	0.12
2005	0.39	0.42	0.39	0.45	0.53	0.46	0.39	0.42	0.39	0.45	0.53	0.46	0.28
2006	0.38	0.36	0.34	0.59	0.51	0.44	0.38	0.36	0.34	0.59	0.51	0.44	0.09
2007	0.55	0.53	0.49	0.68	0.54	0.43	0.55	0.53	0.49	0.68	0.54	0.43	0.08
2008	0.83	0.73	0.70	0.76	0.61	0.57	0.60	0.44	0.44	0.56	0.46	0.49	0.38
2009	1.01	0.94	0.93	0.78	0.75	0.82	0.76	0.66	0.63	0.59	0.47	0.49	0.32
2010	0.22	0.23	0.17	0.27	0.33	0.27	0.22	0.23	0.17	0.27	0.33	0.27	0.13
2003-2006	0.38	0.36	0.34	0.44	0.43	0.38	0.37	0.35	0.33	0.43	0.42	0.37	0.21
2003-2007	0.42	0.40	0.37	0.50	0.45	0.39	0.41	0.40	0.37	0.49	0.44	0.38	0.19
2003-2008	0.51	0.47	0.44	0.55	0.48	0.42	0.45	0.40	0.38	0.50	0.45	0.40	0.23
2003-2009	0.61	0.56	0.54	0.59	0.53	0.50	0.50	0.45	0.43	0.52	0.45	0.41	0.25
2003-2010	0.57	0.53	0.51	0.56	0.51	0.48	0.48	0.43	0.40	0.49	0.44	0.40	0.24

Sources: Eurostat, Markit, OECD real-time data base, author calculations.

Note: Bold and shaded numbers denote lowest error among the respective row, respectively, lower error than the flash GDP estimate, i.e. PMI-rule outperforming the flash GDP estimate.

5. Conclusions

The presented results, which are tentative as they are based on a short sample, show for the first time that simple PMI-based rules-of-thumb have provided not only much earlier signals about the current state of the euro area economy in real time, but also with a similar or even higher accuracy than the first official flash GDP estimate. This conclusion is in particular derived over the period 2003-2007, but even on average for 2003-2010 if one takes into account the change in the PMI construction output put index as well as a different relation in case the PMI composite output index is below 50. This finding implies that for an assessment of the current state of the economy statisticians and analysts might benefit from closely monitoring euro area PMI surveys, which are available well in advance of the flash GDP estimate. In contrast to the euro area, the PMI rules do generally not outperform the flash GDP estimate for the four largest euro area countries, with the main exception of the pre-crisis years in Germany due to a comparatively poor performance of the German flash GDP estimate.

References

- Bañbura, M., Giannone, D. and Reichlein, L., 2010, Nowcasting, European Central Bank Working Paper 1275.
- Gelper, S. and Croux, C., 2010, On the construction of the European Economic Sentiment Indicator, *Oxford Bulletin of Economics and Statistics* 72(1), 47-62.
- Giannone, D., Henry, J., Lalik, M. and Modugno, M., 2010, An area-wide real-time database for the euro area, European Central Bank Working Paper 1145.
- Harris, E.T., 1991, Tracking the economy with the Purchasing Managers' Index, *Federal Reserve Bank of New York Quarterly Review*, Autumn.
- Koenig, E. F., 2002, Using the Purchasing Managers' Index to assess the economy's strength and the likely direction of monetary policy, *Federal Reserve Bank of Dallas Economic and Financial Policy Review* 1(6).
- Massy, C. and Wu, G., 2005, Detecting regime shifts: The causes of under- and overreaction, *Management Science* 51(6), 932-947.
- Lahiri, K. and Monkroussos, G., 2011, Nowcasting US GDP: the role of ISM business surveys, Department of Economics, University at Albany.
- Peláez, R.F., 2003, A Reassessment of the Purchasing Managers' Index, *Business Economics*, October, 35-41.
- Raffinot, T., 2007, A monthly indicator of GDP for euro-area based on business surveys, *Applied Economics Letters* 14(4), 267-270.
- Rossiter, J., 2010, Nowcasting the global economy, Bank of Canada Discussion Paper, 2010-12.
- Vermeulen, P., 2011, On the forecasting relationship between the Purchasing Managers Index and industrial production growth during the financial crisis, Conference Paper.

Appendix Nowcast performance using a logistic transformation

Table A.1 Quarter-on-quarter euro area real GDP growth nowcast errors of PMI-based rules-of-thumb and flash GDP: theoretical correct average of logistic transformation
(percentage points; second release for 2011Q1 as final GDP)

Period	10% rule			10%+ rule			asymmetric rule			asymmetric+ rule			Flash GDP
	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	1 month	2 months	3 months	3 months & 1½ month
<i>Mean absolute error</i>													
2003	0.26	0.23	0.22	0.23	0.19	0.19	0.33	0.30	0.29	0.30	0.26	0.25	0.14
2004	0.10	0.09	0.08	0.14	0.12	0.11	0.10	0.09	0.08	0.14	0.12	0.11	0.08
2005	0.26	0.26	0.25	0.21	0.19	0.17	0.26	0.26	0.25	0.21	0.19	0.17	0.26
2006	0.23	0.21	0.20	0.24	0.19	0.18	0.23	0.21	0.20	0.24	0.19	0.18	0.18
2007	0.17	0.17	0.16	0.20	0.13	0.11	0.17	0.17	0.16	0.20	0.13	0.11	0.11
2008	0.65	0.60	0.59	0.52	0.43	0.43	0.46	0.31	0.31	0.46	0.27	0.27	0.27
2009	0.77	0.69	0.69	0.58	0.50	0.52	0.29	0.24	0.26	0.23	0.14	0.19	0.08
2010	0.20	0.22	0.22	0.20	0.21	0.19	0.20	0.22	0.22	0.20	0.21	0.19	0.05
2003-2006	0.21	0.20	0.19	0.21	0.17	0.16	0.23	0.21	0.20	0.22	0.19	0.18	0.16
2003-2007	0.20	0.19	0.18	0.20	0.17	0.15	0.22	0.21	0.20	0.22	0.18	0.16	0.15
2003-2008	0.28	0.26	0.25	0.26	0.21	0.20	0.26	0.22	0.21	0.26	0.20	0.18	0.17
2003-2009	0.35	0.32	0.31	0.30	0.25	0.24	0.26	0.22	0.22	0.25	0.19	0.18	0.16
2003-2010	0.33	0.31	0.30	0.29	0.25	0.24	0.25	0.22	0.22	0.25	0.19	0.18	0.15
<i>Root mean squared error</i>													
2003	0.33	0.30	0.29	0.28	0.23	0.23	0.39	0.36	0.35	0.34	0.29	0.28	0.19
2004	0.13	0.12	0.11	0.19	0.15	0.13	0.13	0.12	0.11	0.19	0.15	0.13	0.11
2005	0.30	0.30	0.29	0.30	0.27	0.25	0.30	0.30	0.29	0.30	0.27	0.25	0.29
2006	0.23	0.21	0.21	0.26	0.22	0.21	0.23	0.21	0.21	0.26	0.22	0.21	0.19
2007	0.21	0.21	0.20	0.22	0.15	0.13	0.21	0.21	0.20	0.22	0.15	0.13	0.12
2008	0.74	0.66	0.66	0.64	0.53	0.52	0.50	0.36	0.35	0.47	0.33	0.32	0.27
2009	0.91	0.83	0.83	0.67	0.60	0.63	0.36	0.27	0.31	0.28	0.27	0.28	0.10
2010	0.22	0.24	0.23	0.27	0.27	0.25	0.22	0.24	0.23	0.27	0.27	0.25	0.07
2003-2006	0.26	0.24	0.24	0.26	0.22	0.21	0.28	0.26	0.26	0.28	0.24	0.23	0.21
2003-2007	0.25	0.24	0.23	0.25	0.21	0.20	0.27	0.25	0.25	0.27	0.22	0.21	0.19
2003-2008	0.38	0.35	0.34	0.35	0.29	0.28	0.32	0.27	0.27	0.31	0.25	0.23	0.21
2003-2009	0.49	0.45	0.45	0.41	0.35	0.35	0.32	0.27	0.27	0.31	0.25	0.24	0.20
2003-2010	0.47	0.43	0.42	0.40	0.34	0.34	0.31	0.27	0.27	0.30	0.25	0.24	0.19

Sources: Euro area real-time data base, Eurostat, Markit, ECB calculations.